Performance of two plantain cultivars during the first months after establishment.

A comparison between their development, productivity and performance under grazing.

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Cover picture: http://agricom.com.au/products/herbs/plantain/tonic/

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Introduction

Herbs naturally occur in pastures all over the world. In the past some of those herbs were seen as a valuable and healthy addition to the livestock diet. Nowadays, herbs are hardly seen in conventional pastures anymore. Only in organic livestock farming they are still used, although on a small scale, with the aim to reduce the input of external minerals and antibiotics (Rumball et al., 1997; Van Eekeren et al., 2006). In many temperate conventional livestock areas pastures are dominated by two species, namely the highly productive perennial ryegrass (*Lolium perenne)* and the legume white clover (*Trifolium repens)* (e.g. Kemp et al., 2002; Lantinga et al., 2004). White clover is often added to the sward for his nitrogen fixing ability and in order to increase the feed quality of the forage (Ramirez-Restrepo & Barry, 2005). However, in recent decades the use of pasture herbs regained attention in Britain and New Zealand and in recent years also in the Netherlands (Rumball et al., 1997; Geerts et al., 2014). Especially in Britain and New Zealand much research is done at pasture herbs. In New Zealand pasture herbs, like chicory (*Chichorium intybus*) and plantain (*Plantago lanceolota*), are sown in a mixture with perennial ryegrass and white clover at an increasing scale (Moorhead & Piggon, 2009; Cranston et al., 2015).

The increased attention in pasture herbs is mainly based on the high mineral content and the presence of secondary chemicals in herbs, thereby contributing to the health of the livestock (Foster, 1988; Rumball et al., 1997; Harrington et al., 2006; Geerts et al., 2014). It is shown that plantain and dandelion (*Taraxacum officinale*) improve the functioning of the kidneys due to the high content of secondary metabolisms (Geerts et al., 2014; Rumball et al., 1997). Due to the high mineral content of many herbs they can also contribute to the prevention of cattle diseases like milk fever and grass tetany, and to a reduction in the use of antibiotics (Sanderson et al., 2003; Wagenaar, 2012). Another important reason for including herbs in pastures could be the environmental aspect. Including herbs in the livestock diet is shown to substantially reduce the methane emissions by livestock, especially if the condensed tannin content in the herbs is high (Ramirez-Restrepo & Barry, 2005). Besides, it is also reasoned that including herbs in pastures can increase the nitrogen uptake efficiency on field level. The difference in root morphology and rooting depth of herbs compared to grasses increases the total root surface, thereby capturing more nitrate resulting in lower run off and leaching losses (Høgh-Jensen et al. 2006; Deru et al., 2010). Although research at this aspect is limited, it can gain importance as environmental regulations are or will be tightened in several temperate regions around the world (Schroder et al., 2007; Jay, 2007).

In addition, from the production perspective pasture herbs can also have large economic advantages. Yield of herb pastures is found to be equal or even higher than perennial ryegrass based pastures in New Zealand, having a higher performance especially during summer (Li & Kemp, 2005; Powell et al., 2007; Moorhead & Piggot, 2009). This is mainly caused by the relatively high drought tolerance of several herbs compared to grasses (Van Eekeren et al., 2006; Powell et al., 2007). It is also shown that the implementation of high quality legume herb forage in livestock systems can result in an increase in the milk production of ewes and dairy cows (Li & Kemp, 2005; Kemp et al., 2010). In addition, lamb growth rates of above 220 g live weight/day have been found in lambs grazing on herb pastures in New Zealand (Kerr, 2000; Moorhead et al., 2002). This was an increase of almost 70% in the daily live weight gain of lambs compared to lambs grown on regular perennial ryegrass based pastures. Lambs are thereby growing faster to their slaughter weight when foraging on herb-rich pastures, resulting in large economic advantages. This positive effect of pasture herbs on growth and milk production is mainly caused by the higher feeding value and the higher voluntary daily intake of herb-rich forage (Kemp et al., 2010).

These findings indicate that pasture herbs like chicory and plantain can play an important role in pasture systems in temperate regions, regarding both the environmental and the economic perspective. However, potential disadvantages need to be overcome. Pasture herbs can have a poor persistency, especially under grazing, and therefore often require adaptions to grazing management (Kemp et al., 2010). In contrast to chicory, which first cultivar was already released in 1985, not much research is done at plantain (Rumball et al., 1997; Powell et al., 2007). In most parts of the world it is still regarded as a pasture weed unless the fact that in recent years breeding has resulted in the establishment of uniform and productive cultivars (Rumball et al., 1997). It is therefore important to do more research at plantain, as it is next to chicory one of the most promising pasture herbs. Early research showed that plantain is a deep rooting species with a high palatability and drought resistance (Foster, 1988).

In 1993 Grassland Lancelot's plantain was the first cultivar that was given Plant Breeder Rights in New Zealand (Rumball et al., 1997). In the late 1990's a new well performing variety was set on the market, namely Tonic. This variety has a high production and is by far the most used variety of plantain around the world (Kemp, pers. comm.). Erelong, a new cultivar called '742' will be introduced on the market. In this research the performance of Tonic and this new variety of plantain will be compared under field conditions. Development during establishment and performance under two different grazing frequencies will be investigated. This objective led to the following research questions:

- Which plantain variety, Tonic or '742', has the highest performance under field conditions?
    - What is the performance during early establishment of Tonic and '742' plantain, regarding shoot and root growth?
    - What is the effect of grazing frequency on the performance of Tonic and '742'plantain?
    - What are the differences in mineral and secondary chemical content between Tonic and '742' plantain?

Based on breeder information it can be expected that 742 plantain will develop a higher number of shoots, whereas it is expected that Tonic develops taller leaves. It is therefore difficult to predict which cultivar will have the highest biomass production. In addition, knowledge about the effect of grazing frequency on the performance of 742 compared to Tonic plantain is not known yet. This will therefore be investigated in this research project.

Methods

Study site and data collection

The experiment was carried out on the Massey University Pasture and Crop Research Unit on the No. 1 Dairy farm in Palmerston North (New Zealand). Annual precipitation in Palmerston North is 967 mm. The average annual temperature is 13.3 °C, ranging from 9.1 °C in June till 18.3 °C in February (NIWA, 2015). The soil is a Manawata silt loam over sand with a pH of 5.7 (Powell et al., 2007). The design of the experiment was a randomized complete block design, with grazing frequency as treatment. The experimental fields consist of four blocks, each containing four plots of 4.5 by 7 meters. In order to create a good seed bed the experimental fields were ploughed and power-harrowed before seeding. The seed mixture consisted of one of the two plantain varieties, added with white (*Trifolium repens*, Relish) and red clover (*Trifolium pratense*, Tribute). Red clover was added because of the high summer performance, thereby ensuring nitrogen fixation during this period. The seed densities were 8 kg/ha for plantain, 6 kg/ha for red clover and 4 kg/ha for white clover. Sowing took place on the 20th of October. The plots received Cropmaster 15 as a NPK start fertilizer at an application rate of 250 kg/ha after seeding. The plots were irrigated with a pivot on the 5th and 17th of November to prevent drought damage.

Performance of the two plantain varieties was followed during establishment. In every plot 10 individual plantain plants (160 individuals in total) were randomly selected and followed over time. The number of true leaves were counted, and the leaf width and length of the respectively broadest and longest true leaf were measured weekly. True leaves were divided in 4 classes, from ¼ till fully developed. A leaf is regarded as fully developed if it has a defined neck at the base of the leaf. During the first weeks after seeding plant density was measured every week. In every plot plant density was measured at three randomly chosen transects of 1 meter. Besides, 10 plantain individuals were randomly selected from every plot to determine the root biomass and the taproot length and width. Root sampling was done on the 3rd of December and 4th of January. In this way the root development of the two plantain varieties could be followed over time and compared. A fast development of roots is important, as it could increase the resistance to perturbations like drought and grazing in an early stage.

Grazing was simulated by mowing the plots with a loan mower at a height of 7.5 cm, which is the recommended mowing and grazing height for plantain (Cranston et al., 2015). Half of the plots were mown every 2 weeks whereas the other half of the plots were mown every 4 weeks. Grazing started at the 8th of December. At this date circa five true leaves were present, which is slightly lower than the recommended six leaves by Powell et al.. The presence of six true leaves would indicate that root development is sufficient to survive grazing and to ensure a fast recovery (Powell et al. 2007). Before mowing the sward height of the plots was measured by taking 20 measurements in each plot using a vegetation disk (Hutchings, 1991), and two biomass samples of plantain were taken from squares of 0.1 m^2 within every plot. Biomass samples were cut with an automatic scissor at a height of 5 cm. Before cutting the plantain plant density in the 0.1 m^2 quadrates was determined. In this way biomass production per individual plant could be calculated. Samples were not taken at the edge of the plots, in order to exclude potential edge effects. Taking biomass samples will give an indication of the productivity and the effect of grazing frequency on the performance of both varieties. Besides, leaves of the two varieties were analysed to determine their macro- and micronutrient, and secondary chemical content. The analysis of the nutrient content was done by

Hill laboratories. Leaf samples were oven dried at 70 °C before analysing. Nitrogen content was determined with the Dumas combustion method, all the other nutrient levels were determined by Nitric acid/ Hydrogen Peroxide digestion. To determine the secondary metabolites content leaf samples were put in the freezer before analysing.

Data analysis

Data was analysed in SPSS statistics 2.0. The number of leaves, leaf size, biomass production and biomass production after grazing of the two plantain varieties were compared. For all parameters the data followed a normal distribution. Therefore an ANOVA was carried out to compare the difference in biomass production, plant density, height, mineral content and regrowth of the two plantain varieties under the two grazing frequencies. In this case the plant performance indicators were the dependent variable, and the plantain varieties, grazing frequency and blocks were the factors. It was assumed that there are no interactions with blocks. In the case of significant differences a LSD posthoc multiple comparison was carried out. The development of leaves was followed over time and therefore included repeated measurements at the same individuals. This data was therefore analysed with a linear mixed model, with leaf performance as dependent variable, and plantain variety, grazing frequency, block and measure date as factor.

Results

Individual performance

The first part of the experiment included the development of individuals over time. The number of shoots, leaf height and leaf width were weekly measured. All data followed a normal distribution and equal variances were assumed.

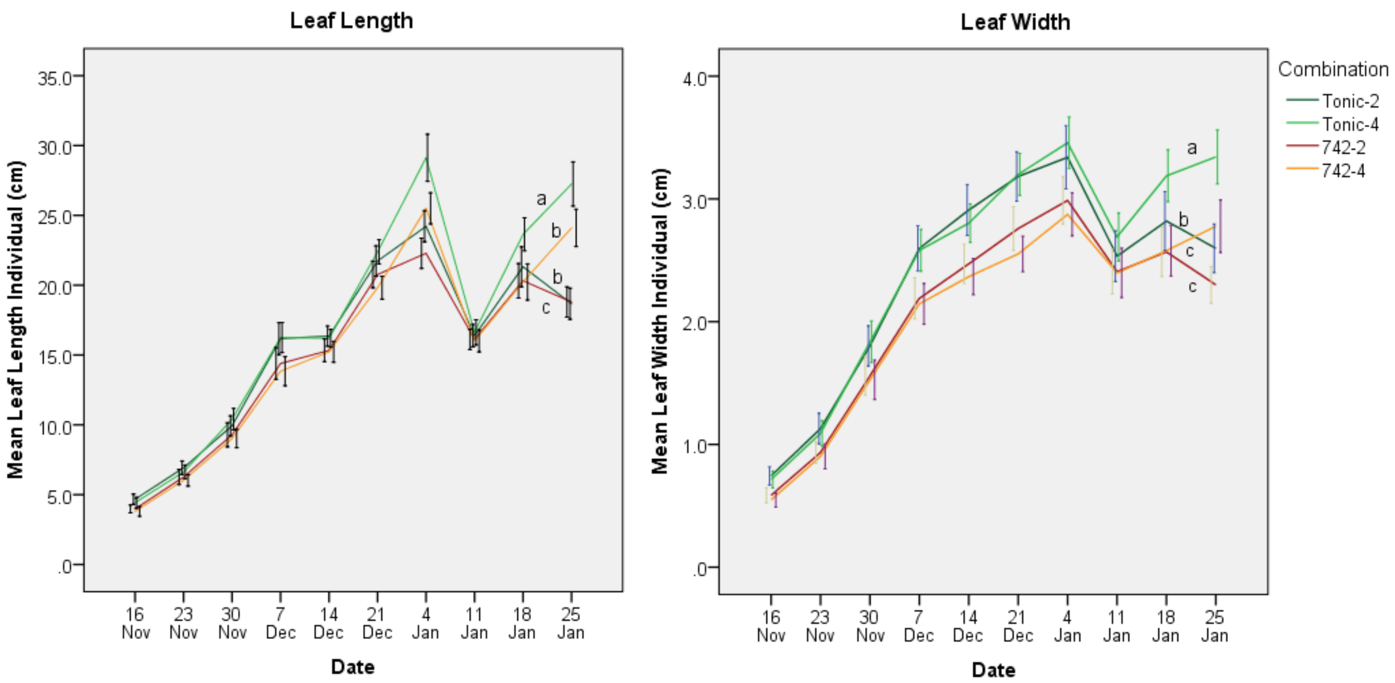


Figure 1 a. Leaf length (cm) development of Tonic and 742 plantain individuals under a 2 weekly (Tonic-2 and 742-2) and a 4 weekly grazing rotation (Tonic-4 and 742-4). b. Leaf width (cm) development over time of Tonic and 742 plantain individuals under a 2 and 4 weekly grazing rotation.

Grazing took place at 8th of December (all plots), 22nd of December (half of the plots), 6th of January (all plots), 20th of January (half of the plots) and 2nd of February (all plots). There was a block effect for leaf length, leaf width and the average number of leaves per individual. Both leaf height and leaf width were larger for Tonic ($F_{1,1155}$=88.9, p<0.001; $F_{1,705.9}$=155.15, p<0.001) (Figure 1a, 1b). On average Tonic leaves were 1.54 cm longer and 0.43 cm wider than 742 leaves. Grazing frequency had a significant effect on leaf growth ($F_{1,1155}$= 57.25, p<0.001). Plantain in a 4 weekly rotation logically had a higher leaf length, however for Tonic it also seemed that regrowth after mowing was faster in a 4 weekly grazing rotation (figure 1a). In contrast grazing frequency didn't have a significant effect on leaf width development. Leaf width was not influenced by grazing during the first weeks of the grazing trial (figure 1b), it only decreased after grazing on the 4th of January. After this stage differences in leaf width between the two grazing frequencies were emerging with both Tonic and 742 plantain having significantly wider leaves under a 4 weekly grazing rotation on the 28th of January ($F_{1,15.28}$=18.9, p<0.001) (figure 1b). The average number of leaves per individual was higher at 742 plantain individuals ($F_{1, 452}$=4.939, p=0.027) (figure 2), which on average established 2.33 more leaves than Tonic. This difference in the number of true leaves was increasing over time ($F_{9,261}$=3.885, p<0.001), but was not influenced by grazing frequency.

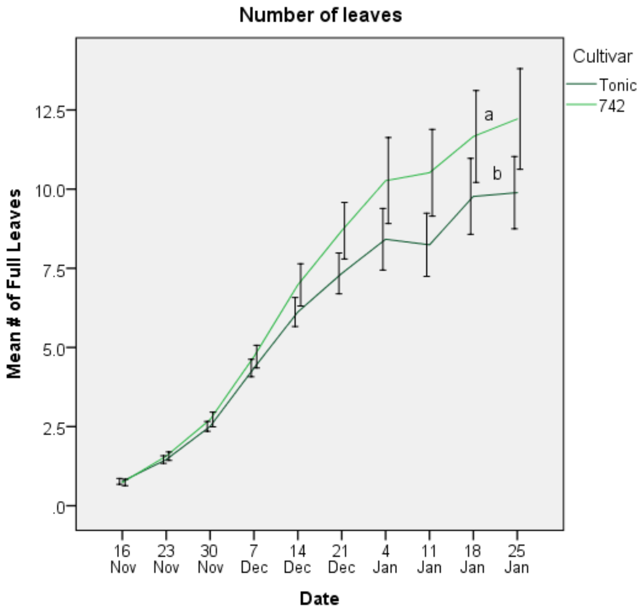


Figure 2. The mean number of full leaves per plantain individual of Tonic and 742 plantain.

Plot performance

There were no significant differences between the plant densities of the two cultivars (figure 2). Plantain density was highest at the start of the experiment (figure 2). Three weeks after seeding, on the 10th of November, the average density was 38 plants per transect of 1 meter. Plantain density significantly decreased after the 17th of November ($F_{6,3435.1}$=4.13; p=0.032). However, plant density of especially 742 plantain seems to increase, although not significantly, after the 15th of December which was after the start of the grazing treatment.

Every time before mowing the plot height was measured with a vegetation disk. The first measurements were carried out on the 8th of December, prior to mowing, giving the average plot

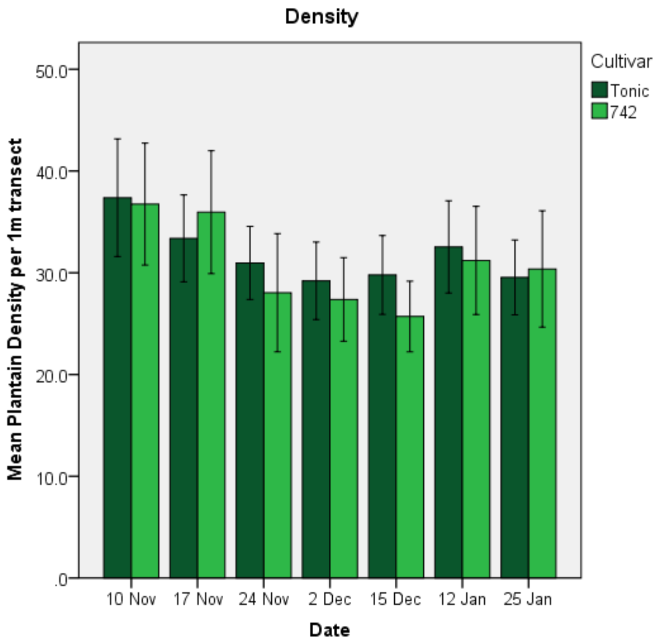


Figure 3. Mean plantain density per 1 meter transect for Tonic and 742 plantain.

height at the start of the grazing trial. Till the 18th of December no effect of grazing frequency could therefore be observed, as all plots were mown at the first grazing round. At the 8th and 18th of December a cultivar effect was observed ($F_{1,33}$=7.25; p=0.012; $F_{1,3.65}$=5.515; p=0.027), with Tonic having a higher plot height than 742 (figure 4). Although there was a cultivar effect this didn't result in a treatment effect. There were no significant differences between the four treatments. At the third grazing round at the 5th of January both a grazing frequency and a cultivar effect were observed ($F_{1,103}$=21.21, p=<0.001; $F_{1,488}$=100.78, p=<0.001) (figure 4). Tonic had a significantly higher plot height than 742 plantain in the 4 weekly grazing rotation, whereas in the 2 weekly rotation there was no significant difference between the two cultivars. At the 19th of January, 2 weeks after all plots were mown, no effect of grazing frequency could be observed (figure 4). Plots with a 4 weekly grazing frequency didn't recover significantly faster than plots with a more intensive grazing frequency. At the 28th of January again both a grazing frequency and a cultivar effect were observed ($F_{1, 45.36}$=15.932; p=0.001; $F_{1,823}$=289.11; p<0.001). Besides there was an interaction between grazing frequency and cultivar ($F_{1,30.23}$= 10.62; p=0.003). Both cultivars performed different under the two grazing frequencies, indicating that there is a combined effect of cultivar and grazing frequency on the performance of plantain. The difference between the two cultivars is disproportional higher under a 4 weekly grazing rotation. There were no differences between Tonic and 742 plantain in the 2 weekly grazing rotation, whereas in the 4 weekly rotation Tonic had a higher sward height (figure 4).

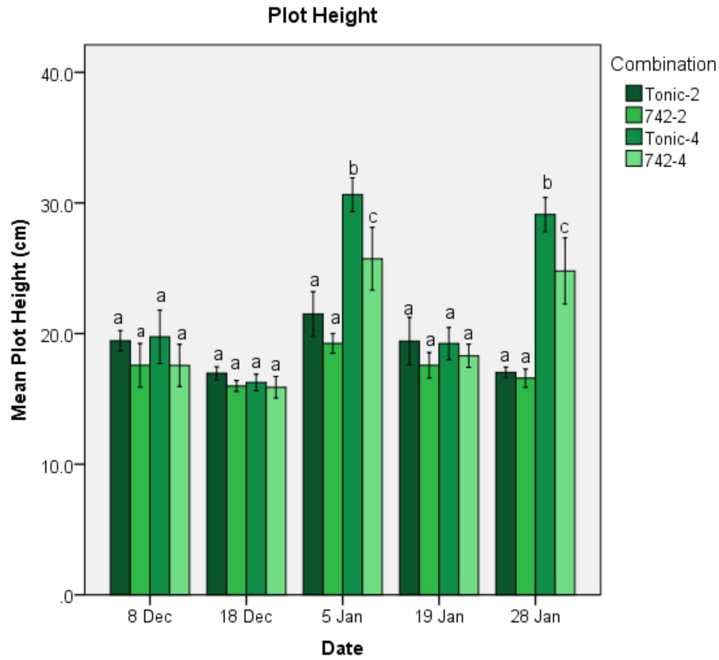


Figure 4. The effect of grazing frequency and cultivar on plot height over time

On a two weekly basis biomass samples were taken prior to mowing (figure 5a). After the first biomass sampling all plots were mown. After the second biomass sampling half of the plots, only the plots with a 2 weekly grazing frequency, were mown. Within the first biomass sample round therefore no effect of grazing frequency could be observed. On all dates there was a cultivar effect, with Tonic having a higher biomass production than 742 plantain in all cases. Logically a 4 weekly grazing frequency resulted in a higher biomass harvest at the 5th of January, as those treatment plots were not mown at the previous round. Tonic had a higher biomass production in the 4 weekly treatments ($F_{3,1793}$=11.53; p<0.001), whereas there were no significant differences between the two cultivars in the 2 weekly grazing treatments (Figure 5a). On the 18th of January, 2 weeks after all the plots were mown, Tonic with a 4 weekly grazing rotation had the highest biomass production. However, the difference in biomass production between the two grazing frequencies didn't differ significantly.

If you look at the cumulative biomass production over a period of 4 weeks, there are no differences in production between a 2 and a 4 weekly grazing frequency (figure 5b). For 742 the biomass production under a 2 weekly grazing period seems to be slightly higher, although the difference is not significant.

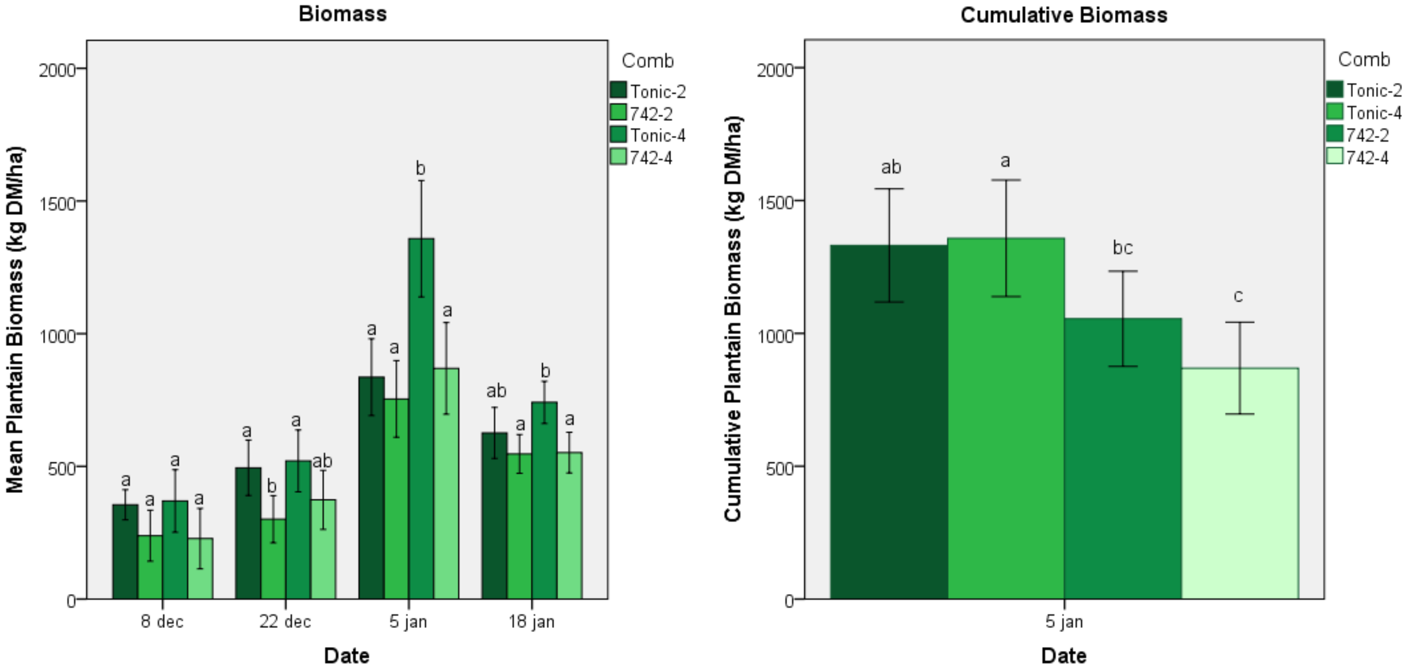


Figure 5a. Average biomass production during four moments of time of Tonic and 742 plantain under a 2 and 4 weekly grazing frequency. b. Cumulative biomass production of Tonic and 742 plantain under a 2 and 4 weekly grazing frequency on the 5th of January.

Root performance

At two moments in time root samples were taken. The first sampling date was at the 8th of December. At this time there were no differences in rooting depth, root width and (tap)root biomass between the two cultivars (figure 6a,b, and 7a,b). The second root sampling date was at the fifth of January. At this stage grazing frequency didn't have a significant effect on root length, root width and (tap)root biomass. Tonic had longer roots than 742 plantain ($F_{1, 68}$=11.55, p=0.001) (figure 6a). For root width there were no differences between the two cultivars, although the average root width of Tonic was higher than 742 plantain (figure 6b). Tonic had a higher taproot biomass than 742 on the 5th of January ($F_{1, 0.062}$=10.48; P=0.003) (figure 7a). For total root biomass there was no significant difference between Tonic and 742 (figure 7b).

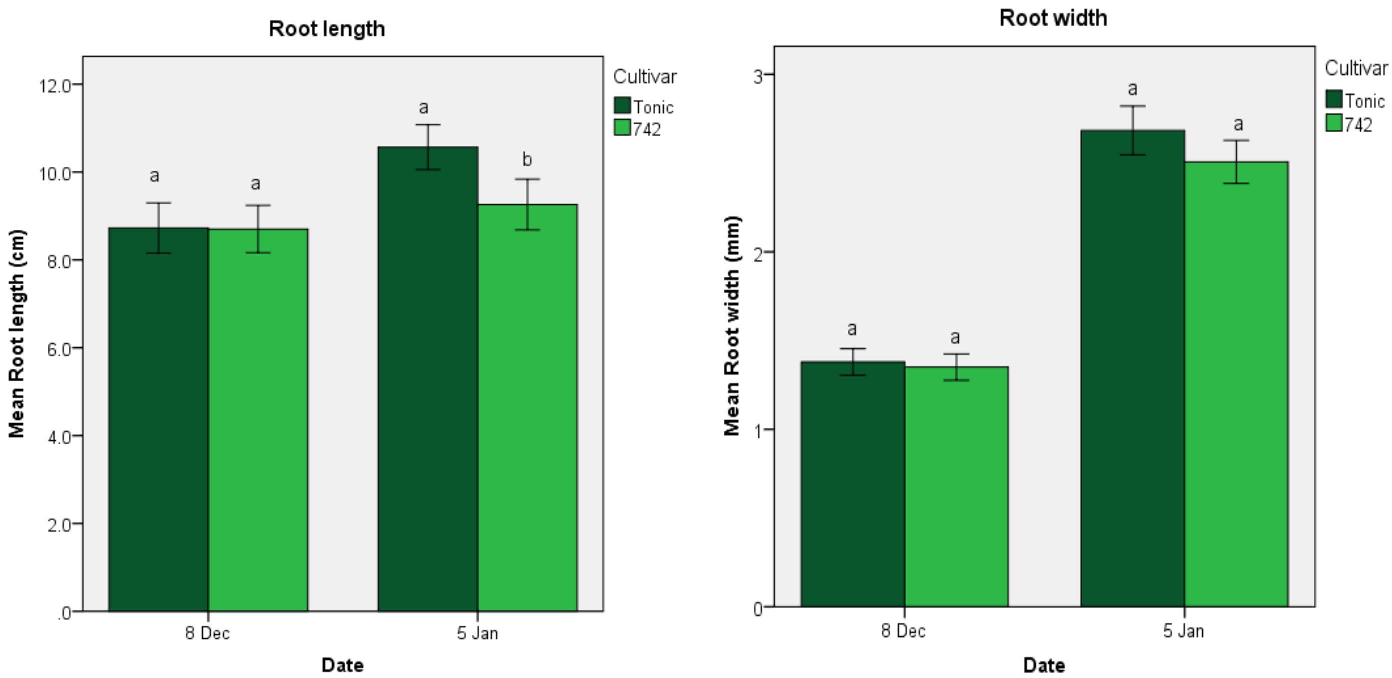


Figure 6.a. The average root length (cm) for Tonic and 742 plantain on the 8th of December and the 5th of January. b. The average root width (mm) of Tonic and 742 plantain on the 8th of December and the 5th of January.

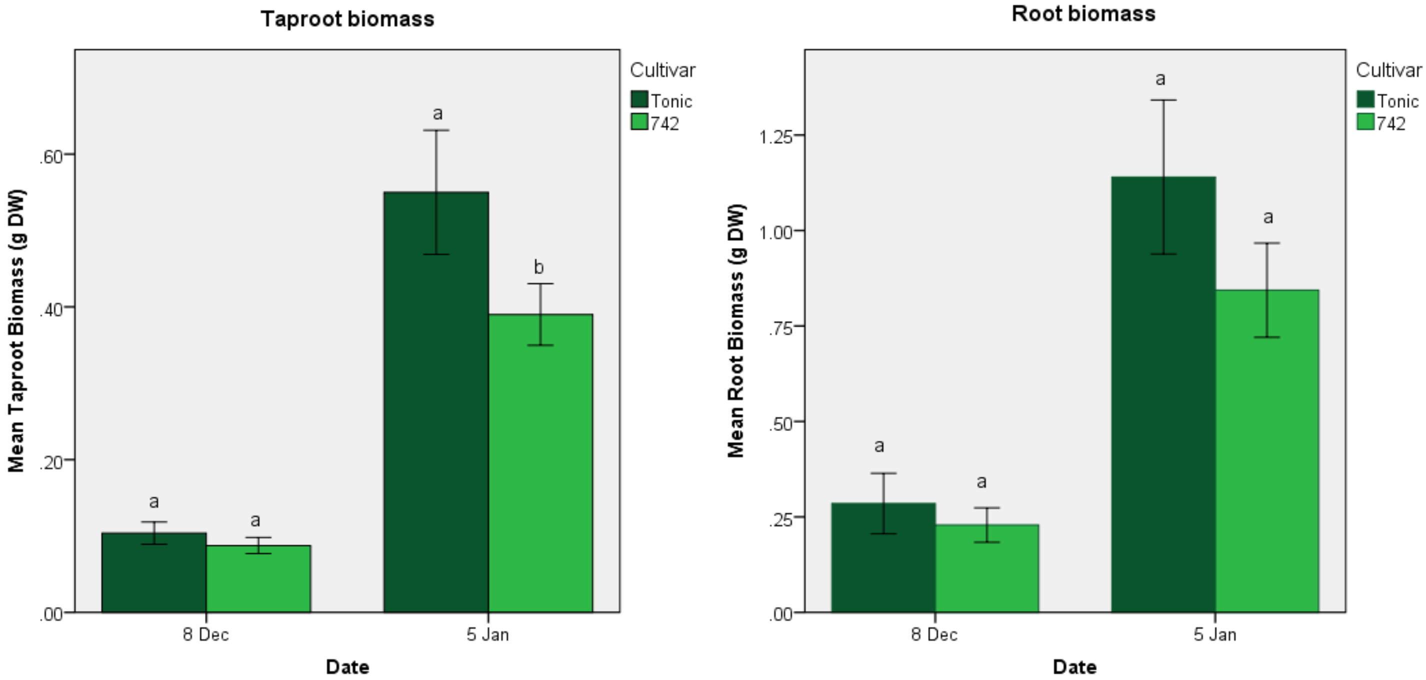


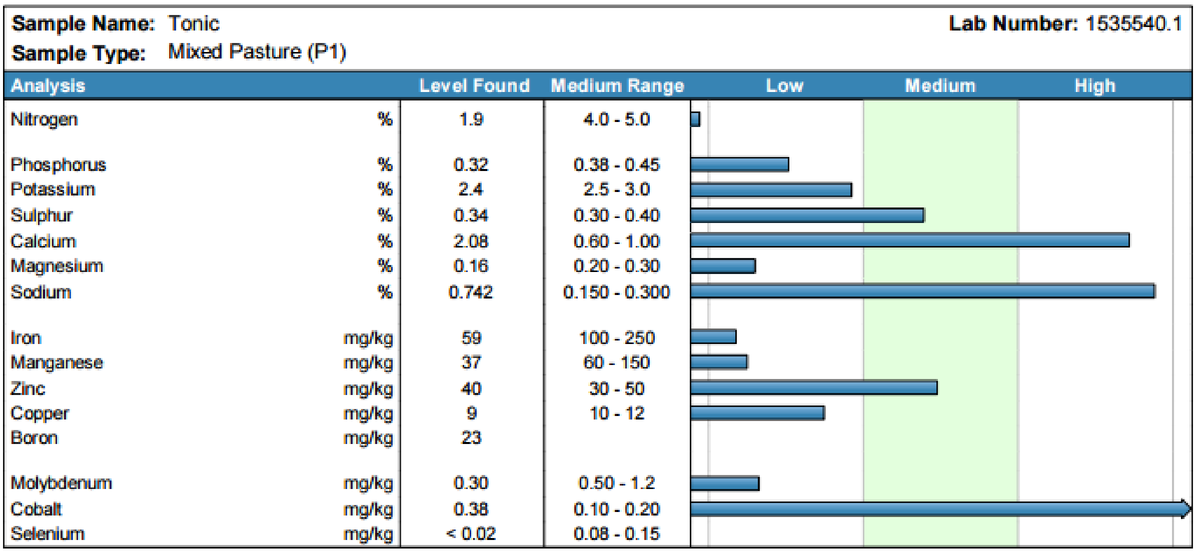
Figure 7ab. The average taproot (a) and root (b) biomass of Tonic and 742 plantain on the 8th of December and the 5th of January.

Mineral and secondary chemical content

Tonic has a higher calcium, sodium, iron, copper and cobalt content and a lower nitrogen, phosphorus, potassium, sulphur, manganese, zinc, boron and molybdenum content than 742 plantain (figure 1a, 1b). The two cultivars were equal in their magnesium content. Both cultivars are high in calcium, sodium and cobalt content, whereas they have a low nitrogen, phosphorus, potassium, magnesium, iron , manganese, copper, molybdenum and selenium content. If you compare both cultivars on their secondary chemical content, 742 plantain has a higher catapol, aucubin and acteoside content (table 1).

Table 1. Catapol, aucubin and acteoside content of Tonic and 742 plantain leaves.

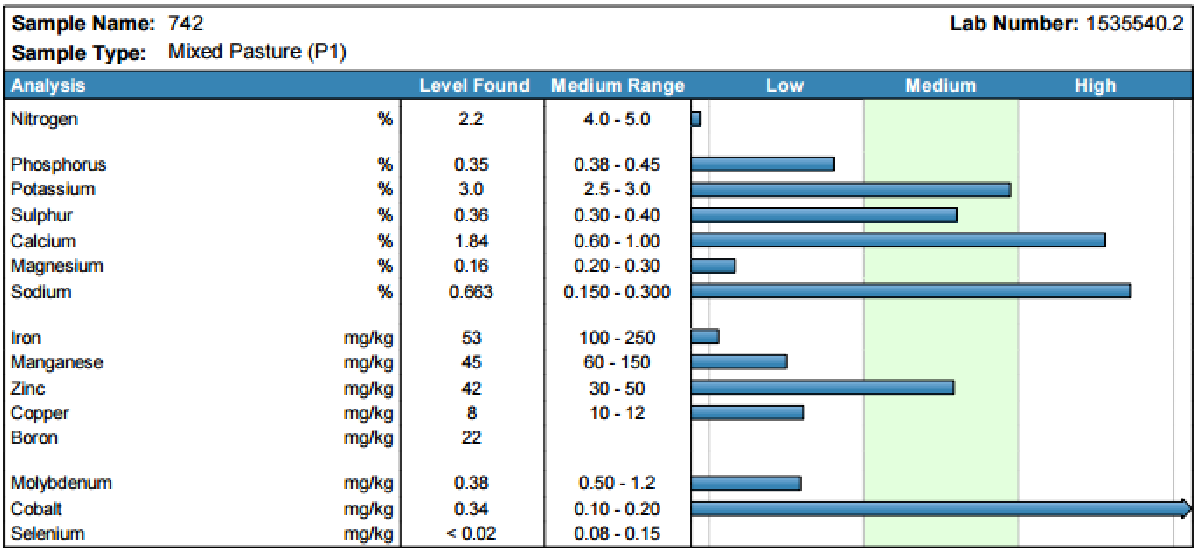
	Catapol (mg/g)	Aucubin (mg/g)	Acteoside (mg/g)
Tonic	0.11	3.58	9.64
742	0.29	6.46	15.60



Sample Name: Tonic — Lab Number: 1535540.1
Sample Type: Mixed Pasture (P1)

Analysis		Level Found	Medium Range
Nitrogen	%	1.9	4.0 - 5.0
Phosphorus	%	0.32	0.38 - 0.45
Potassium	%	2.4	2.5 - 3.0
Sulphur	%	0.34	0.30 - 0.40
Calcium	%	2.08	0.60 - 1.00
Magnesium	%	0.16	0.20 - 0.30
Sodium	%	0.742	0.150 - 0.300
Iron	mg/kg	59	100 - 250
Manganese	mg/kg	37	60 - 150
Zinc	mg/kg	40	30 - 50
Copper	mg/kg	9	10 - 12
Boron	mg/kg	23	
Molybdenum	mg/kg	0.30	0.50 - 1.2
Cobalt	mg/kg	0.38	0.10 - 0.20
Selenium	mg/kg	< 0.02	0.08 - 0.15

Figure 8a. Macro- (%) and micronutrient (mg/kg) content of Tonic plantain leaves.



Sample Name: 742 | Lab Number: 1535540.2
Sample Type: Mixed Pasture (P1)

Analysis		Level Found	Medium Range
Nitrogen	%	2.2	4.0 - 5.0
Phosphorus	%	0.35	0.38 - 0.45
Potassium	%	3.0	2.5 - 3.0
Sulphur	%	0.36	0.30 - 0.40
Calcium	%	1.84	0.60 - 1.00
Magnesium	%	0.16	0.20 - 0.30
Sodium	%	0.663	0.150 - 0.300
Iron	mg/kg	53	100 - 250
Manganese	mg/kg	45	60 - 150
Zinc	mg/kg	42	30 - 50
Copper	mg/kg	8	10 - 12
Boron	mg/kg	22	
Molybdenum	mg/kg	0.38	0.50 - 1.2
Cobalt	mg/kg	0.34	0.10 - 0.20
Selenium	mg/kg	< 0.02	0.08 - 0.15

Figure 8b. Macro- (%) and micronutrient (mg/kg) content of 742 plantain leaves.

Discussion

Leaf performance

Based on breeder information it was expected that Tonic would have taller and wider leaves. This is in line with the results of this experiment. Over time Tonic had consistently taller and wider leaves than 742 plantain. Tonic plots were also significantly higher than 742 plots. Based on breeder information it could also be expected that 742 had a higher number of shoots, which was also the case in this experiment. At the last measurement date 742 had on average 2 more full leaves than Tonic. However, this didn't result in a higher biomass production. Tonic plantain was more productive than 742 during the whole experiment. However, from figure 2 it can be seen that the difference in shoot numbers between the two cultivars is increasing over time. Over longer time periods this could therefore result in a higher biomass production of 742 plantain, as in this experiment measurements were only done during the first three months after establishment. In addition, a higher number of shoots results in the development of a denser sward resulting in a greater grazing persistence.

Root performance

Tonic had a longer main root and a higher main root biomass than 742 plantain. This has probably contributed to the higher above ground performance of Tonic. A higher root biomass could have resulted in a better and higher uptake of resources, resulting in a faster growth. The difference in root performance could be a result of a faster root development during early establishment, resulting in a higher plant performance during the entire experiment.

Grazing frequency

Biomass production between the two grazing frequencies was compared by calculating the cumulative biomass production (figure 5a). At this stage there was no significant effect of grazing frequency on the cumulative biomass production. However, data indicates that leaf recovery is affected by grazing frequency. Leafs in a 4 weekly grazing rotation recovered faster than leaves from plantain individuals in a 2 weekly grazing rotation (figure 1a). Grazing didn't have an effect on leaf width at the start of the trial. Leaf width kept increasing till the 5th of January. This could be explained by the fast development of new leaves after mowing. However, after the 5th of January leaf width decreased. It could be that frequent mowing resulted in a depletion of the root reserves, resulting in a slower recovery. From the mineral analysis it can be seen that both Tonic and 742 plantain leaves were relatively low in nitrogen and phosphorous (figure 8a,b), indicating a possible shortage. A possible effect of grazing frequency on recovery can also be seen from figure 1a and 1b. Tonic leaves seem to have a higher recovery, resulting in a higher leaf length and width two weeks after mowing.

Mineral and secondary chemical content

Comparing 742 plantain and Tonic on their mineral content, 742 had a higher N,P,K content, whereas Tonic contained more calcium, sodium, iron and cobalt, thereby having a larger contribution to the prevention of milk fever and grass tetany (Sanderson et al., 2003). The higher N,P, K content implies that 742 plantain has a higher feeding value for livestock than Tonic, which is in line with the expectations based on breeder information. However, differences in mineral content between the two cultivars were relatively small. In this experiment both cultivars were low in their N and P content. Previous research carried out in New Zealand showed an N content of 3.37% and a P content of 0.48% in Tonic leaves (Harrington et al., 2006), compared to 1.9% N and 0.32% P found for Tonic in this research. During seeding a NPK start fertilizer was applied, however it could be that this was not sufficient if the soil was already low in nitrogen and phosphorous. Unfortunately soil samples still need to be taken, whereas it is not possible to confirm this suggestion. Based on previous research it is known that plantain has a high calcium, magnesium, phosphorous, cobalt, zinc and sodium content (e.g. Stewart, 1996; Wilman and Riley, 1993). In this research both Tonic and 742 plantain were high in calcium, cobalt, zinc and sodium. The content of magnesium, phosphorous were lower than what would be expected, whereas the potassium content was higher.

The secondary chemical content was higher in 742 plantain, which had a higher aucubin, acteoside and catapol content. A high secondary chemical content will improve the N-utilization in the livestock. However, compared to other research the aucubin and catapol content found in this research is low. Ramirez-Restrepo and Barry found a catapol content of 8 mg/g DM and a aucubin content of 22 mg/g DM, compared to a catapol content of 0.29 mg/g DM and an aucubin content of 6.46 mg/g DM for 742 plantain in this research. The two plantain cultivars had, compared to previous research by Fajer et al., also a low acteoside content, 0.96% of the dry matter content of Tonic and 1.56% of 742 consist of acteoside. Fajer et al. found an acteoside content of 9% for the plantain cultivar Lancelot. Acteoside acts as an antioxidant, having strong antimicrobial effects, which can improve the health of the livestock (Andary et al. 1982). From aucubin and catapol it is known that they have chemical defence properties in the plant. The low secondary metabolite content found in this research could possibly be explained by the young age of the plants and the high number of young leaves. The high grazing frequency results in a relatively fast replacement of leaves. It is known that the secondary chemical content in leaves increases with leaf age.

Conclusion

In general Tonic is a better performing cultivar than 742 plantain. Tonic has wider and longer shoots, resulting in a larger biomass production during the entire experiment. Although 742 plantain had a higher number of shoots this didn't result in a higher biomass production compared to Tonic. However, due to the higher number of shoots it can be expected that 742 plantain will develop a greater grazing persistence than Tonic. At this stage grazing frequency didn't have a significant effect on the cumulative biomass production of Tonic and 742 plantain, although individual leaf recovery seemed to be higher at a 4 weekly grazing frequency. Root biomass and (tap) root length was higher for Tonic, which probably has contributed to the faster growth of Tonic. The macro and micro nutrient composition slightly differed between the two cultivars, with 742 plantain having a higher nitrogen, phosphorus and potassium content and Tonic a higher calcium, sodium, iron and cobalt content. The content of the secondary metabolites acteoside, aucubin and catapol was low for both cultivars. Based on leaf and root performance it can be concluded that Tonic is a better performing cultivar than 742 during the first months after sowing. Based on this experiment it is therefore advised to use the plantain cultivar Tonic on silt loam soils.

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