Comparative study into 7 commercially available soil wetting agents and their effects on disease incidence and turf quality

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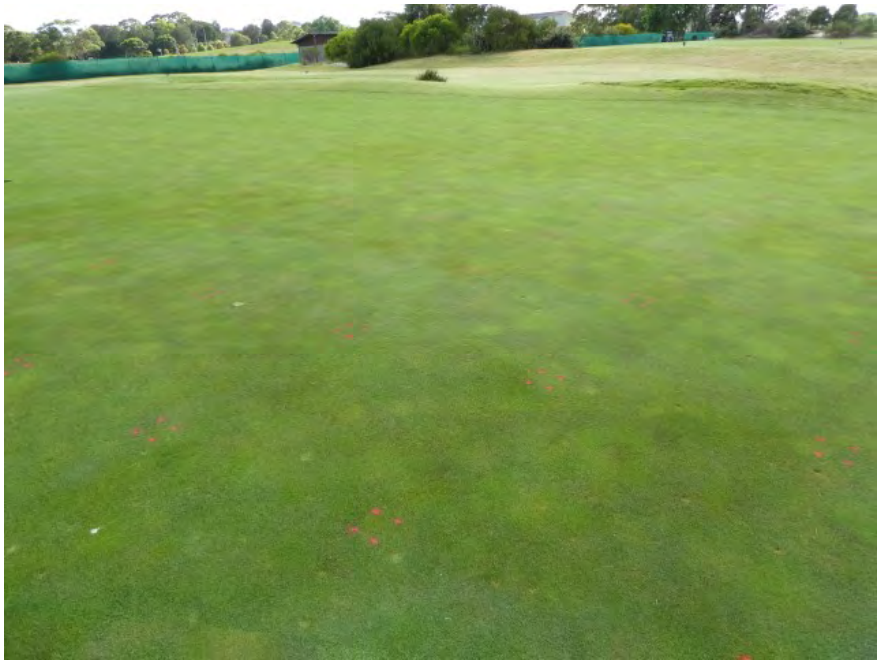


Figure 2: Bonnie Doon wetting agent Trial

1 Abstract

Soil wetting agents are commonly used to reduce the irrigation needs of turfgrass during periods of drought. This research aimed to determine the effects of 7 soil surfactants on a well establish creeping bentgrass (Agrostis stolinifera) golf green in Sydney.

A randomised complete block design was established with 7 water retention products plus 1 at half rate and an untreated control. The products tested were Hydroforce Ultra, Tricure, Propel, Maximizer H2O, Hydrolink Rapid, Hydroforce Recovery, and a proprietary formulation containing salicylic acid.

Plots were evaluated for visual turgrass quality, soil volumetric moisture content (VMC), Surface hardness, and dollar spot incidence by counting dollar spot infection centres per plot.

Results were as follows:

1. The null hypothesis is that none of these products makes any difference to turf quality, soil volumetric moisture content, surface hardness or soil organic matter.
2. Over the duration of the trial only Treatment 5 had a significantly lower quality content than the control (Treatment 6). There was no significant difference between the turf quality of any of the other treatments and the control.
3. Treatment 4 had a significantly higher turf quality than Treatment 5.
4. Over the 200 day trial period there were only three occasions where there were significant differences in turf quality.
5. Treatments 4, 8 and 9 were the only ones with no significant difference in surface hardness compared to the control.
6. Significant differences in Trufirm Readings were only apparent 29 days post first treatment.
7. Only Treatments 9 and 3 had significantly higher moisture contents than the control. Treatment 9 also had significantly high moisture contents than Treatments 5 and 7.
8. Significant differences in moisture content were seen 3, 22, 95, 105, 159, 173, 187 and 200 days post first Treatment. In total 23% of the time significant differences were seen.
9. The numbers of infection centres could be divided between those being less than the control and those that showed no difference from the control.Those showing less infection centres than the control comprised Treatments 1, 2, 3, 4 and 5. Those showing no difference than the control comprised Treatments 7, 8 and 9.
10. Treatments 3, 4, and 5 all had significantly less dollar spot infection centres than the control.

2 Discussion of Results

These results raised a number of questions relating to the performance and claims of these soil wetting agents.

2.1 Turf Quality

The fact that all of them apart from Treatment 5 did not cause any reduction in turf quality compared to the untreated control contradicts the findings of . . . However, it does go to show how the safety of soil wetting agents has improved over the years.

Treatment 4 also contains a significant amount of humic acid and so the good turf quality results and the associated reduction in dollar spot infection centres is not in the least a surprise.

With Treatment 5 the monthly applications leading to a reduction in turf quality is not a true reflection of the product use in a real life situation. It is only supposed to be used for reducing surface soil moisture levels with infrequent applications.

2.2 Volumetric Moisture Content

Significant differences in volumetric moisture content were seen on 3,22,95,105,159,173,187,and 200 days after the first application.

Treatments 3 and 9 both appeared to retain more moisture at a depth of 75mm than the others. This result was a surprise in the case of Treatment 9 due to the very low use rate.

The fact that Treatment 9 held more water but gave a significantly harder surface may well be related to the zone above 75mm depth.

The negative to this is that despite holding more soil moisture Treatment 9 was in the group showing high numbers of dollar spot infection centres.

Treatment 3 in contrast was classified in the low dollar spot infection centre group as a result of the incorporation of salicylic acid and biostimulant package.

2.3 Surface Hardness.

The results that we gained showed significant differences bwetween treatments compared to the control. This confirms the 2015 results of Bauer et al who showed that although firmness measurements were not affected by wetting agent applications in 2014 they were in 2015.

One of the reasons this may have occured is that thatch can have a high affinity for wetting agents, which means that they will tend to dry out much more slowly at the surface (Karnok et al, 2004). Future work proposed in 2023-2024 should help understand this further.

Under the situation of non limiting water Treatments 1 and 2 performed in a pretty similar vein. Both fell into the low dollar spot infection centre group, both showed no reduction in turf quality compared to the control, and both gave no significant differences in surface hardness levels.

Significant differences in surface hardness occurred twice. 29 days post first Treatment, when Treatments 2 and 9 were significantly harder than Treatment 7, and again 67 days post first Treatment when Treatments 3 and 9 were significantly firmer than Treatment 5.

2.4 Dollar Spot Incidence.

This wasn't apaprent until 130 days after the start of the trial. Interestingly the Treatments couod be clearly divided into those showing evidence in reducing disease and those that didn't.

Treatments 1,2,3,4, and 5 all fell into the former group. The reason behind this is possibly that with these particular products you don't have so much dew on the bentgrass, meaning that they are less prone to dollar spot.

3 Future Work

As a result of this trial we are intending to extend it into 2023-2024 but with three major modifications to the protocol.

Firstly we will supplement soil moisture readings at 75mm with additional readings at 37mm. This will allow us to get a better idea what is happening in the upper thatch layer and takes into account the findings of Leinauer et al (2007) that the efficacy of wetting agents was most pronounced at depths of 2.5 cm or less.

Secondly we are going to subject the turf to moisture stress. Treatments 1 and 2 both claim to maintain if not improve turf quality after multiple applications under stress conditions.

Thirdly, we will carry out the water drop penetration time (WDPT) test was used to measure the actual water repellency of the field-moist samples at depths of 0-2, 2-4 and 4-6cm. This will give us a better idea of wetting agent longevity in the soil.

4 Background to Treatments

4.1 Tricure (Product 1)

Figure 3: Tricure 10L

TriCure AD® is marketed as an advanced soil surfactant designed to prevent and control hydrophobic soil conditions while maintaining optimum soil-water management. It works by attaching to both soil and organic particles, reducing the surface tension of water, and attracting a thin film of water close to the particle surfaces. This allows the optimum moisture to be held for plant use while facilitating water release and effective drainage.

Trials

The efficacy of wetting agents varied over depth and was most pronounced at depths of 2.5 cm or less.

Was one of the products that most consistently reduced hydrophobicity. Products that consistently did the best job of reducing hydrophobicity also unfortunately had potential (though limited potential) to cause some reduction in turf quality Karcher et al (2009)

All wetting agent products appear to effectively reduce LDS incidence and increase soil moisture uniformity, over a wide range of depths (75- to 200mm) compared to untreated turf. In addition, there is no evidence that these wetting agents significantly increase surface soil moisture during periods of frequent irrigation or rainfall. These results suggest that these commonly used wetting agents can be used to manage LDS without adversely affecting rootzone moisture (Johnson, A and Leeper K. 2011)

In this study, block polymer and modified block polymer wetting agents (TriCure®, Revolution®) increased soil moisture and uniformity distribution by an average of 4.7 and 4.8%, respectively.

A follow up study was conducted in 2011 TriCure®, Revolution®, Immerse® GT, Magnus®, and Performa Gold® treatments increased soil moisture by an average of 4.4%.

Dispatch® decreased soil moisture by 4.7%. TriCure®, Magnus®, and Revolution® increased uniformity by 6.5%.

Baird et al, 2011

Under extreme water stress conditions, Revolution® (Aquatrols) performed the best of all products tested in alleviating turf drought symptoms and LDS incidence. TriCure AD® (Mitchell Products) was next best.

4.2 HydroForce Ultra (Product 2 and Treatment 7 half rate)

Figure 4: Hydroforce Ultra 10L liquid

This is sold as HydroForce Ultra in Australia, Excalibur in the US and Evolve in the UK. It is composed of 90% Polyalkylene glycols and 10% inert ingredients.

HydroForce Ultra is a new chemistry, with a unique molecular design, developed in partnership with one of the leading manufacturers of block co-polymer technology in the United States. The new molecular design, comprises of a block co-polymer with a modified structure to provide unique performance characteristics.

HydroForce Ultra is manufactured in the United States to the strictest standards. The product comes available in a 10L pack size and has been developed and is supported by Dr Stan Kostka, Dr Mike Fidanza and Dr Cale Bigalow from Rhizosolutions LLC.

4.3 Gilba SA (Product 3)

Bially et al in 2005 concluded that there is a huge variation in wetting efficacy among surfactant chemistries. Their conclusions were that an enhanced wetting rate occurred when the alkyl glucoside to block copolymer ratio was from approximately 6:1 to 0.5:1 by weight, ideally when the ratio was from approximately 4:1 to 0.7:1.

Gilba SA comprises an alkyl glucoside to block copolymer ratio of 4:1 whilst also containing a high loading of salicylic acid (SA) plus root stimulants.

4.4 Salicylic acid

Salicylic acid (SA) is a phenolic phytohormone and is found in plants with roles in plant growth and development, photosynthesis, transpiration, ion uptake and transport. It is involved in endogenous signaling against both biotic and abiotic stress, being an important plant hormone that regulates many aspects of plant growth and development.

Salicylic acid or orthohydroxy benzoic acid is ubiquitously distributed plant growth regulator (Raskin, 1992) and has positive effects on plant growth and developmental processes (Senaratna et al, 2000).

Research has shown its roles in:

- Seed germination and fruit yield (Klessig and Malamy 1994).
- Photosynthetic rate, and in transpiration (Khan et al, 2003).
- Reducing oxidative stress (Shirasu et al,1997).
- Plant-water relations in abiotic stress affected plants were regulated by SA (Miura and Tada, 2014).
- Increased heat tolerance (Larkindale, 2002).
- Stress resistance in biotic stressed plants have also been reported (Kumar, 2014).

SA is an effective SAR inducer, but it can be highly phytotoxic (Conrath et al, 2015). Using high rates will directly induce the activation of plant defences. However, if the rates are too low they elicit little to no response. Following subsequent infection, however, defences are activated more rapidly and/or strongly (Conrath et al, 2006).

Wang et al (2010) looked at treating the leaves of young grapevines before heat stress (25°C), during heat stress (43°C for 5 h), and through the following recovery period (25°C). SA treated leaves showed an increased rate of recovery compared to the control (H2O-treated) leaves

Comparative work looking at the efficacy of salicylic acid and Acibenzolar-S-methyl (ASM) was carried out into Alternaria solani, which is a destructive pathogen to tomato crops (Aslam et al, 2019).

Foliar and seedling root dipping application of Bion and salicylic acid not only reduced the disease severity but also enhanced the plant growth.

4.5 Disease fighting properties

Hsiang et al (2022) looked at using 0.69-0.7g/100ml Aspirin (acetylsalicylic acid) in growth room tests and found little effectiveness. The product we are researchng contains a significantly higher rate of salicylic acid than this.

Rahman et al (2013) found that innoculating perennial ryegrass with salicylic acid prior to innoculation with grey leaf spot (Magnaporthe oryzae) gave significant disease reductions.

4.6 Turf specific research

- Creeping Bentgrass (Agrostis stolonifera) subjected to heat has been shown to exhibit elevated SA levels after an hour (Larkindale and Huang 2005).
- Shahgholi et al, 2013 looked at the interaction between Trinexapac ethyl and salicylic acid on perennial ryegrass. Applying 0.27 g of salicylic acid gave a significant height response. Also salicylic acid with concentrations of 0.27 and 0.54 g/ m2 increased colour quality and chlorophyll content.
- He et al 2005 looked at various rates of SA on the heat tolerance of Kentucky bluegrass exposed to 46°C for 72 h in a growth chamber. 0.25 mmol SA gave the best heat tolerance and subsequent recovery.
- Hosseini, Kafi and Arghavani (2016) looked at perennial grass (Lolium perenne cv. 'Numan') under drought stress. Foliar applications of SA increased the chlorophyll content and reduced electrolyte leakage, proline accumulation and antioxidant enzyme activity, which suggested that salicylic acid can be used to reduce the negative impacts of drought stress.

4.7 Previous Research

Our 2020 work showed that salicylic acid applied to creeping bentgrass lead to increased root growth and lateral root branching, better turf quality and faster and more consistent seed germination.

By incorporating this into the wetting agent formulation, the idea is to increase the ability of turf to better abiotic stress and drought whilst also maintaining a strong and vigorous root architecture.

4.8 Propel (Product 4)

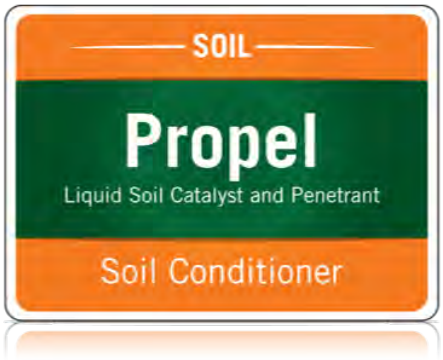


Figure 5: Propel 10L container

Propel is based on Di-Sulfosuccinate Surfactant chemistry.

4.9 Hydroforce Recovery (Product 5)

HydroForce Recovery is a premium soil surfactant blend, specifically designed to overcome hydrophobic soil situations. HydroForce Recovery's key performance characteristics are due to it's unique combination of powerful, highest quality surfactant technologies fulfilling rapid soil wetting, reliable re-wetting and plant health improvement performance. This is an 80% Proprietary Blend of Non-Ionic Surfactants and 10% L form Amino Acids & Root promotants.

4.10 H2O Maximizer (Product 8)

Figure 6: 20L drum Maximizer H2O

This is a soil surfactant and polymer resin blend that can be tank mixed for spray application or injected directly into irrigation lines.

The product claims to initially wet soil while the polymer resin adsorbs to soil particles for enhanced water retention.

Due to the surfactant reducing the surface tension combined with the polymer resin's attachment to soil particles it has a dual activity.

4.11 Hydrolink Rapid (Product 9)

This is designed to re-wet and penetrate through hydrophobic or compacted soils and thatch layers.

It contains two unique active ingredients, one compact surface acting anionic surfactant designed to penetrate even the most hydrophobic soils, and a heavier-weighted reverse block co-polymer for residual re-wetting performance.

Figure 7: HydroLink Rapid 20L drum

5 Trial Overview

The practice putting green at Bonnie Doon G.C in Sydney, NSW was chosen to carry out this trial. The surface was composed of 85% creeping bentgrass (agrostis stolonifera var A1/A4)

a) A randomised block trial was marked out after using Edgar II for its design and layout. This comprised 54 plots, each having a surface area of 1m2 with a 50mm buffer around each.

The randomized block trial initially comprised 9 treatments with 6 replicates. One treatment was an untreated control. These were initially treated on Monday 7th November 2022 with further applications being made on 7th December 2022, 6th February 2023, 3rd March 2023, 3rd April 2023,and the final application being made on 1st May.

All treatments were applied in the label rate amount of water and then immediately washed in using the in ground irrigation system present at the site. This applied approximately 6mm of water.

The trial plots were not fed or treated for disease over the trial duration. Irrigation was also applied as and when required with soil moisture levels being recorded to a depth of 75mm.

Table 1: Table showing Treatments and Rates for product applications vs untreated control

Treatment	Rate Product g(ml)/1m2	Rate Product Kg (L)/Ha	water volume L/Ha
Tricure (1)	1.2	12	800
Hydroforce Ultra (2)	1.25	12.5	800
Gilba SA (3)	1.25	12.5	800
Propel (4)	1	10	800
HydroForce Recovery (5)	2	20	800
Untreated control (6)	-	-	800
Hydroforce Ultra (7)	0.625	6.25	800
H2O Maximizer (8)	3	30	800
Hydrolink Rapid (9)	0.5	5	800

Assessments were as follows: 1. Turf Quality. Was this effected by the Treatment? 2. Surface Hardness 3. Soil Volumetric Moisture Capacity (VMC%).4 Dollar spot incidence.

Table 2: Table showing Treatments and Block layout for product applications vs Control -No Treatment

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Hydrolink Rapid	Hydroforce Ultra full	Hydroforce Recovery	Hydrolink Rapid	Gilba SA	Control
Hydroforce Ultra half rate	H20 Maximizer	Hydroforce Ultra full	Hydroforce Ultra full	Hydroforce Ultra full	Gilba SA
Hydroforce Recovery	Tricure	Control	H20 Maximizer	H20 Maximizer	Propel
Hydroforce Ultra full	Hydroforce Recovery	Gilba SA	Hydroforce Recovery	Hydroforce Ultra half rate	H20 Maximizer
Control	Hydroforce Ultra full	Hydroforce Ultra half rate	Gilba SA	Control	Hydroforce Recovery
Gilba SA	Gilba SA	H20 Maximizer	Control	Hydrolink Rapid	Hydroforce Ultra Half rate

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Tricure	Control	Tricure	Hydroforce Ultra half rate	Propel	Tricure
Propel	Hydroforce Ultra half rate	Hydrolink Rapid	Gilba SA	Tricure	Hydrolink Rapid
H20 Maximizer	Hydrolink Rapid	Propel	Tricure	Hydroforce Recovery	Hydroforce Ultra full

5.1 Turf Quality.

Turf Quality Analysis was carried out using a light box and then analyzed using Turf analyzer software. Images were taken with a Panasonic DMC-TZ80.

Figure 8: Light box on trial green

5.2 Surface Hardness

Surface hardness was measured with a Trufirm Turf Firmness Meter (Spectrum Technologies). This has an impact hammer that mimics the shape of a golf ball in order to simulate golf ball impacts. The mass is dropped from a consistent height and the maximum turf penetration value is recorded and correlated to the surface firmness. The lower the reading, the firmer the turf. It measures impact of falling mass in 1000th of an inch readings.

A reading of 500, means you create a depression of 1/2", if the reading is 250 the depth is 1/4".

A TruFirm reading of 0.4 is the target after rainfall or heavy leaching (40 - 60 minute irrigation cycle). Pat Gross of the USGA also feels that a TruFirm reading 0.4 is a good firmness reading for routine golf play – low for tournament conditions but after rainfall might be acceptable.

Research has demonstrated an inverse relationship between volumetric water content (VWC) and firmness (Moeller et al., 2007; Linde et al., 2011), and because of this, wetting agents have the potential to influence surface firmness by creating drier surfaces under moist soil conditions.

Figure 9: Trufirm end view showing impact hammer

Figure 10: Using the Trufirm with the bluetooth ap and an iPhone

Figure 11: Side view of LCD screen on Turufirm

5.3 Soil Volumetric Moisture Capacity (VMC%)

Soil volumetric moisture content (VMC %) was recorded using a TDR 350 (Spectrum Technologies) fitted with 75mmm (3 inch) tines.

Time domain reflectometry (TDR) indirectly measures the soil water content based on the travel time of a high frequency electromagnetic pulse through the soil; this travel time is used to calculate the permittivity (dielectric constant) of the material.

The TDR probes are inserted directly into the soil at the desired soil depth.

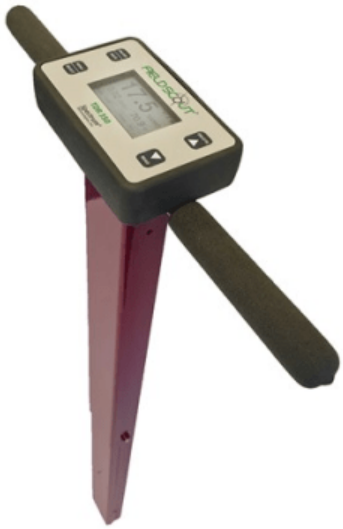


Figure 12: Spectrum TDR 350 with inbuilt GPS and bluetooth

5.4 Dollar Spot Infection Centres

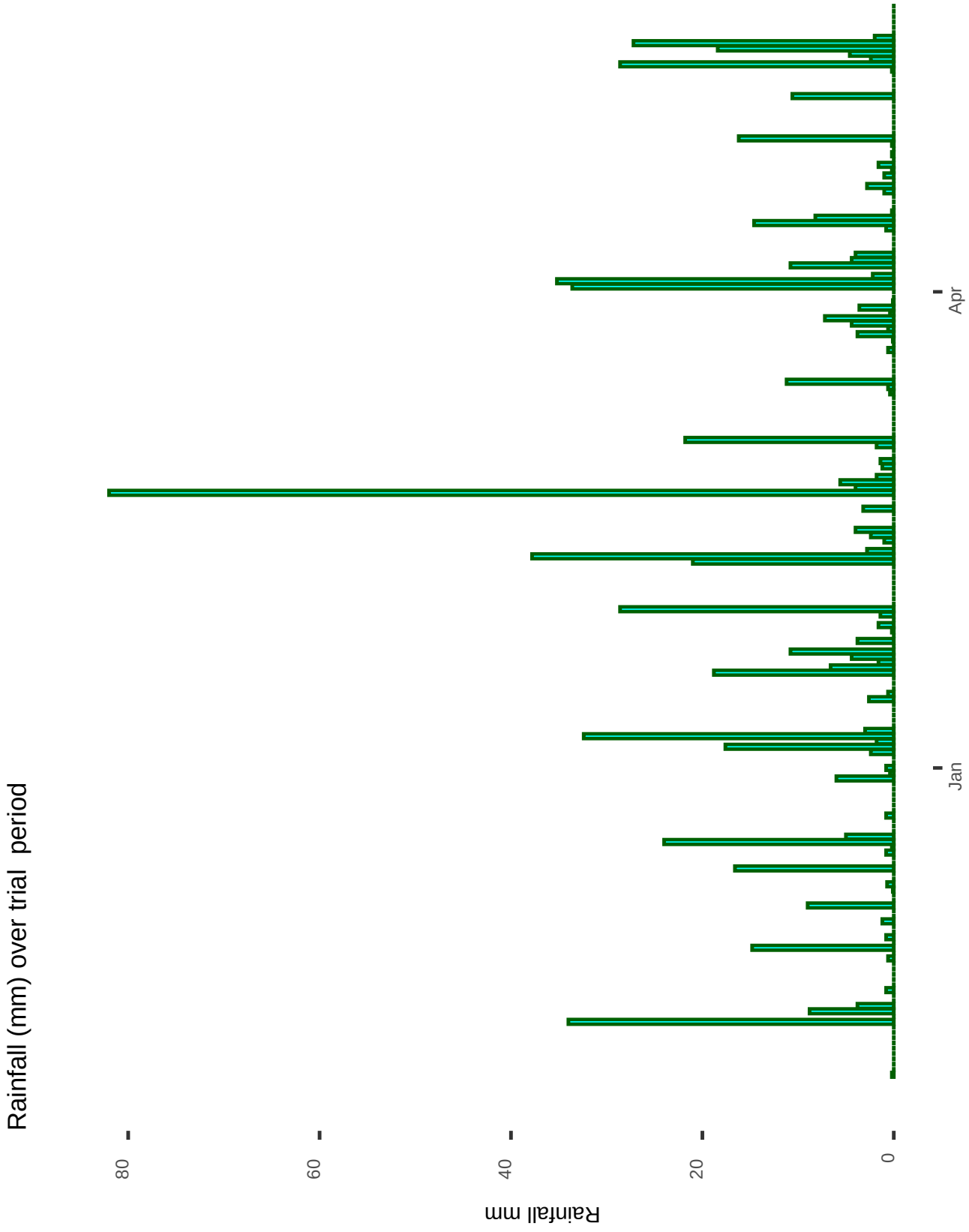
After 106 days dollar spot became apparent. Thanks to Craig Geeves Assistant Superintenedent for carrying out a visual count of the infection centres on the plots.

6 Results

Plots were analyzed using digital image analysis in combination with Image J. Images were taken regularly with a Lumix . Image analysis was then carried out using Turf Analyzer software (https://turfanalyzer.com).

Statistical analysis was carried out using RStudio. All data was subjected to a one-way ANOVA (analysis of variance) to determine the effects of the Treatment on Soil moisture content (VMC), Surface hardness (Trufirm), Turf Quality and number of dollar spot infection centres (DSIC). Data were subjected to an analysis of variance (ANOVA) using RStudio. Significant results were then subjected to post hoc testing with mean values being separated using Duncan's multiple range test (DMRT) at the 0.05 probability level.

7 Weather


Rainfall (mm) over trial period
Rainfall mm
0
20
40
60
80
Jan
Apr

8 Turf Quality on a Scale of 1-9

An overview of the data recorded is shown below

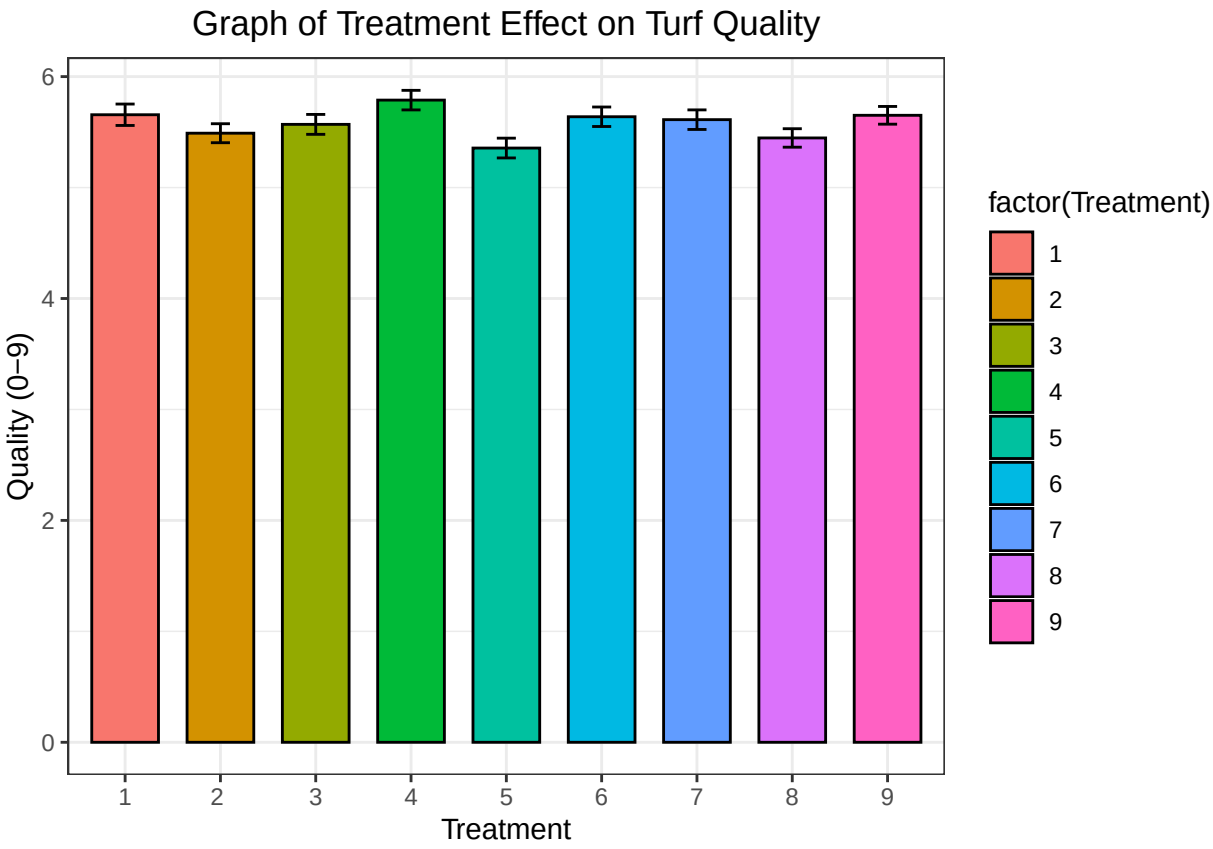
Table 3: Statistics by Treatment

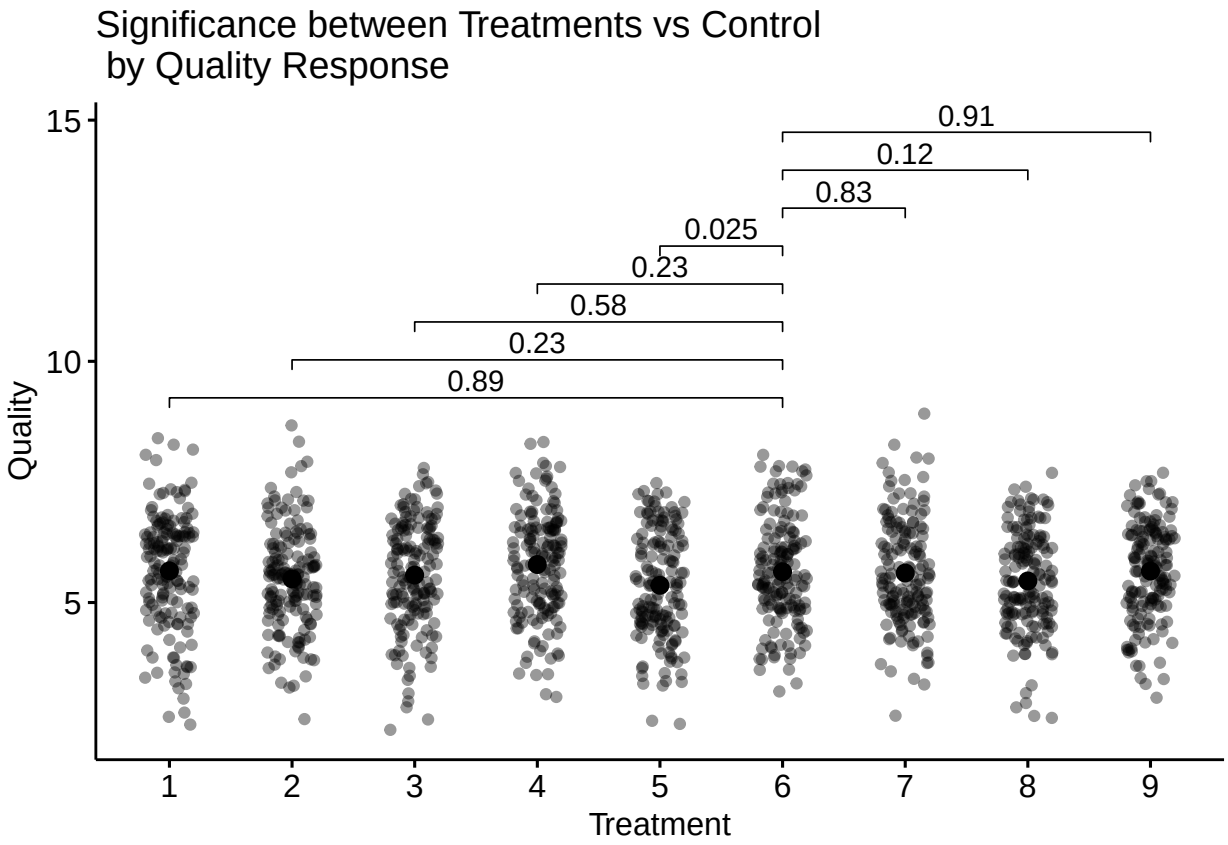
Treatment	n	Quality	sd	se	ci
1	156	5.656	1.204	0.09643	0.1905
2	156	5.49	1.07	0.08564	0.1692
3	156	5.569	1.121	0.08978	0.1773
4	156	5.788	1.102	0.08825	0.1743
5	156	5.356	1.114	0.08917	0.1761
6	156	5.638	1.099	0.08795	0.1737
7	156	5.612	1.101	0.08817	0.1742
8	156	5.447	1.04	0.08326	0.1645
9	156	5.651	0.9985	0.07995	0.1579

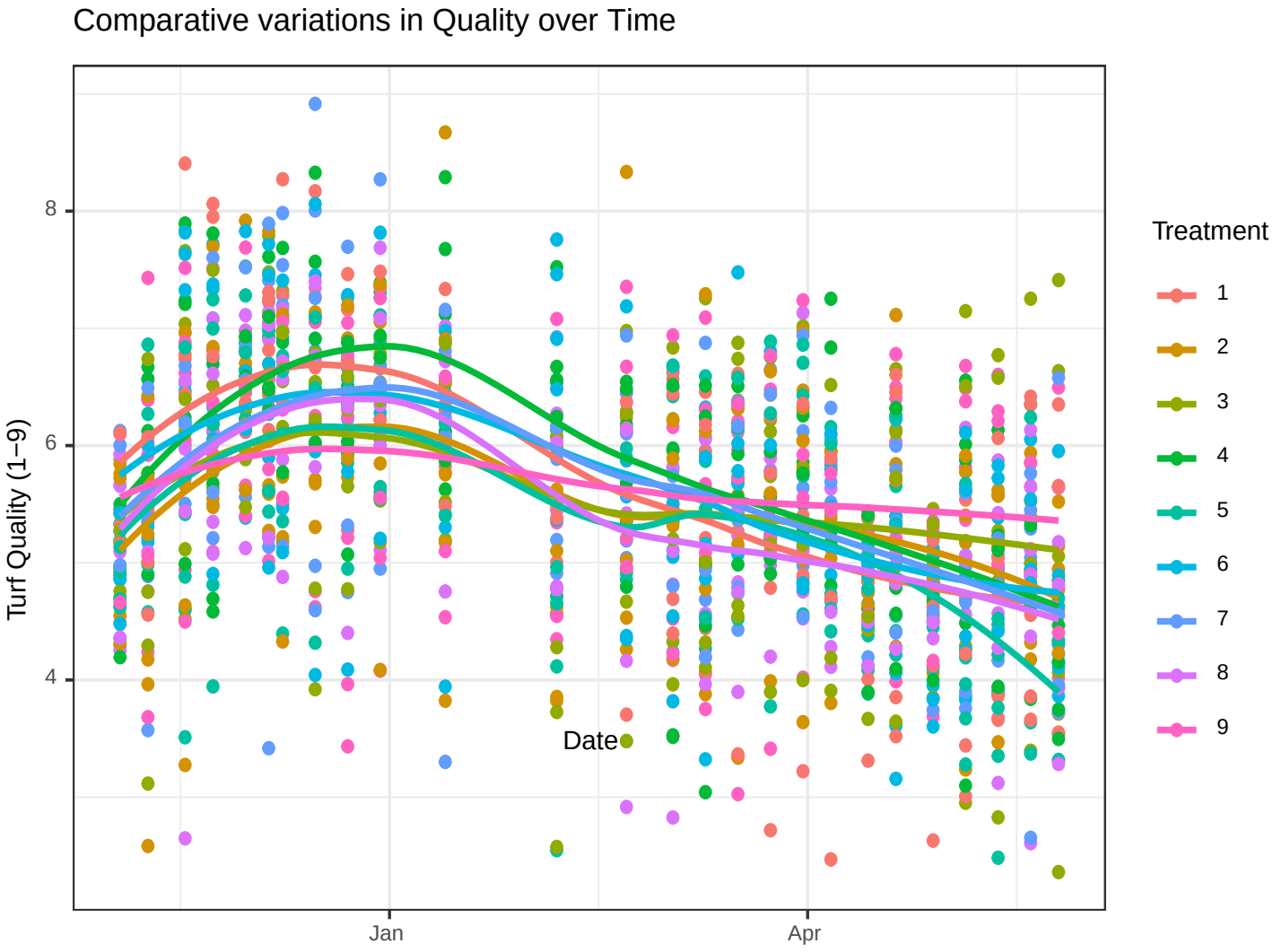
The following table summarises this

Treatment	Quality
1	5.656
2	5.49
3	5.569
4	5.788
5	5.356
6	5.638
7	5.612
8	5.447
9	5.651

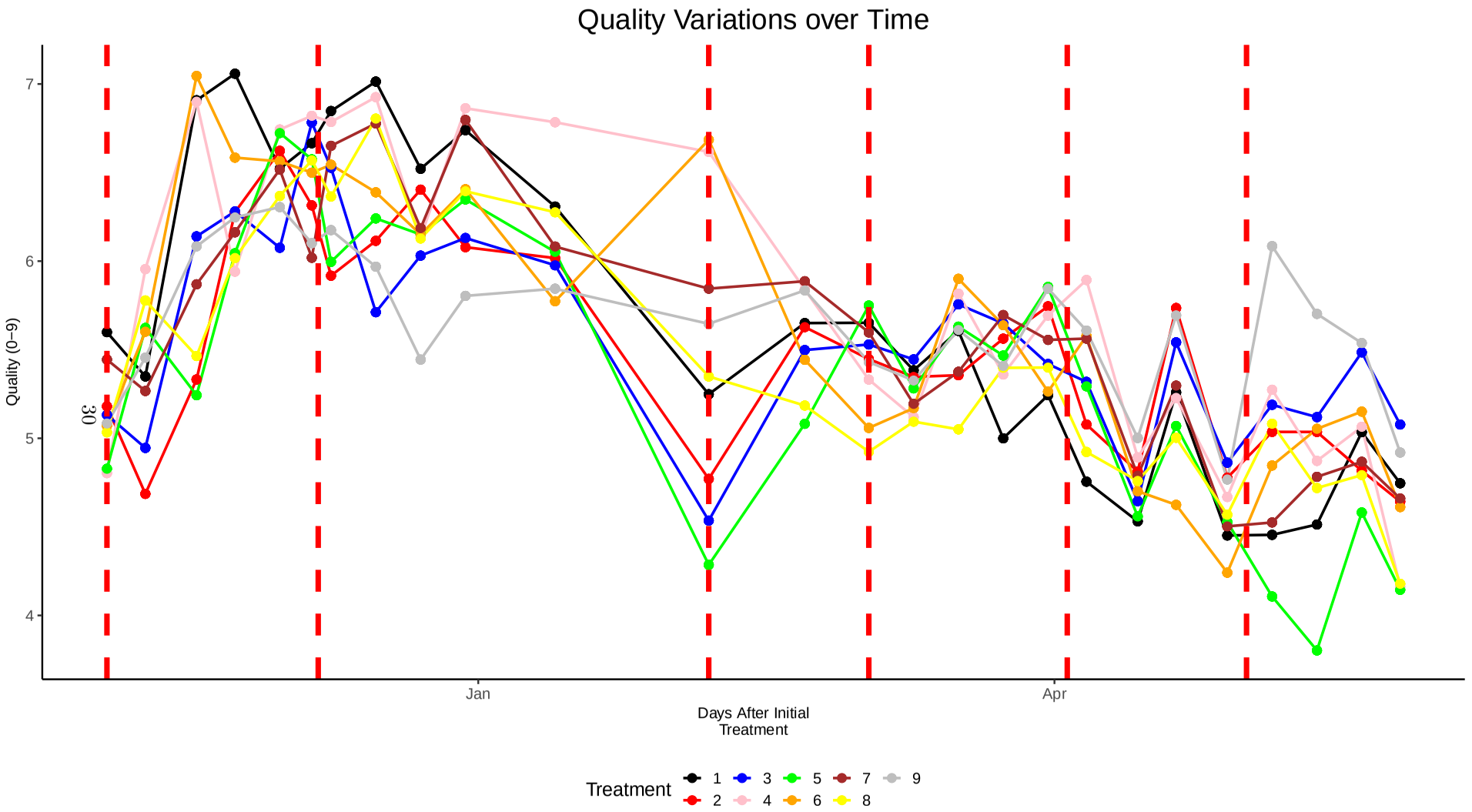
This shows that the Treatment 4 gave the highest quality reading and Treatment 5 the lowest. However the only significant differences compared to the untreated control was Treatment 5 which exhibited significantly lower turf quality. There was no significant differences between any of the other Treatments.


Graph of Treatment Effect on Turf Quality
Quality (0–9)
Treatment
0
2
4
6
1
2
3
4
5
6
7
8
9
factor(Treatment)
1
2
3
4
5
6
7
8
9


Significance between Treatments vs Control
by Quality Response
Quality
15
10
5
0.91
0.12
0.83
0.025
0.23
0.58
0.23
0.89
1
2
3
4
5
6
7
8
9
Treatment



Over time there was a decline in turf quality from long term usage of Treatment 5. This decline was mirrored by the other Treatments but was noticeably less over the same time period.


Quality Variations over Time
Quality (0–9)
7
6
5
4
30
Jan
Apr
Days After Initial Treatment
Treatment
1
2
3
4
5
6
7
8
9

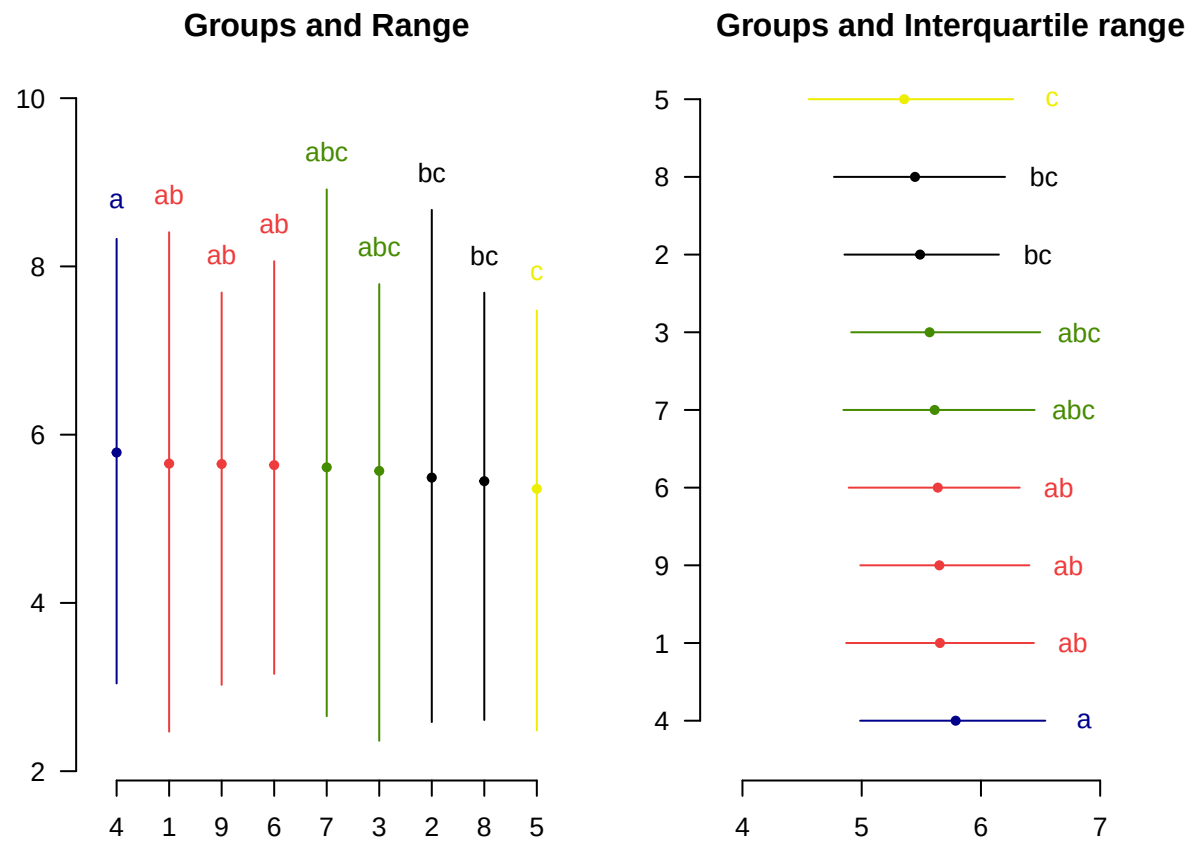
Analysis showed that the Treatment has a significant effect in relation to turf quality.

Table 5: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(Treatment)	8	21	2.625	2.186	0.02606
Residuals	1395	1675	1.201	NA	NA

Table 6: Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	5	173.2	34.64	41.29	1.076e-39
Treatment	8	21	2.625	3.128	0.001644
Date	1	307.9	307.9	367	9.932e-73
Treatment:Date	8	35.22	4.402	5.247	1.722e-06
Residuals	1381	1159	0.839	NA	NA



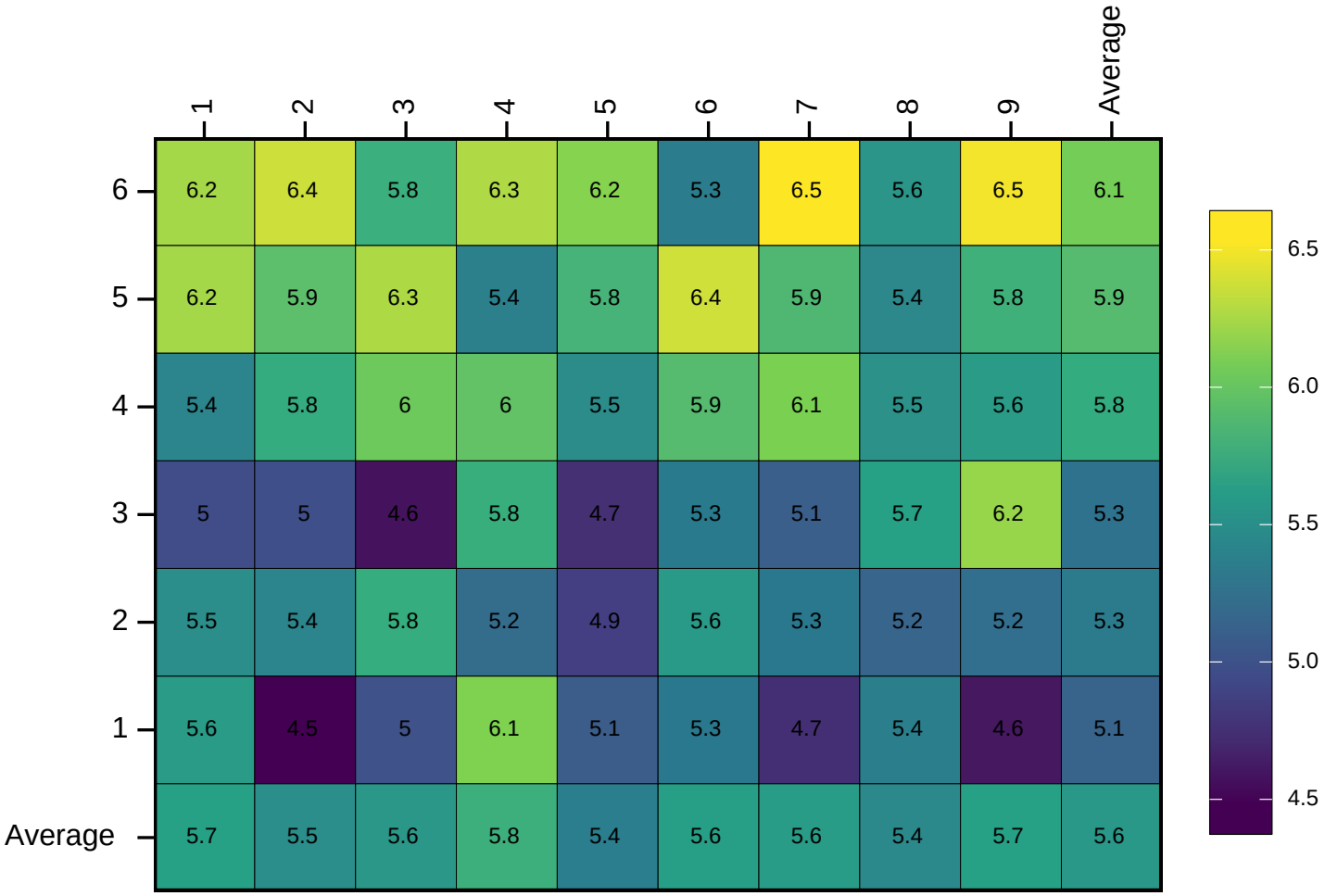
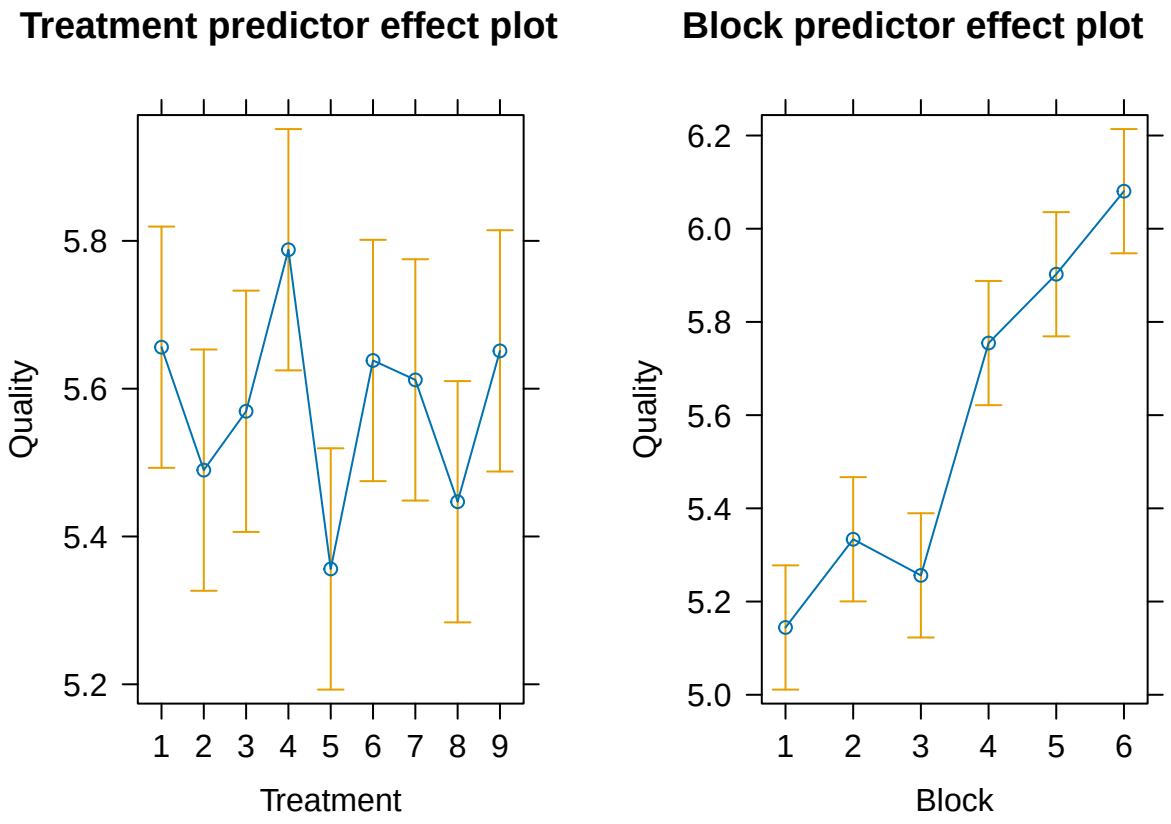


Figure 13: Plot means for Turf Quality for Treatment and Block

9 Block Effect with Treatment on Turf Quality



There was a significant Block effect across the trial site with Blocks with this being most evident in Blocks 4, 5 and 6. There was no Treatment:Block interaction.

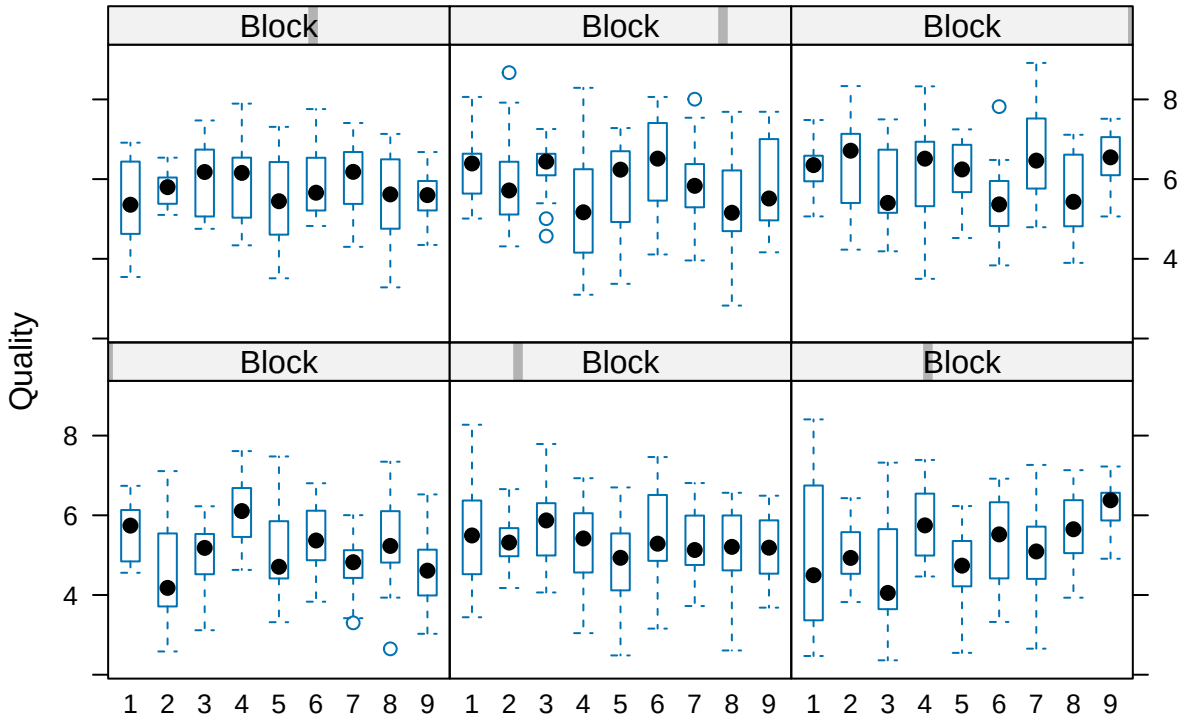
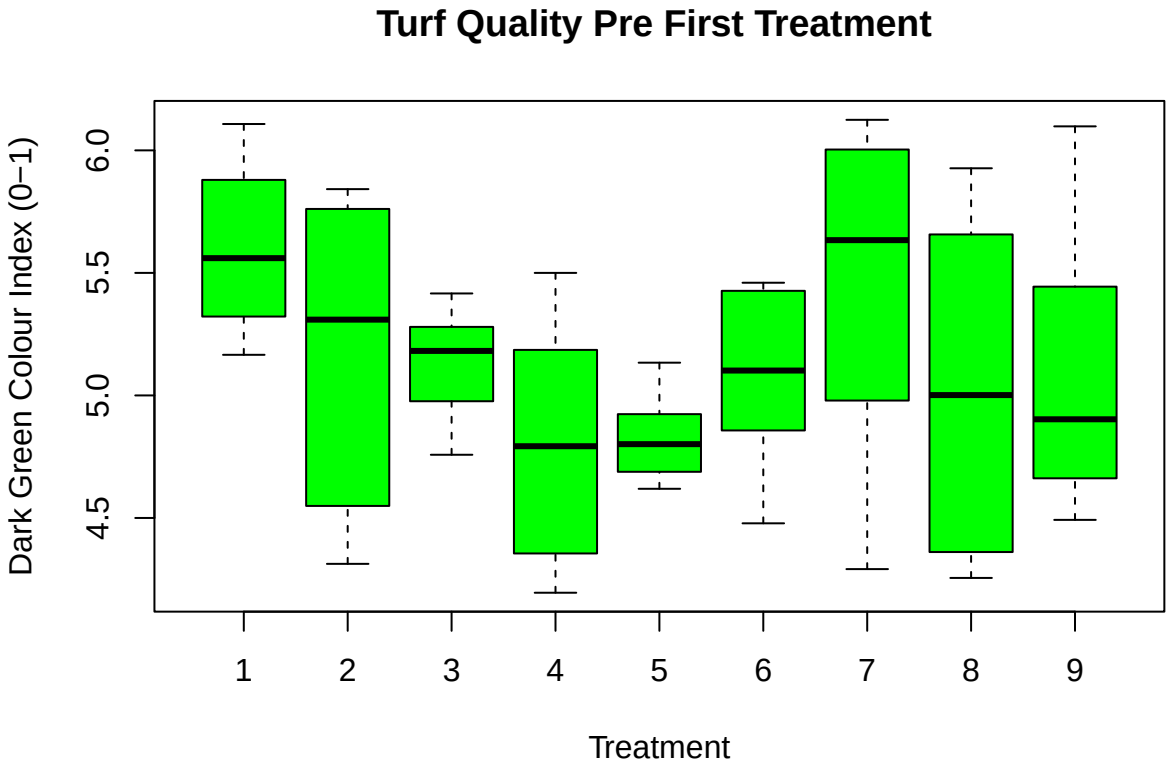


Table 7: Significance of Results by Treatment, Block and Days after Initial Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	1	158.5	158.5	221.4	5.414e-46
Treatment	8	21	2.625	3.667	0.0003108
DAT	25	518.6	20.74	28.98	3.304e-104
Treatment:DAT	200	161.3	0.8063	1.127	0.1268
Residuals	1169	836.6	0.7157	NA	NA

9.1 Turf Quality at Trial start and 3 days following the First Treatment (2022-11-07)

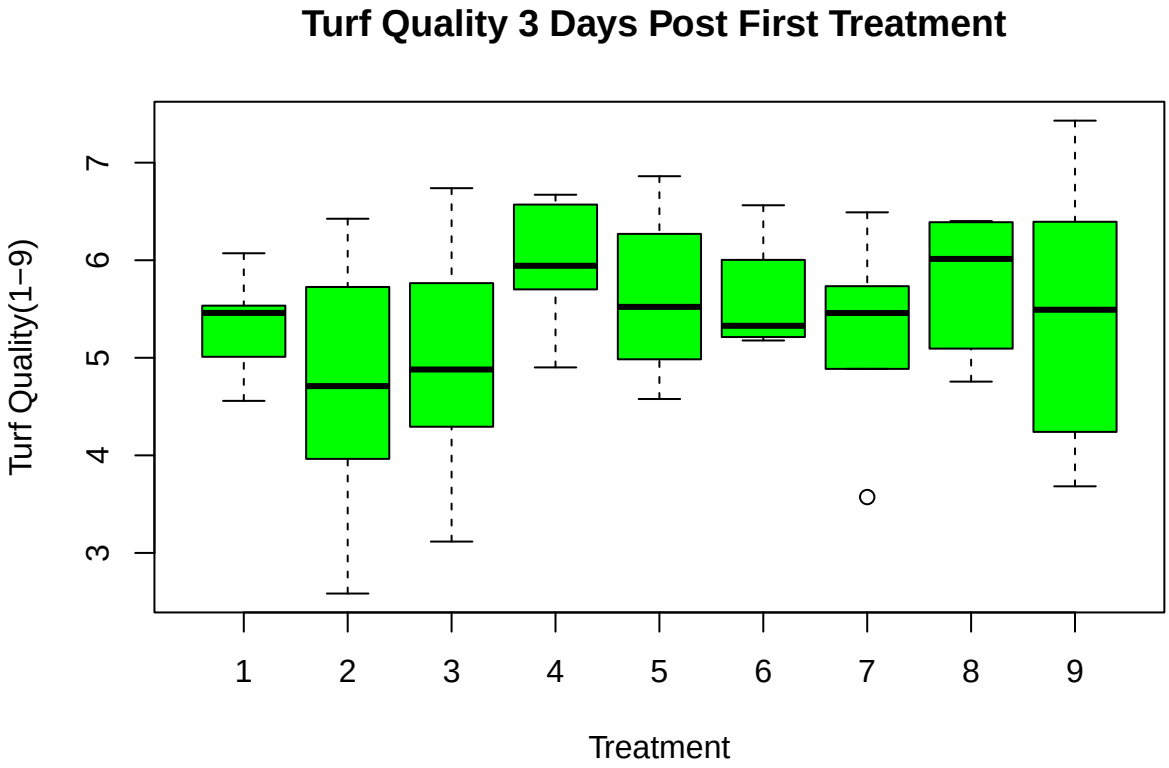


In the resulting ANOVA table, the F-tests show that there is no significant difference in Treatment factor levels.

Table 8: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	3.205	0.4006	1.489	0.188
Residuals	45	12.11	0.269	NA	NA

9.2 Quality 3 Days post First Treatment (2022-11-10)



In the resulting ANOVA table, the F-tests show that there is no significant difference in Treatment factor levels.

Table 9: Analysis of Variance Model Day 3

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	7.681	0.9602	1.009	0.4426
Residuals	45	42.81	0.9512	NA	NA

9.3 Quality 11 Days post First Treatment (2022-11-18)

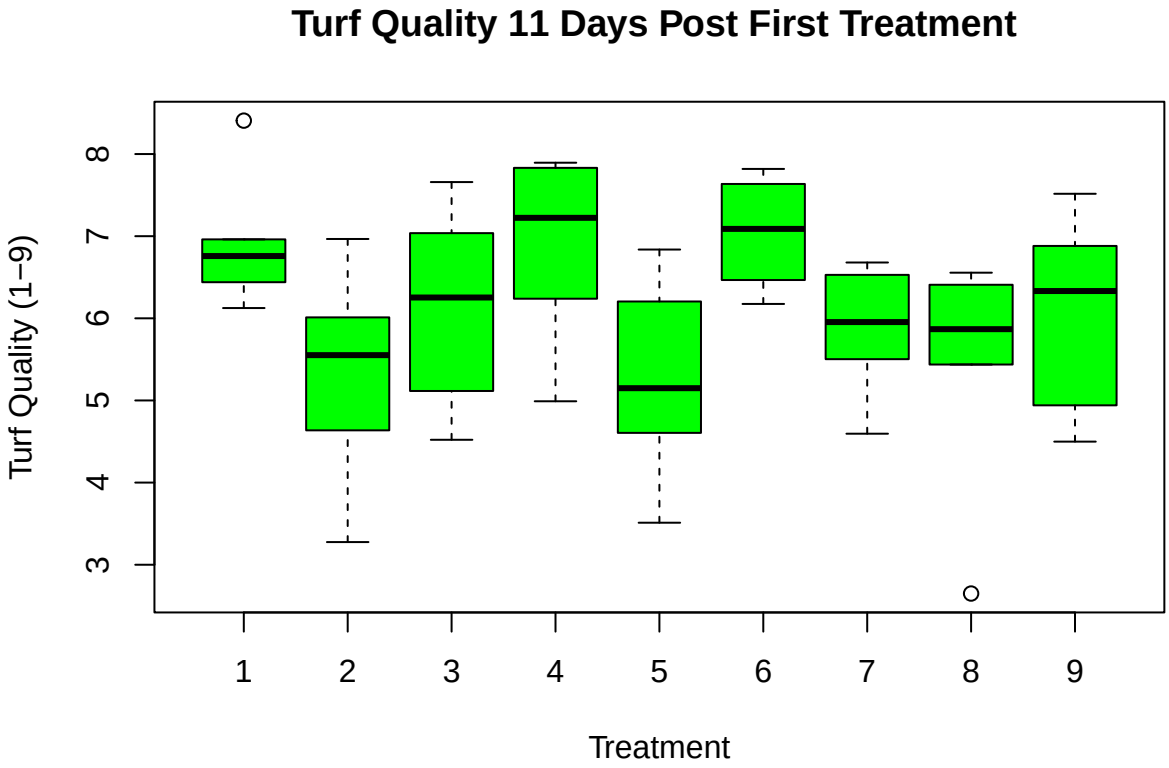
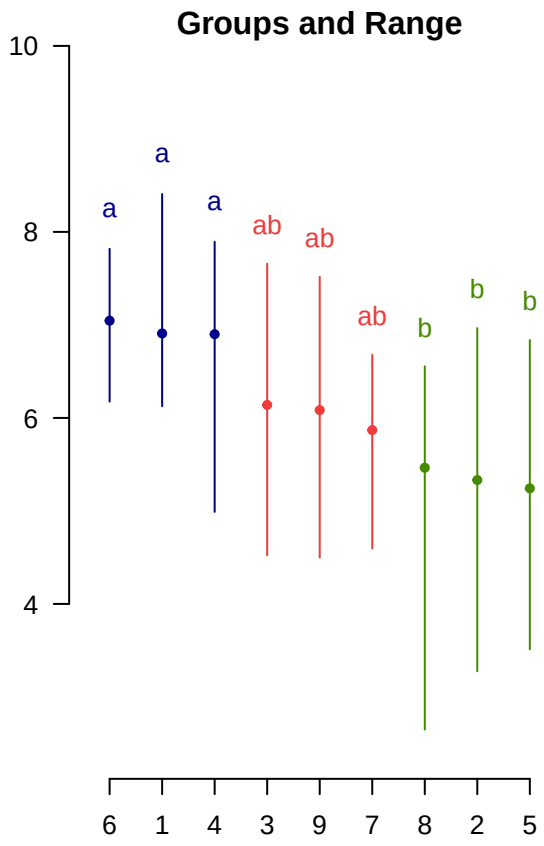


Table 10: Analysis of Variance Model Day 11

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	23.82	2.977	2.509	0.02401
Residuals	45	53.4	1.187	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
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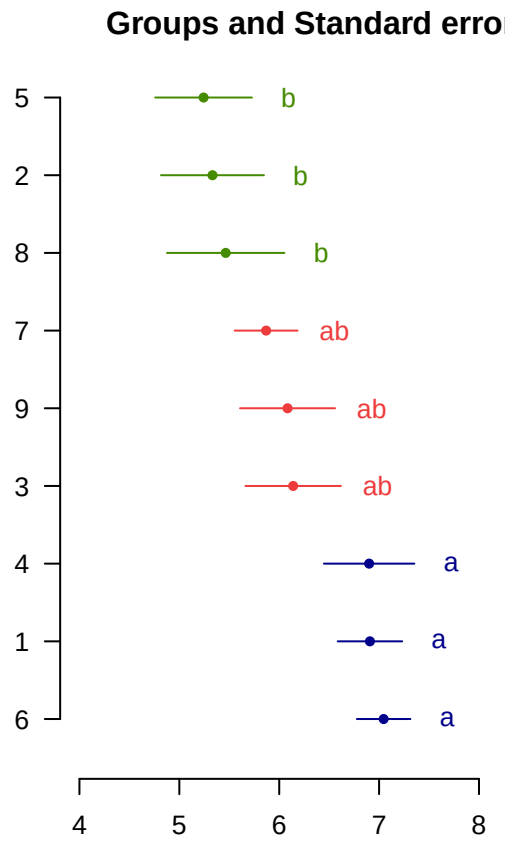
6 1 4 3 9 7 8 2 5


Groups and Standard error
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9.4 Quality 17 Days post First Treatment (2022-11-24)

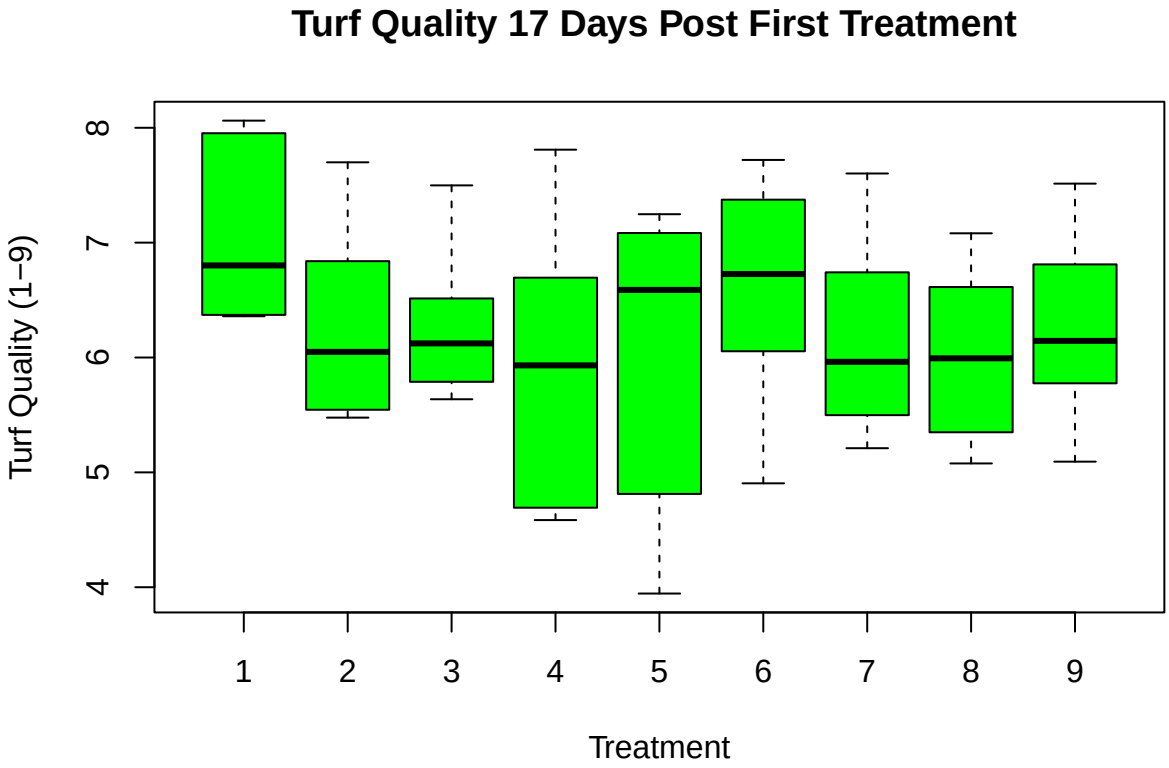


Table 11: Analysis of Variance Model Day 17

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5.707	0.7134	0.7615	0.6378
Residuals	45	42.16	0.9368	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.5 Quality 24 Days post First Treatment (2022-12-01)

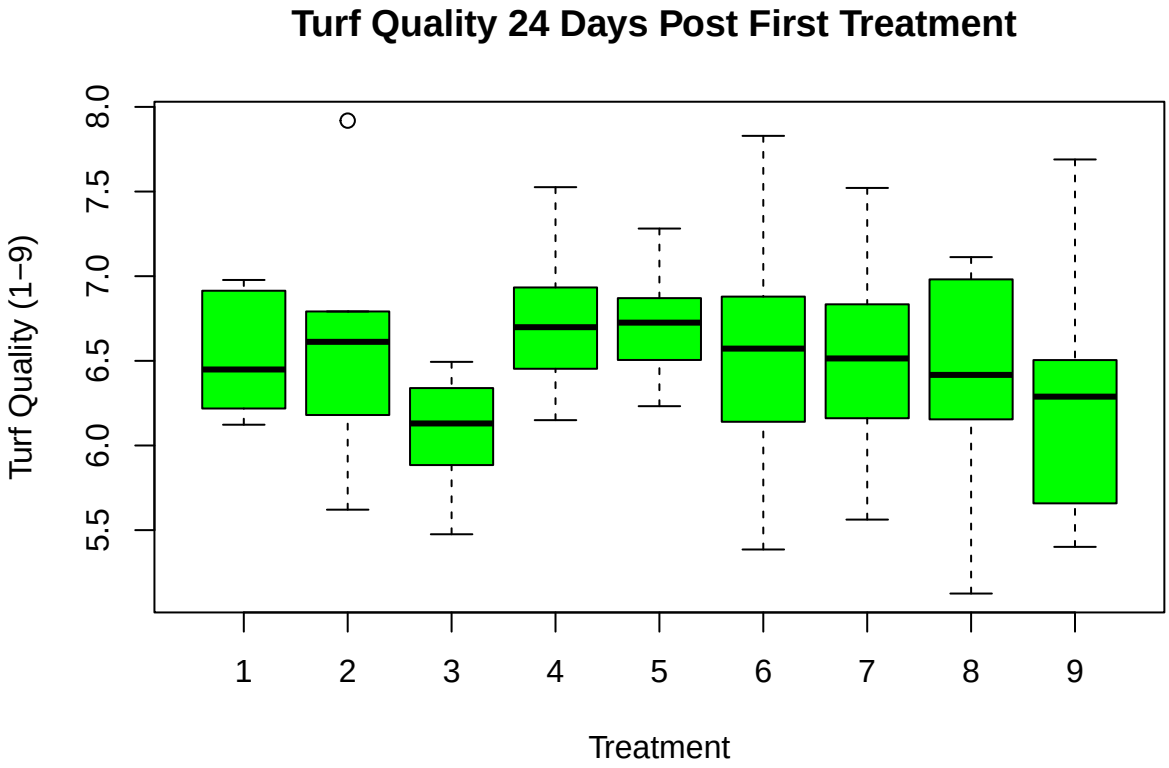


Table 12: Analysis of Variance Model Day 24

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	2.185	0.2731	0.7133	0.6785
Residuals	45	17.23	0.3829	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.6 Quality 29 Days post First Treatment (2022-12-06)

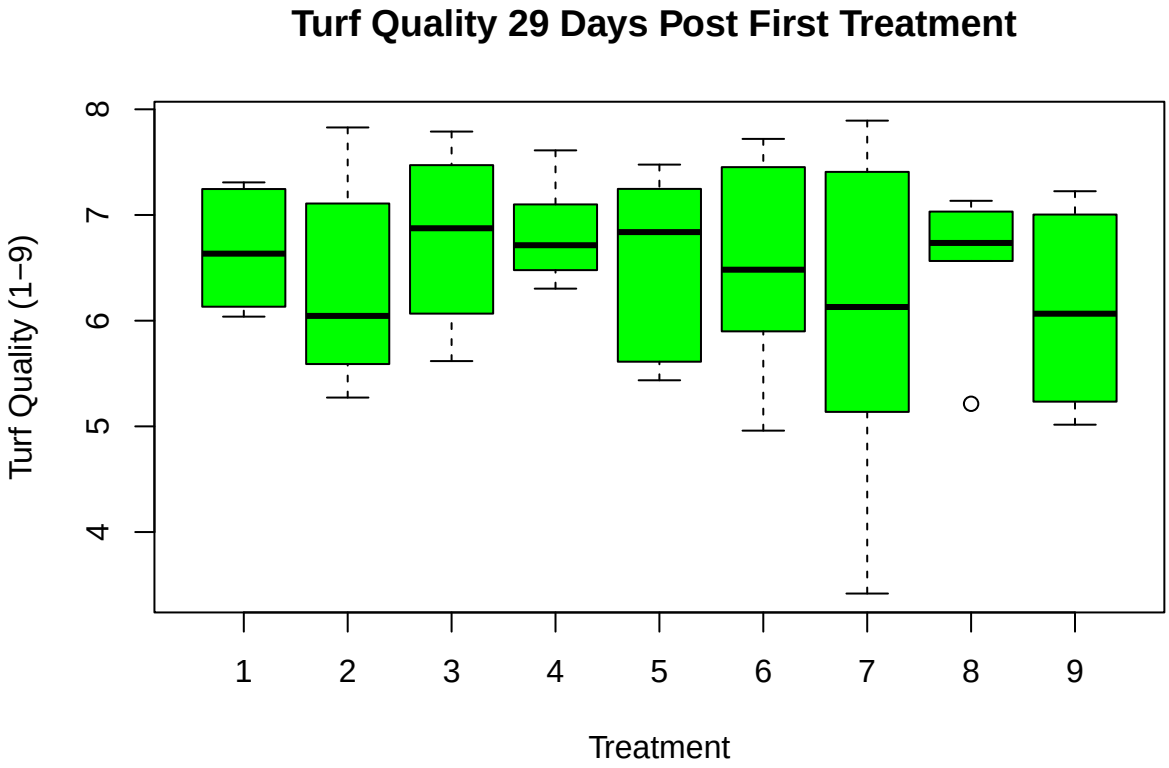


Table 13: Analysis of Variance Model Day 29

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	3.849	0.4811	0.5229	0.8329
Residuals	45	41.4	0.9201	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.7 Quality 32 Days post First Treatment (2022-12-09)

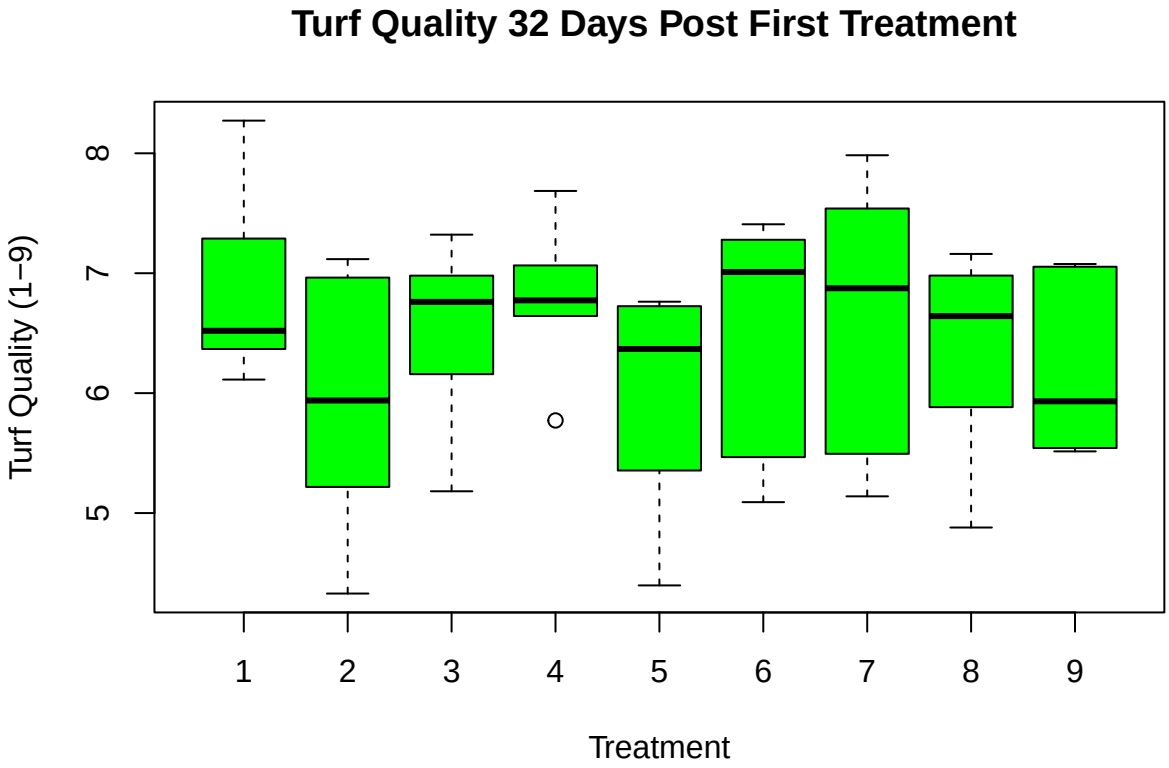


Table 14: Analysis of Variance Model Day 32

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5.35	0.6687	0.8295	0.5814
Residuals	45	36.28	0.8062	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.8 Quality 39 Days post First Treatment (2022-12-16)

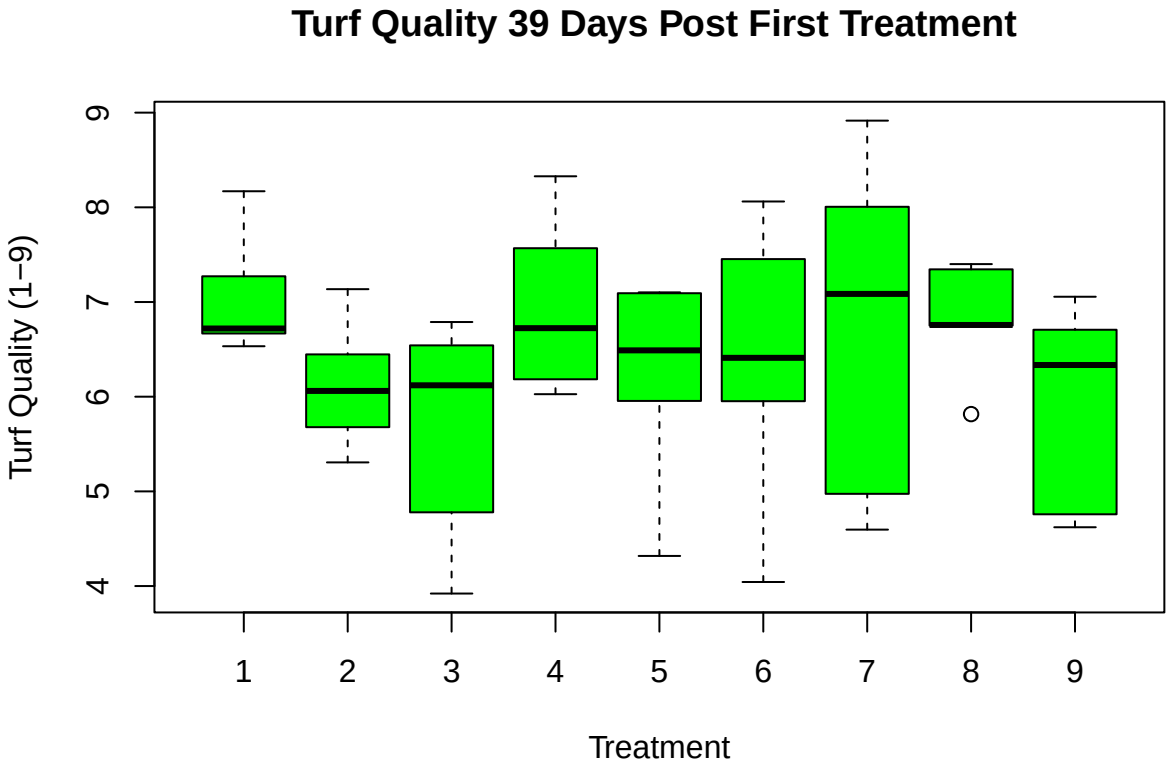


Table 15: Analysis of Variance Model Day 39

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	10.27	1.284	1.135	0.3591
Residuals	45	50.91	1.131	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.9 Quality 46 Days post First Treatment (2022-12-23)

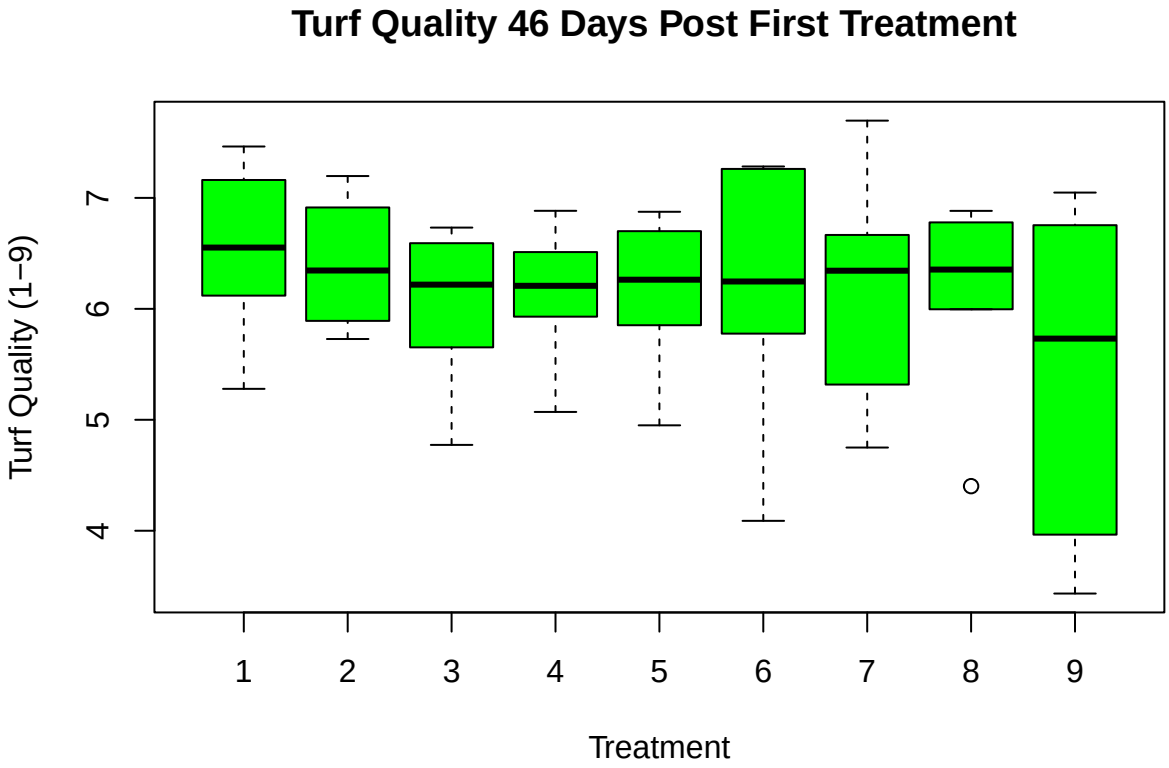


Table 16: Analysis of Variance Model Day 46

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	4.273	0.5341	0.6063	0.7676
Residuals	45	39.64	0.8809	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.10 Quality 53 Days post First Treatment (2022-12-23)

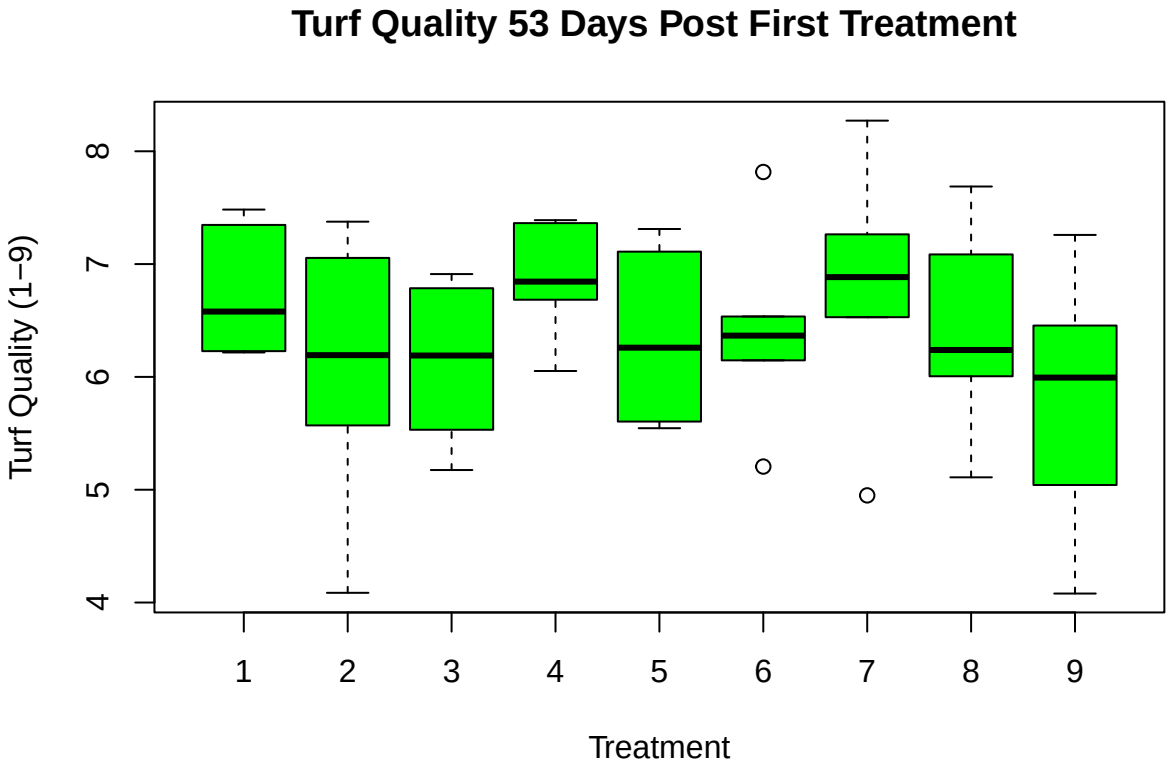


Table 17: Analysis of Variance Model Day 53

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6.125	0.7657	0.9598	0.4789
Residuals	45	35.9	0.7978	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.11 Quality 67 Days post First Treatment (2023-01-13)

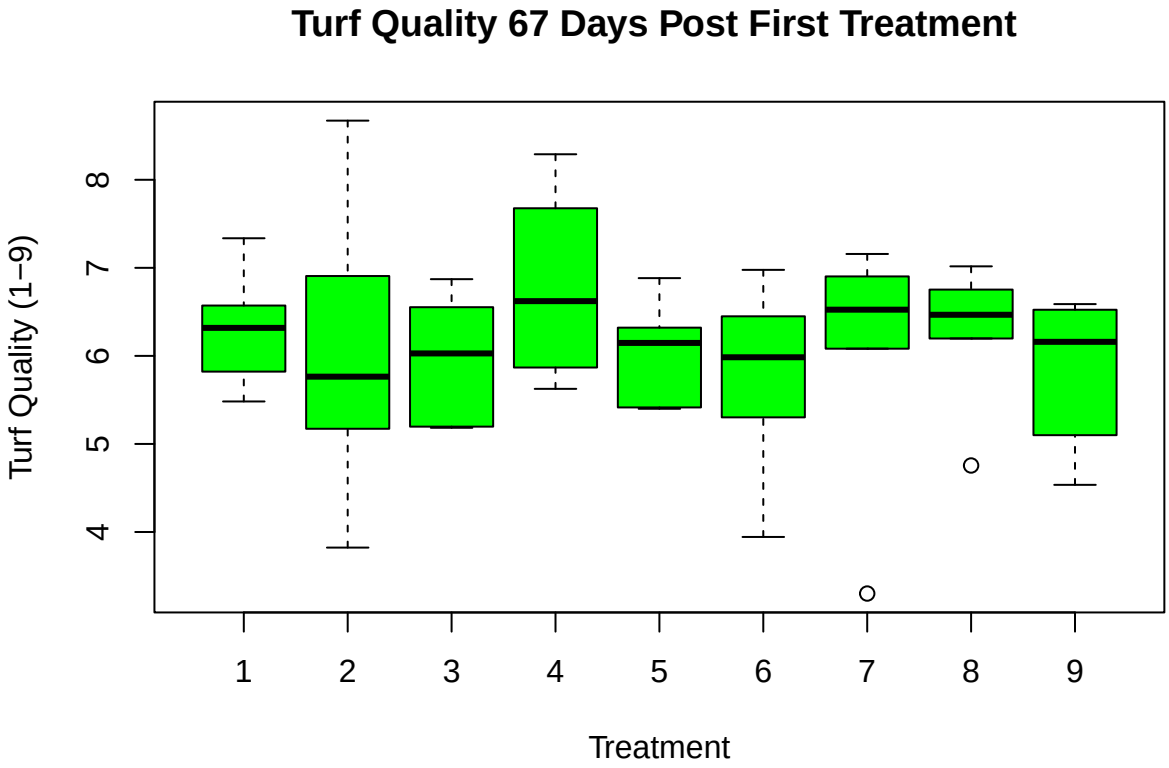


Table 18: Analysis of Variance Model Day 67

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	4.403	0.5503	0.512	0.841
Residuals	45	48.36	1.075	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.12 Quality 91 Days post First Treatment (2023-02-06)

This data was recorded after a two month gap in applications and prior to reapplication on the same day.

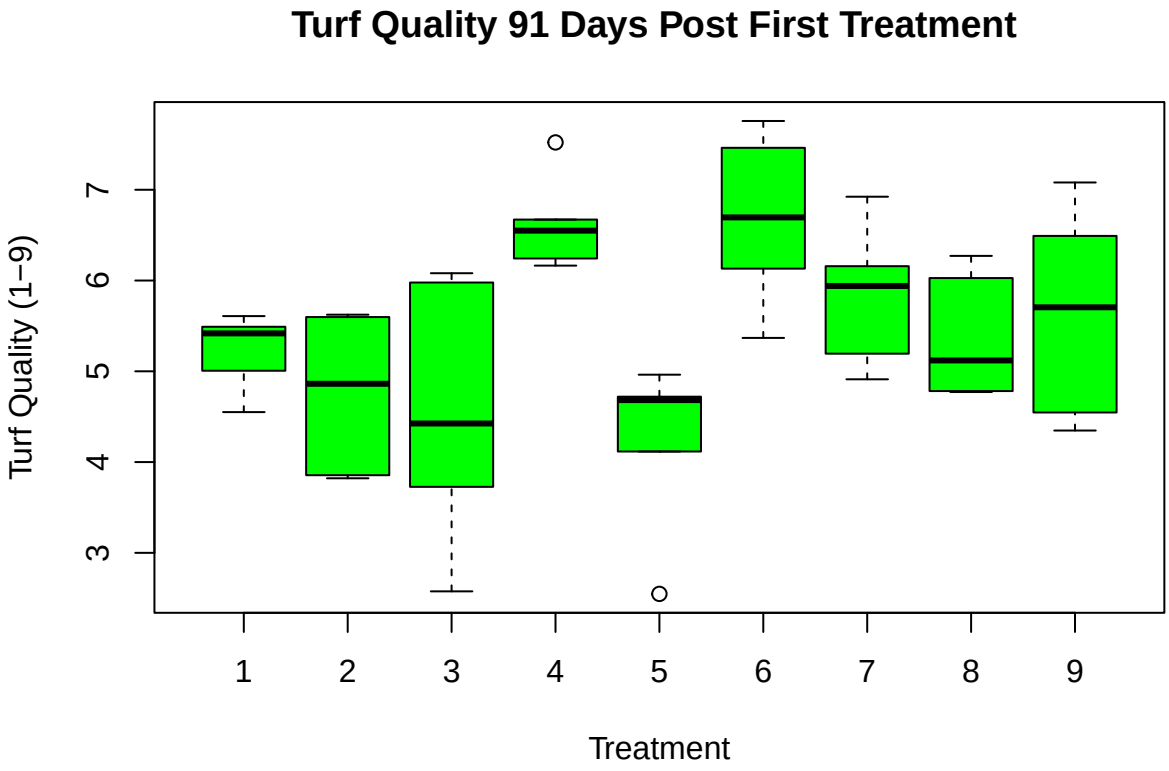
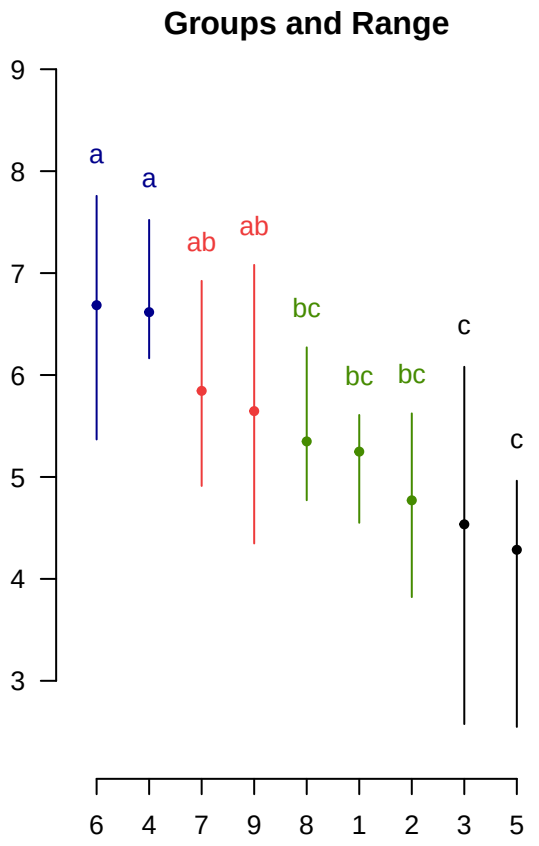


Table 19: Analysis of Variance Model Day 91

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	34.71	4.339	5.922	3.5e-05
Residuals	45	32.97	0.7327	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a highly significant difference in Treatment factor levels.


Groups and Range
9
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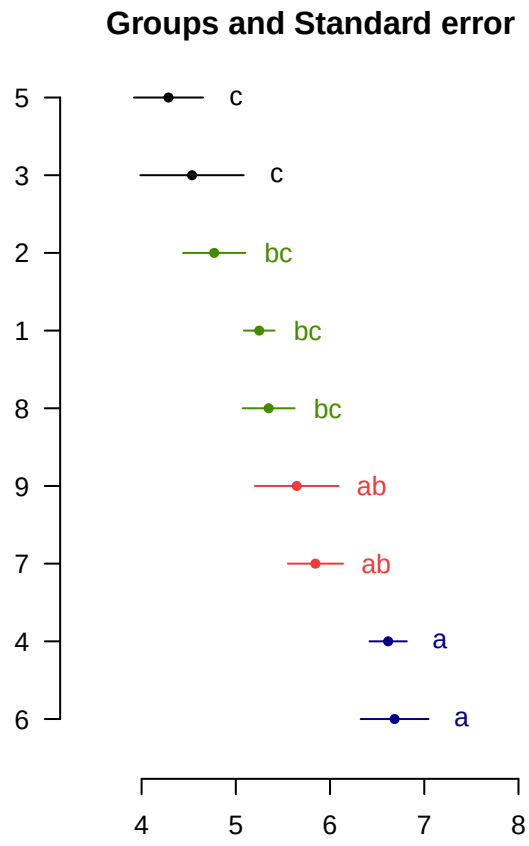
6 4 7 9 8 1 2 3 5


Groups and Standard error
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9.13 Quality 106 Days post First Treatment (2023-02-21)

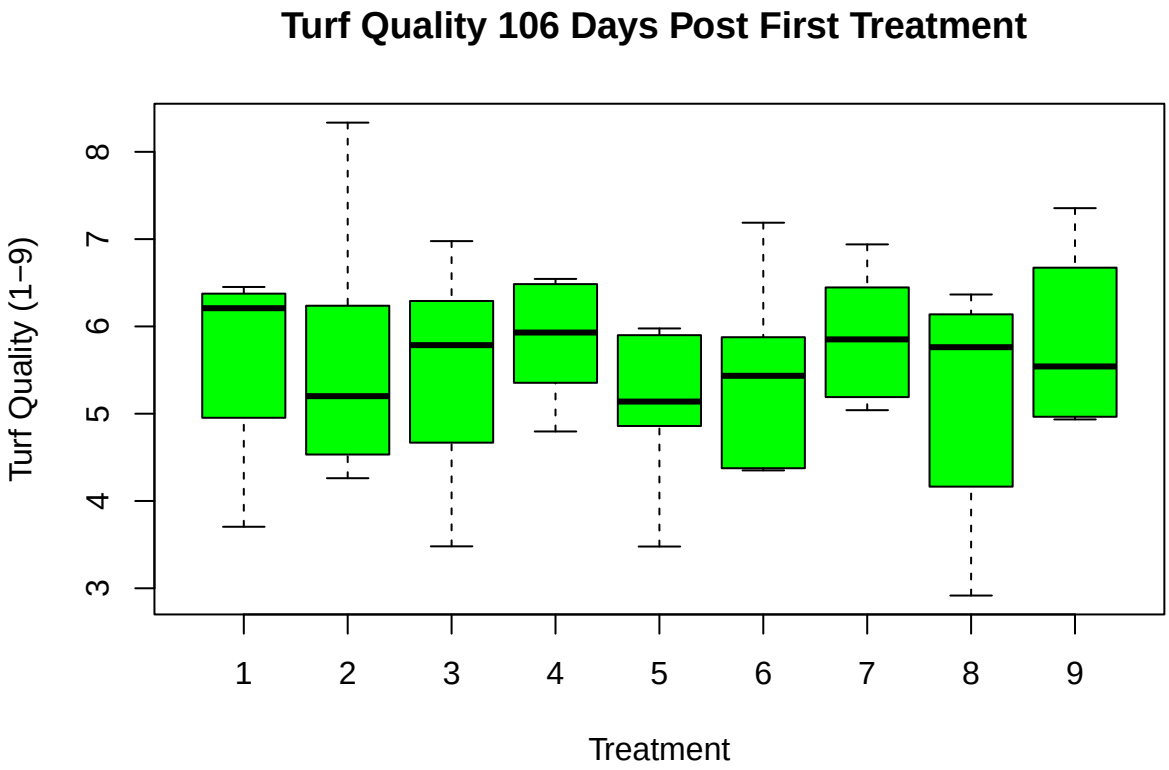


Table 20: Analysis of Variance Model Day 106

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	3.961	0.4951	0.4065	0.9109
Residuals	45	54.8	1.218	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.14 Quality 116 Days post First Treatment (2023-03-03)

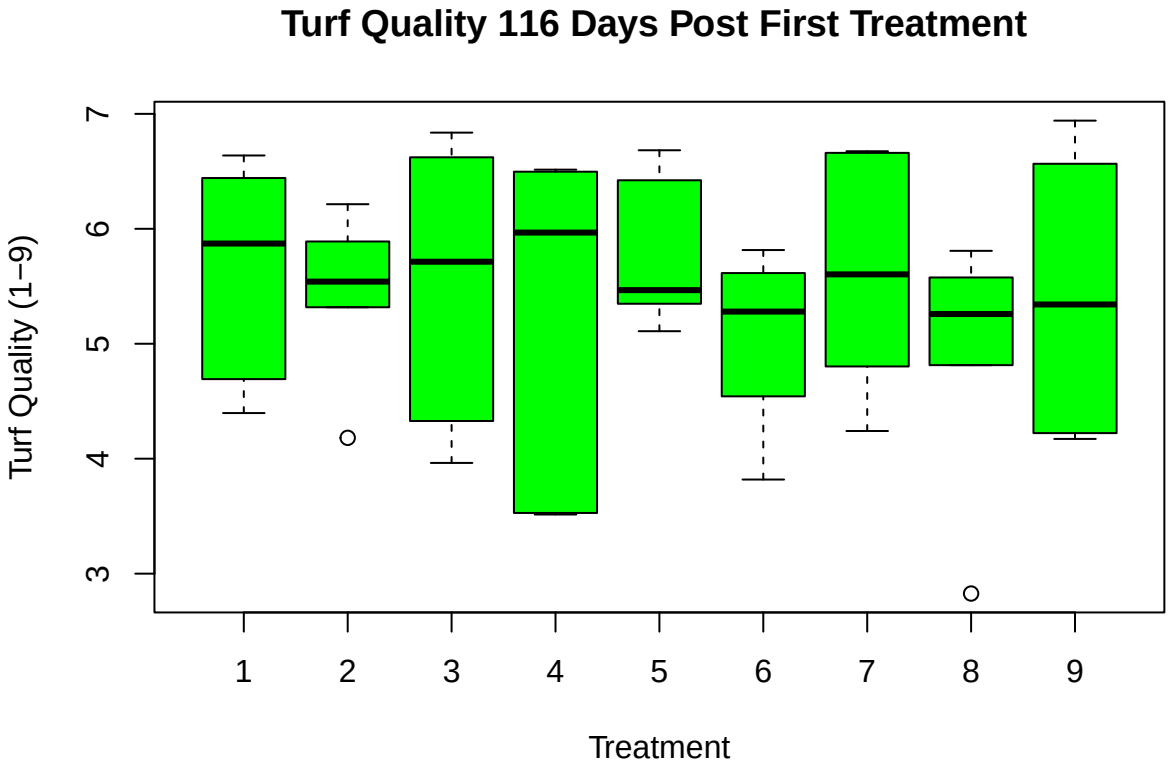


Table 21: Analysis of Variance Model Day 116

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	3.547	0.4433	0.4177	0.9043
Residuals	45	47.76	1.061	NA	NA

In the resulting ANOVA table, the F-tests show that there is no significant difference in Treatment factor levels.

9.15 Quality 123 Days post First Treatment (2023-03-10)

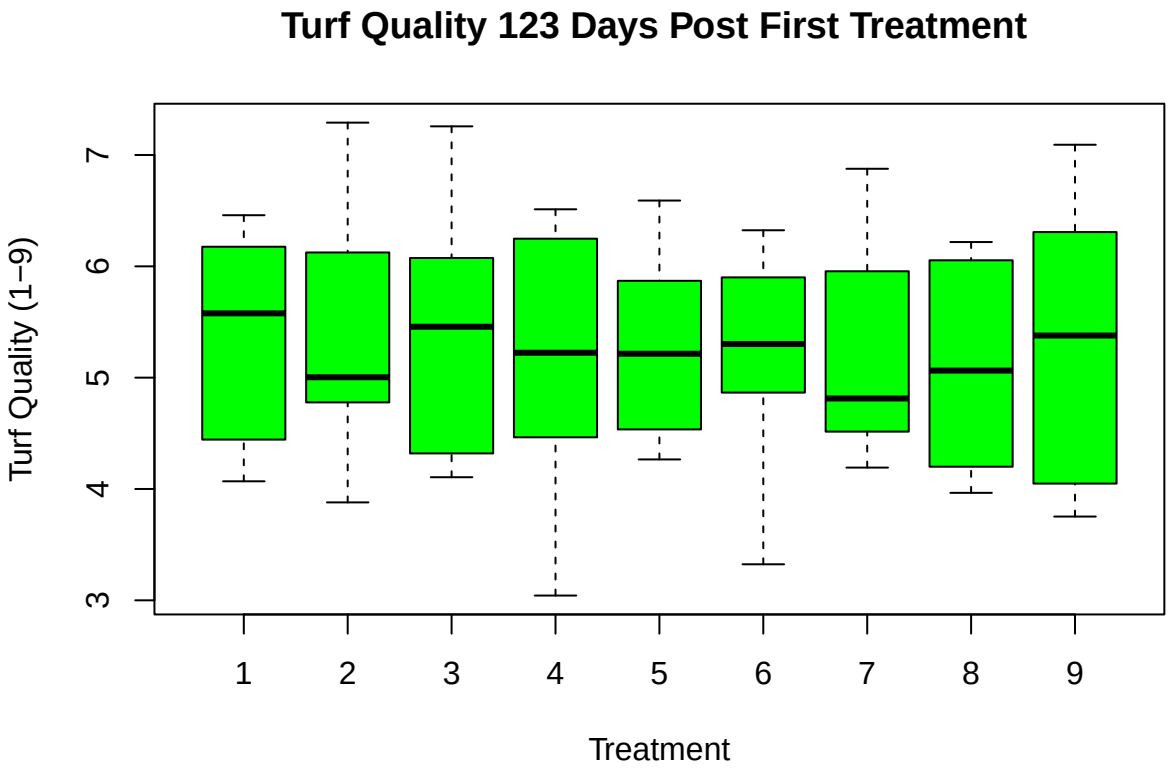


Table 22: Analysis of Variance Model Day 123

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	0.7308	0.09135	0.07527	0.9997
Residuals	45	54.62	1.214	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.16 Turf Quality Reading 130 Days Post Treatment (2022-03-17)

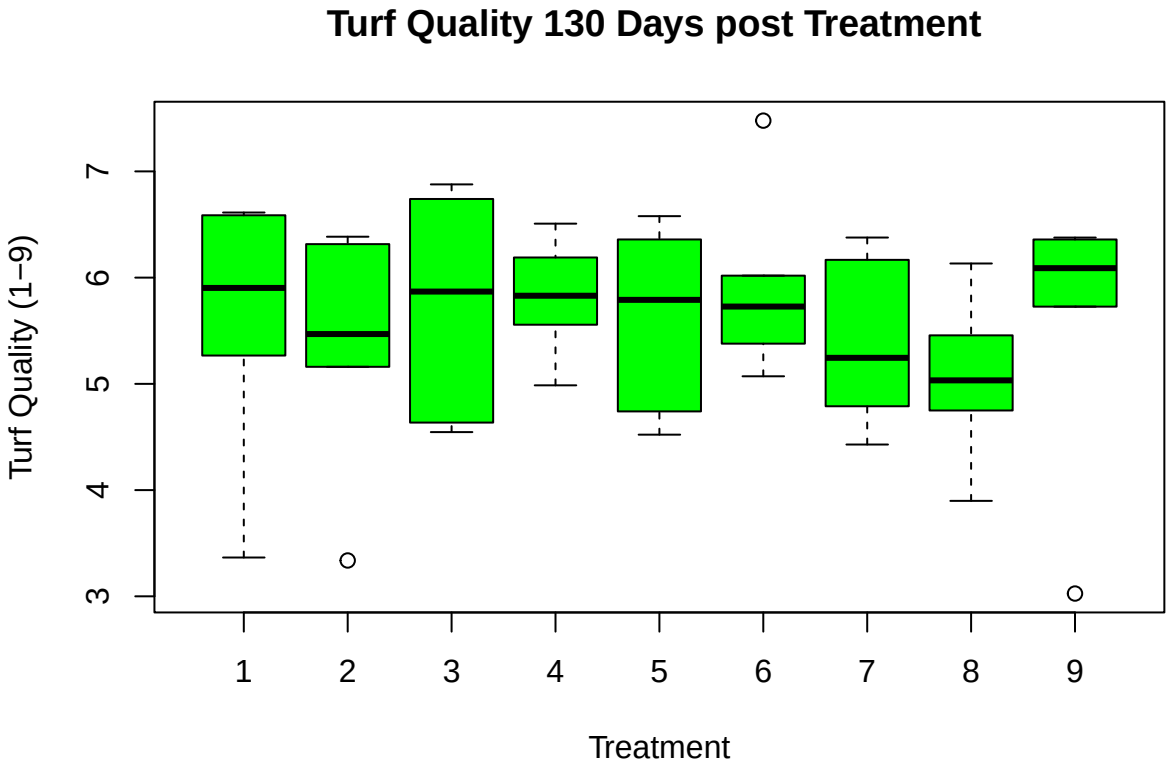


Table 23: Analysis of Variance Model 130 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	3.388	0.4234	0.4574	0.8792
Residuals	45	41.66	0.9258	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.17 Turf Quality Reading 137 Days Post Treatment (2022-03-24)

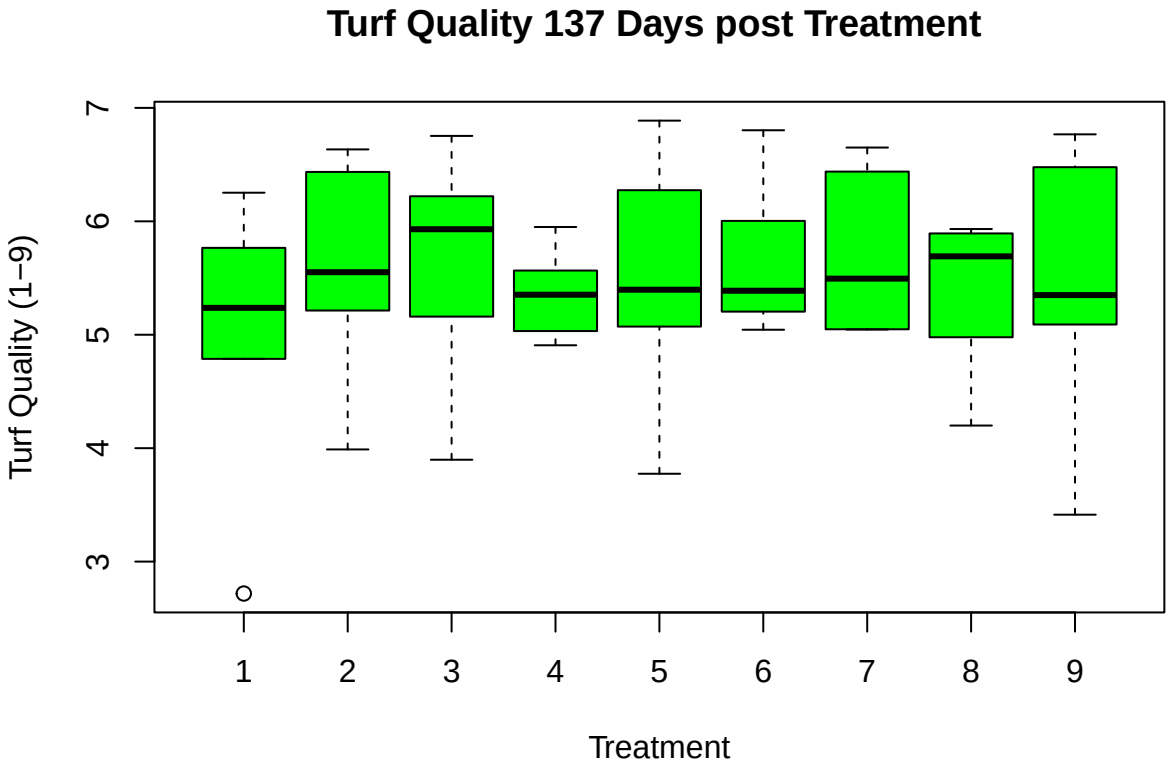


Table 24: Analysis of Variance Model 137 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	2.171	0.2713	0.3231	0.953
Residuals	45	37.79	0.8397	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.18 Turf Quality Reading 144 Days Post Treatment (2022-03-31)

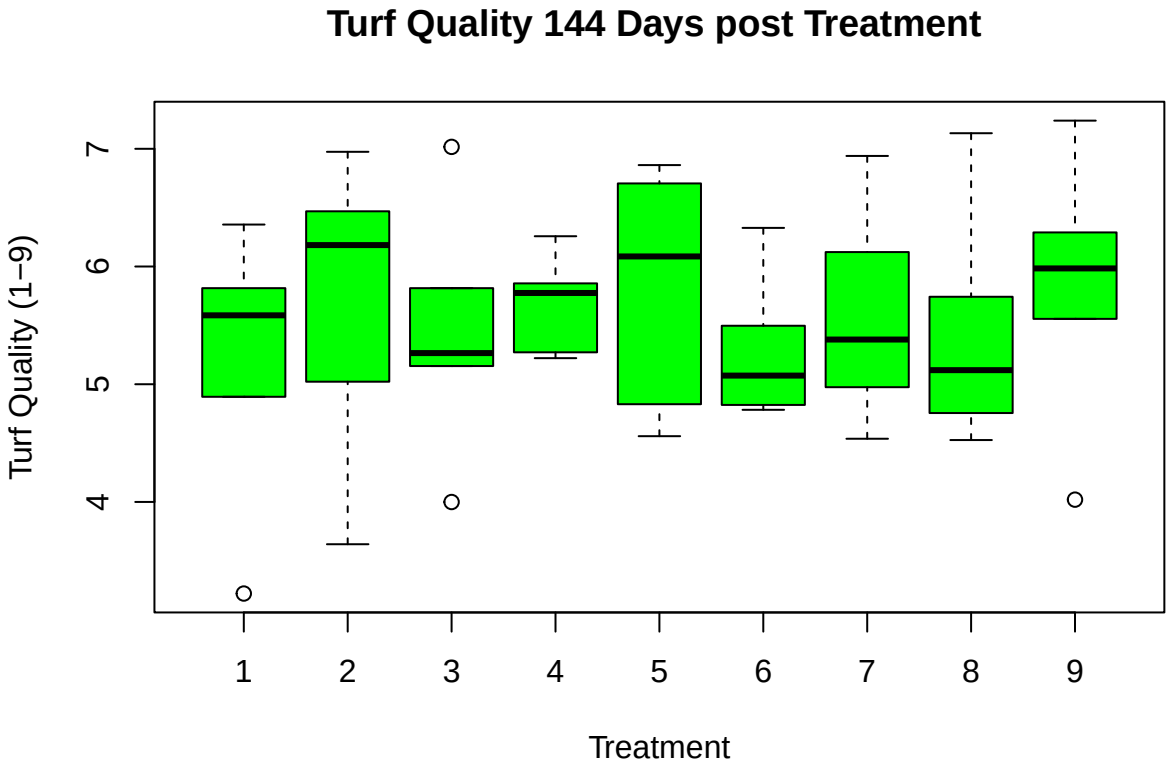


Table 25: Analysis of Variance Model 144 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	2.725	0.3406	0.3877	0.9215
Residuals	45	39.53	0.8785	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.19 Turf Quality Reading 151 Days Post Treatment (2022-04-06)

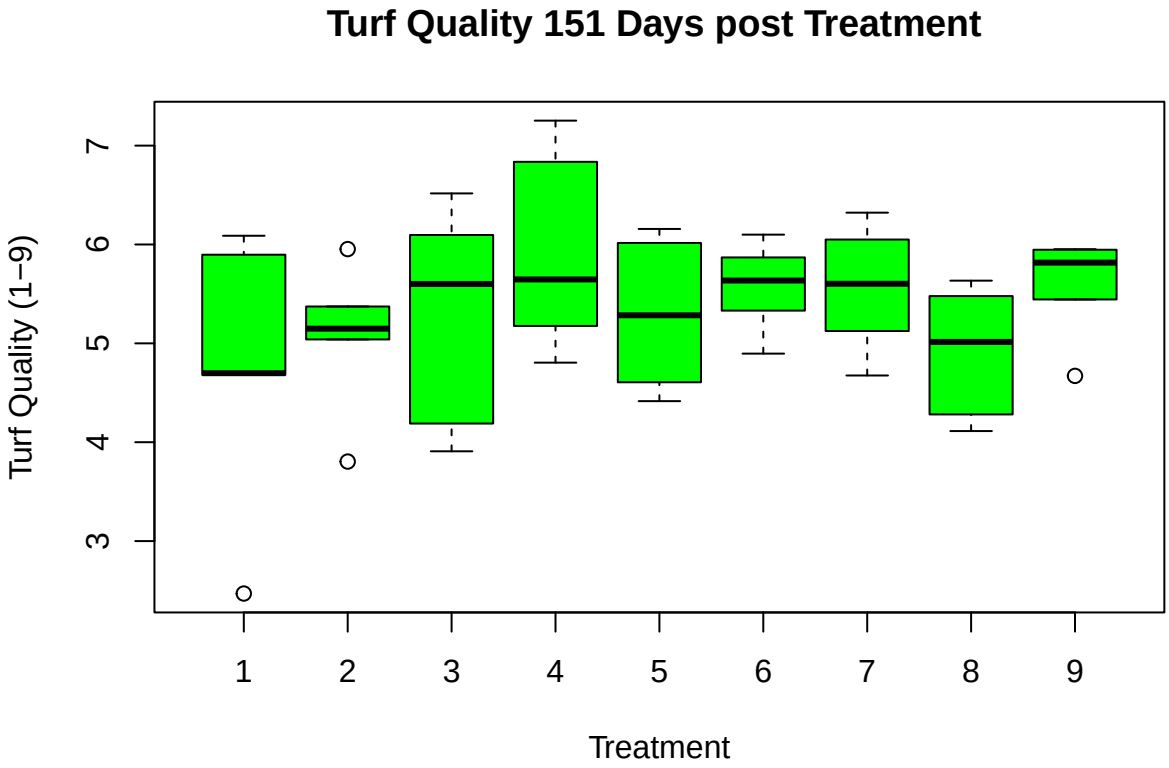


Table 26: Analysis of Variance Model 151 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6.43	0.8038	1.183	0.3302
Residuals	45	30.56	0.6792	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.20 Turf Quality Reading 159 Days Post Treatment (2022-04-14)

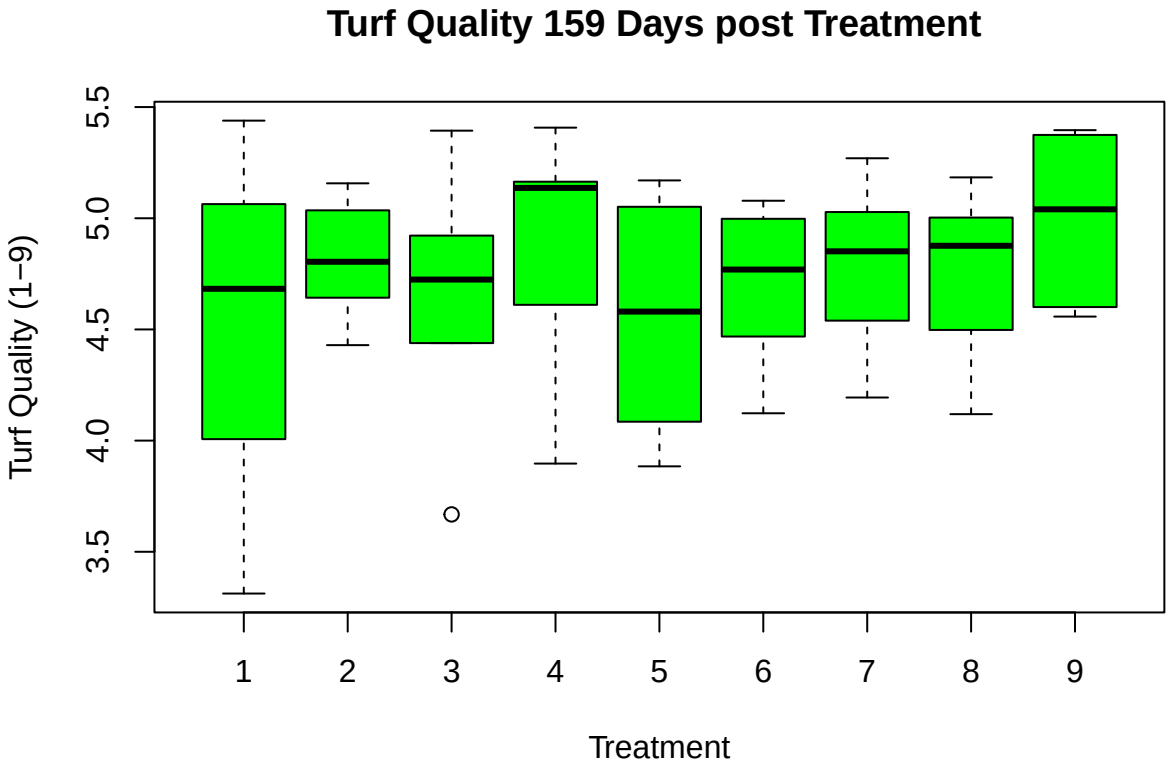


Table 27: Analysis of Variance Model 159 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	1.119	0.1398	0.5811	0.7879
Residuals	45	10.83	0.2407	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.21 Turf Quality Reading 165 Days Post Treatment (2022-04-20)

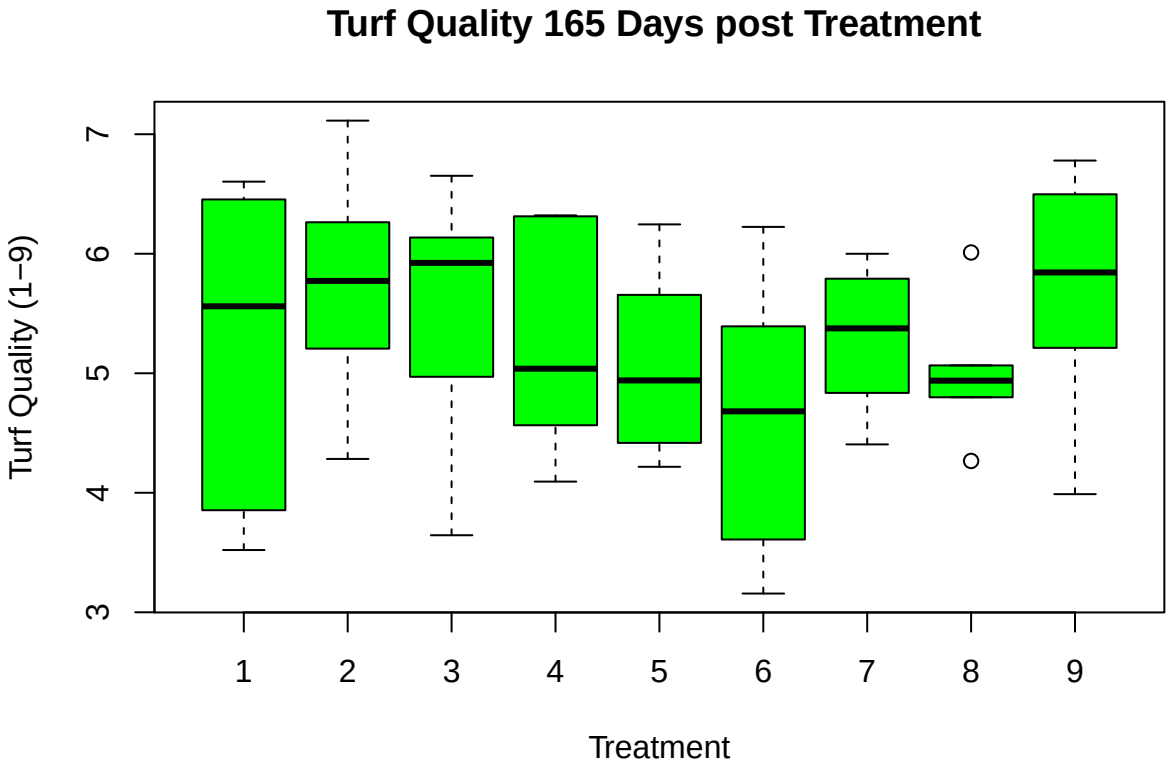


Table 28: Analysis of Variance Model 165 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6.008	0.751	0.7862	0.6172
Residuals	45	42.98	0.9552	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.22 Turf Quality Reading 173 Days Post Treatment (2022-04-28)

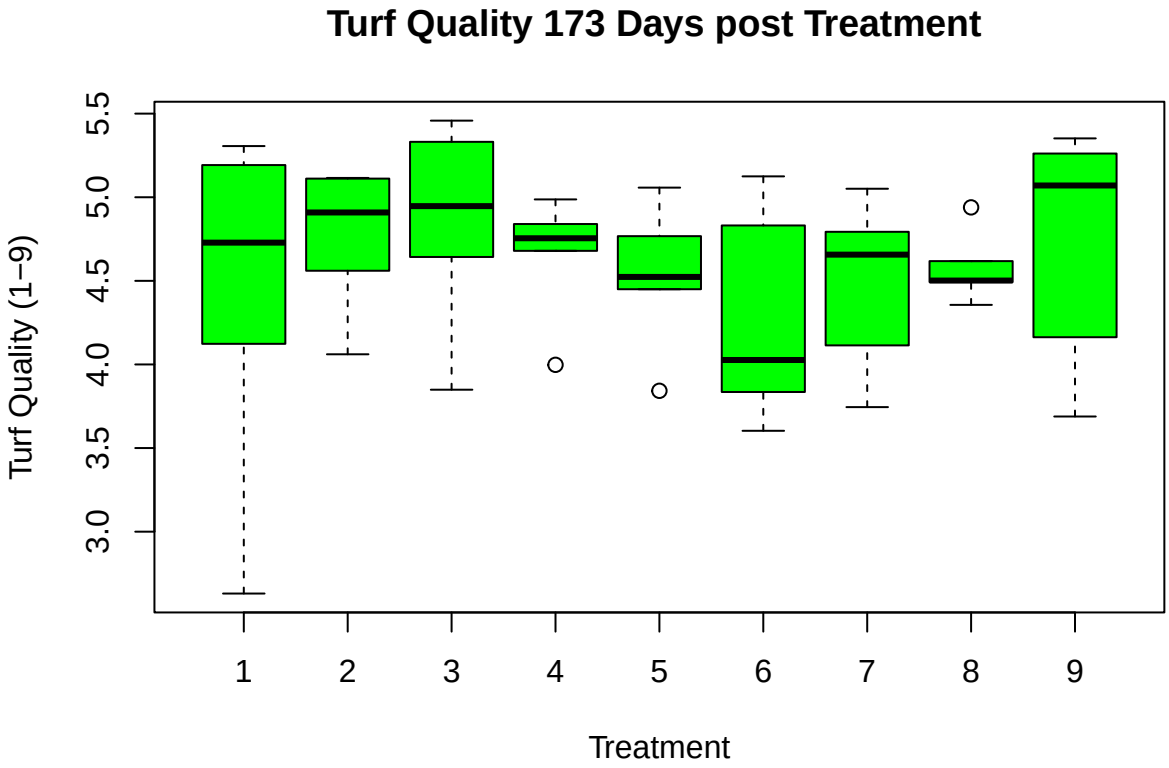


Table 29: Analysis of Variance Model 173 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	1.797	0.2247	0.7074	0.6835
Residuals	45	14.29	0.3176	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.23 Turf Quality Reading 180 Days Post Treatment (2022-05-05)

This is 4 days post re application (6th application in total).

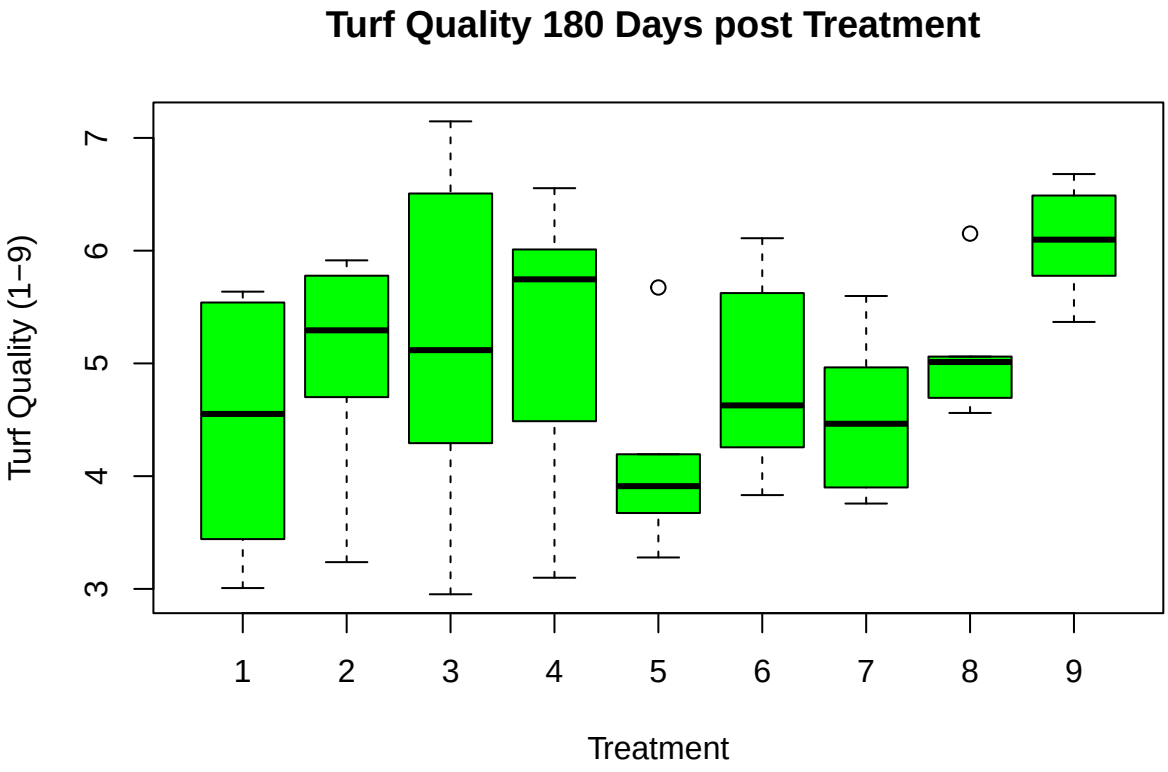
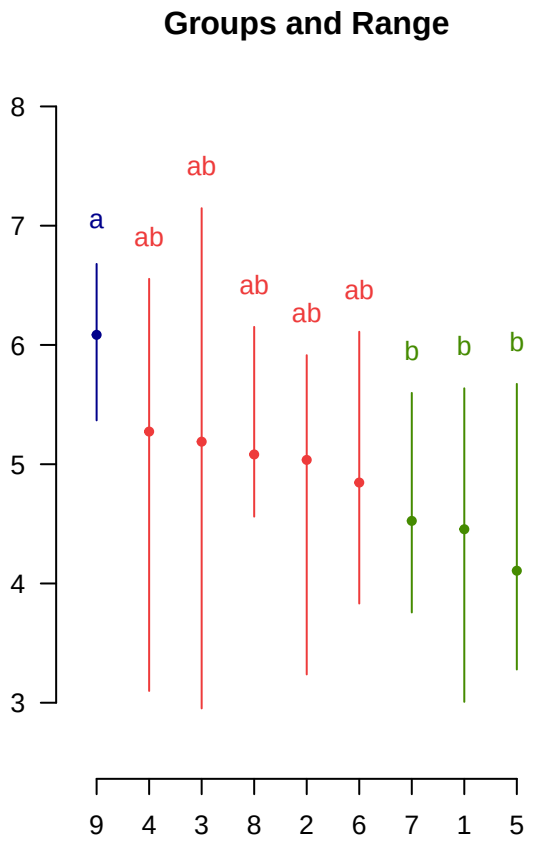


Table 30: Analysis of Variance Model 180 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	15.73	1.966	2.075	0.0586
Residuals	45	42.65	0.9478	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
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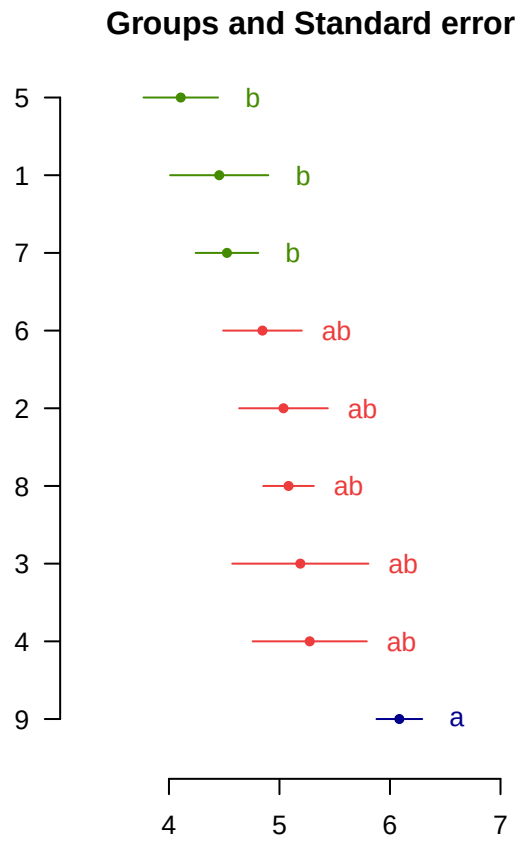
Groups and Standard error
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9.24 Turf Quality Reading 187 Days Post Treatment (2022-05-12)

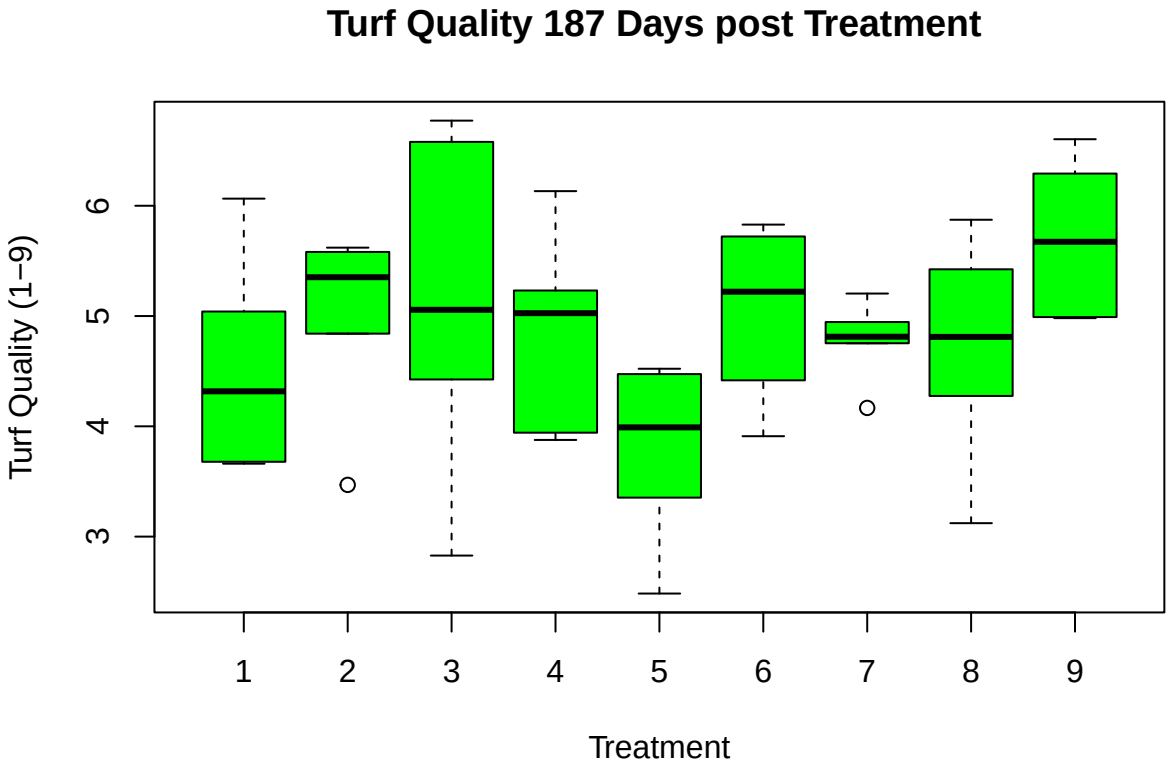
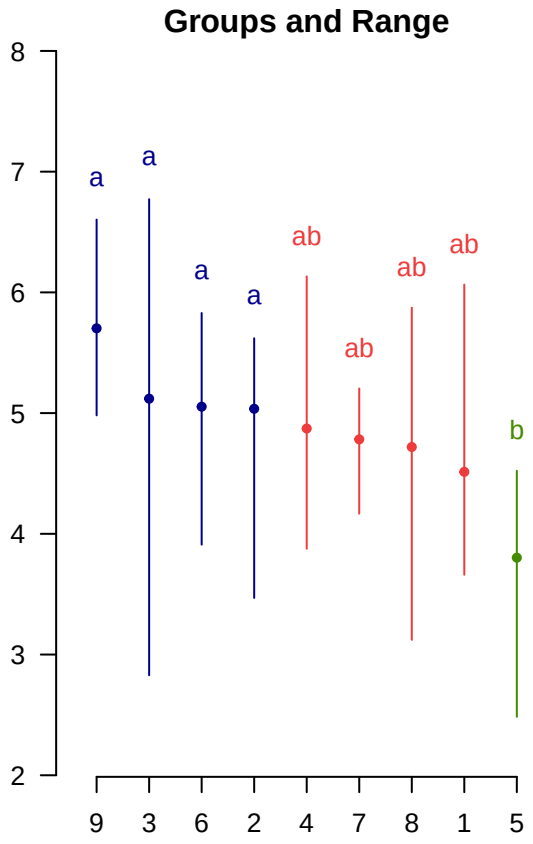


Table 31: Analysis of Variance Model 173 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	12.65	1.581	1.956	0.07461
Residuals	45	36.37	0.8083	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
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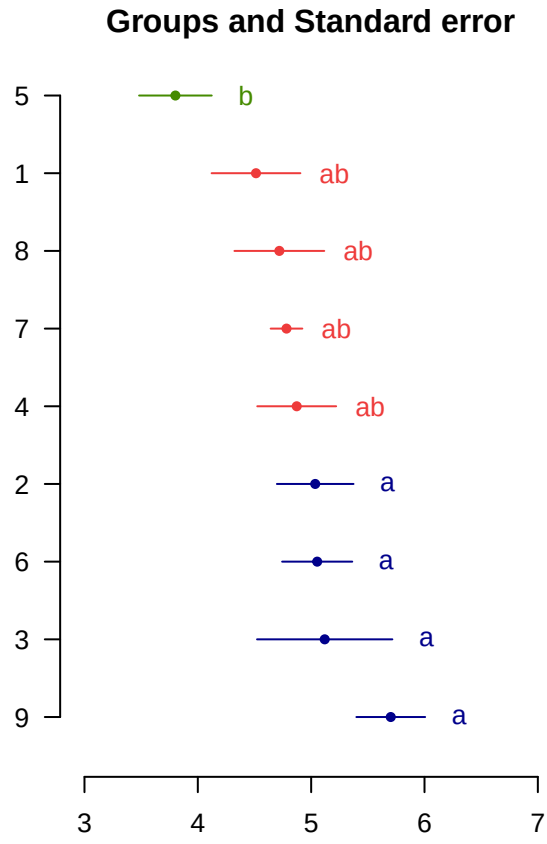
9 3 6 2 4 7 8 1 5


Groups and Standard error
5
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9.25 Turf Quality Reading 194 Days Post Treatment (2022-05-19)

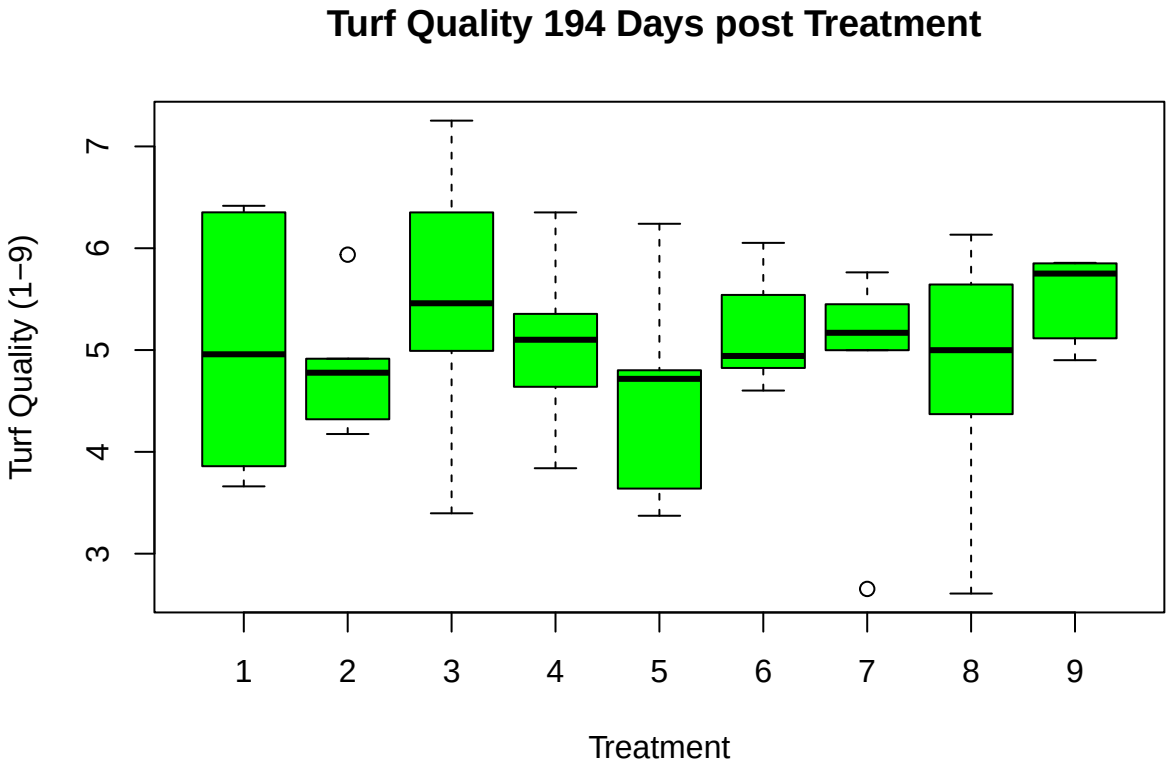


Table 32: Analysis of Variance Model 194 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	4.861	0.6076	0.642	0.7382
Residuals	45	42.59	0.9464	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

9.26 Turf Quality Reading 200 Days Post Treatment (2022-05-25)

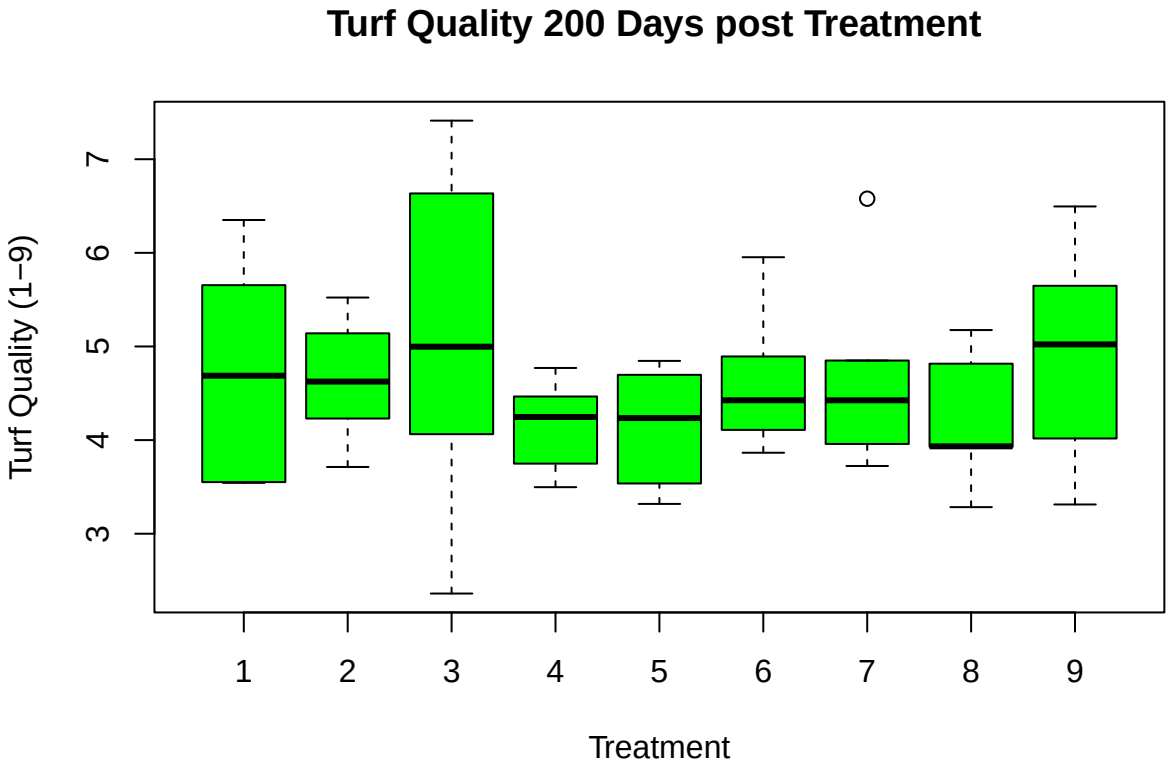


Table 33: Analysis of Variance Model 200 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5.558	0.6947	0.6869	0.7007
Residuals	45	45.51	1.011	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

10 Trufirm - Surface Hardness

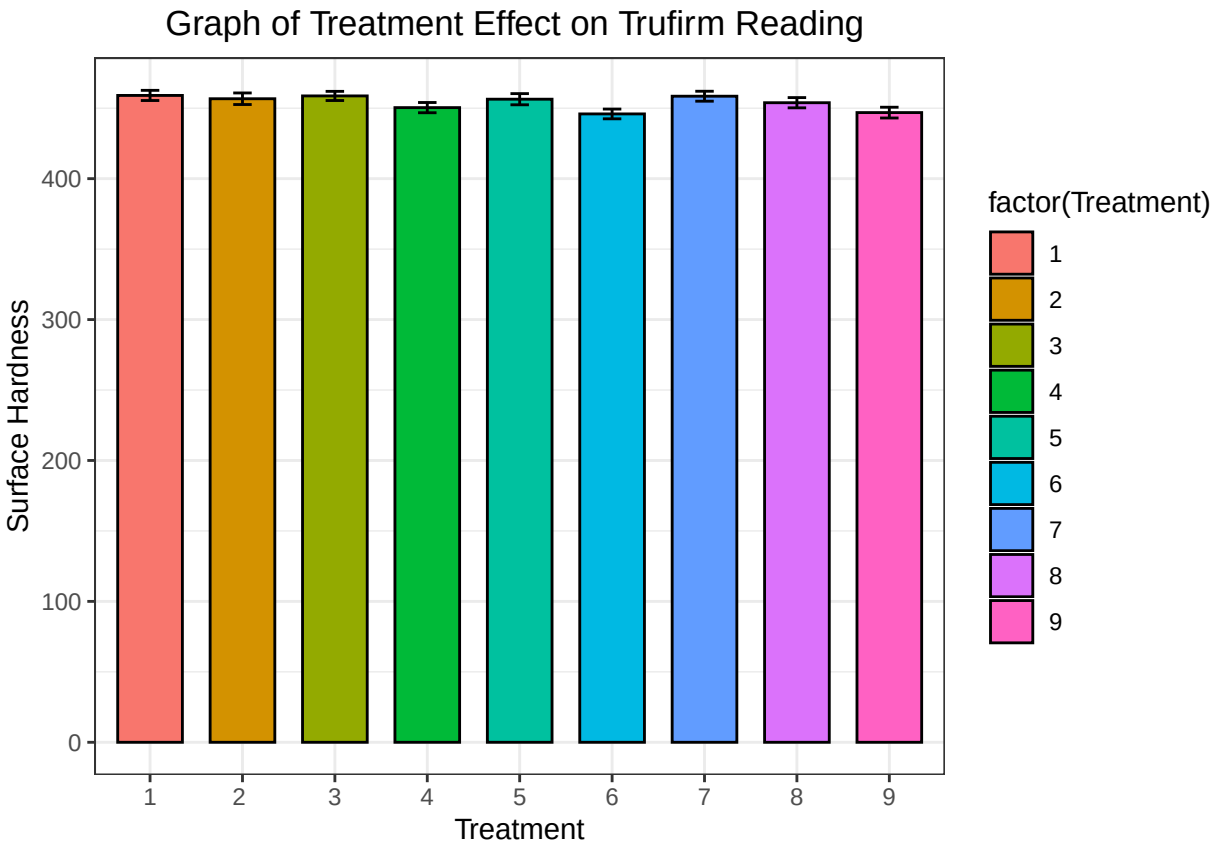
Table 34: Statistics by Treatment

Treatment	n	Trufirm	sd	se	ci
1	156	459.1	45.23	3.621	7.153
2	156	456.7	51.21	4.1	8.099
3	156	458.7	40.63	3.253	6.427
4	156	450.4	45.44	3.638	7.187
5	156	456.4	49.56	3.968	7.839
6	156	445.9	43.24	3.462	6.839
7	156	458.5	44.06	3.528	6.968
8	156	453.9	45.32	3.628	7.167
9	156	446.9	47.73	3.821	7.549

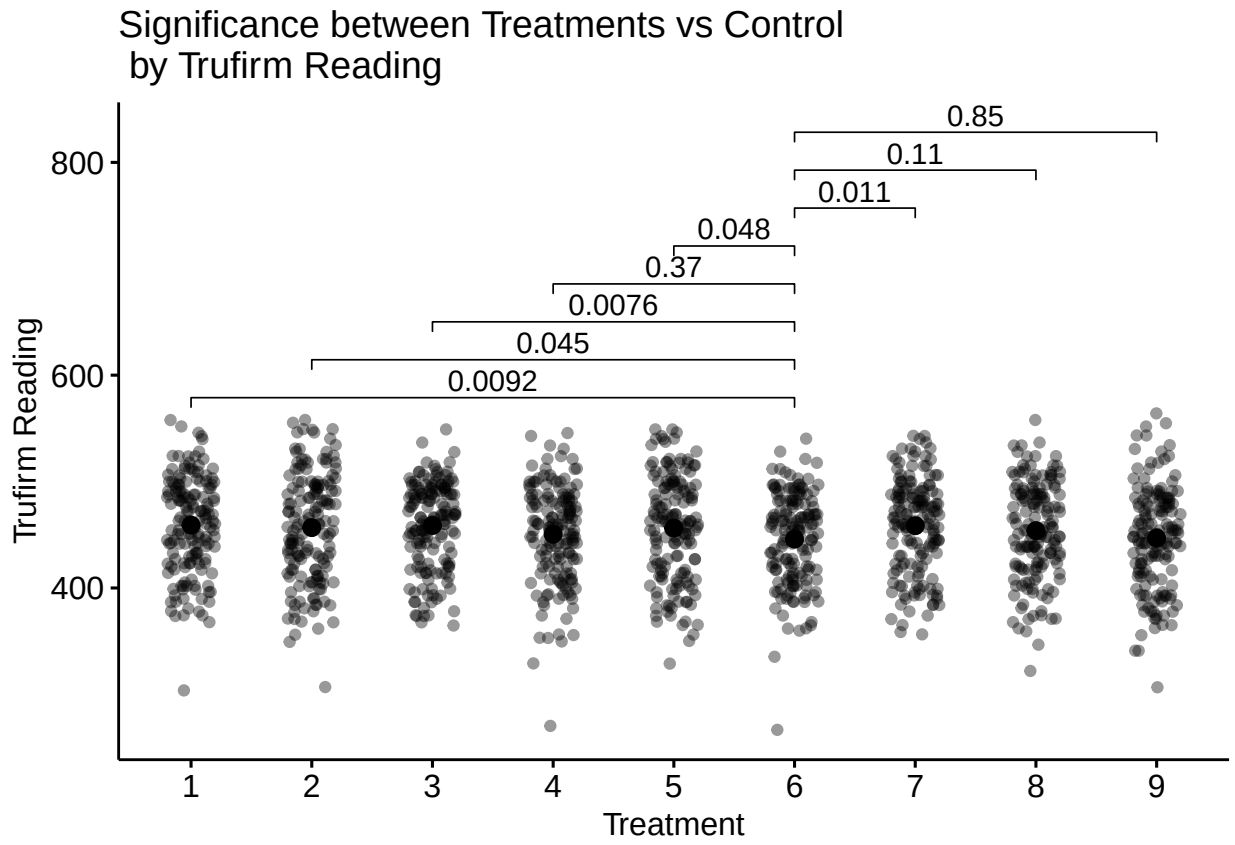
The following table shows the range of surface hardeness readings was from 445.9 (Treatment 6 - the untreated control) being the firmest to 459.1 (Treatment 1) being the softest.

Significant differences in surface hardness and the untreated control existed with all the Treatments apart from Treatment 4, 8 and 9 being significantly softer than the untreated control.

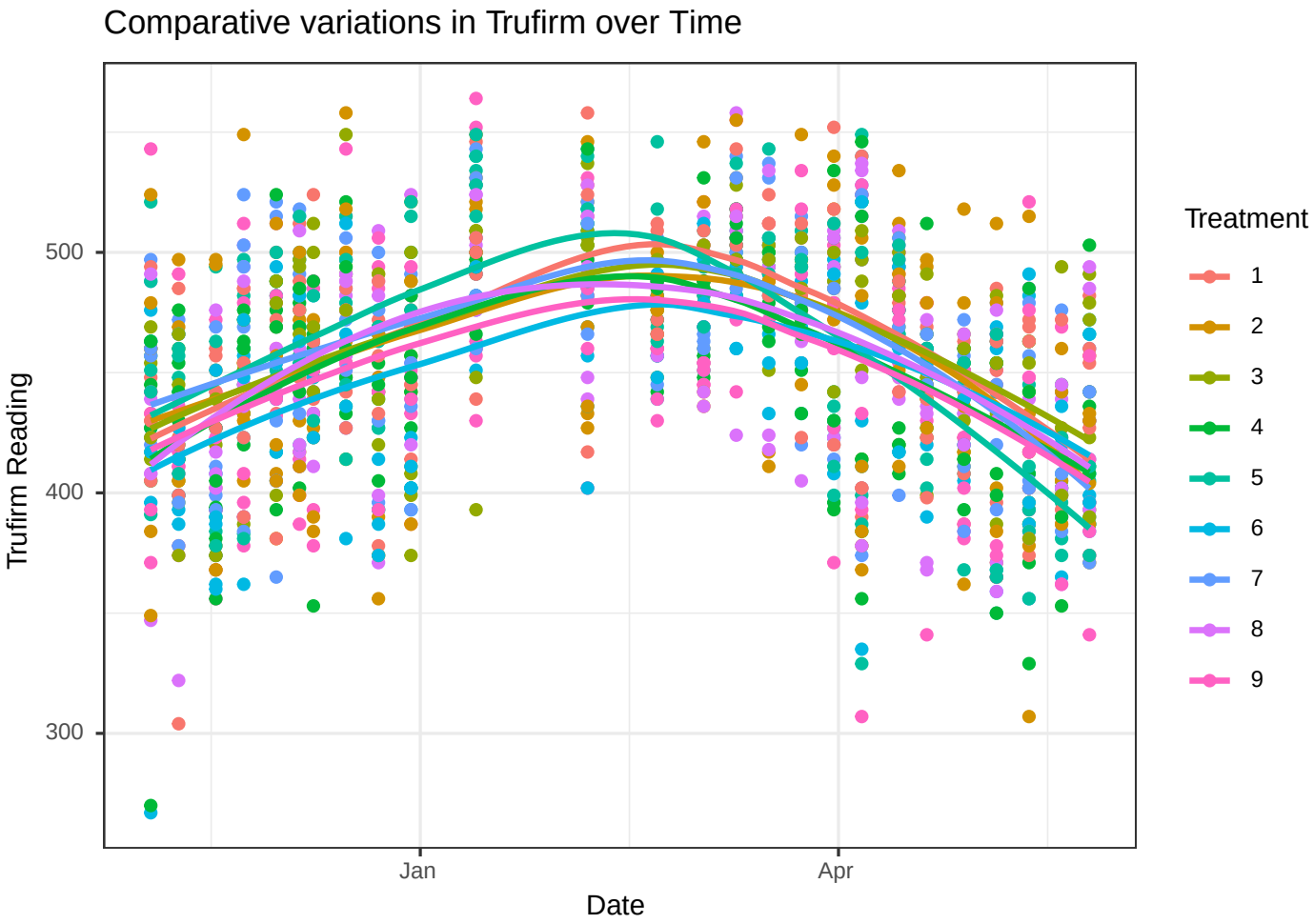
Treatment	Trufirm
1	459.1
2	456.7
3	458.7
4	450.4
5	456.4
6	445.9
7	458.5
8	453.9
9	446.9

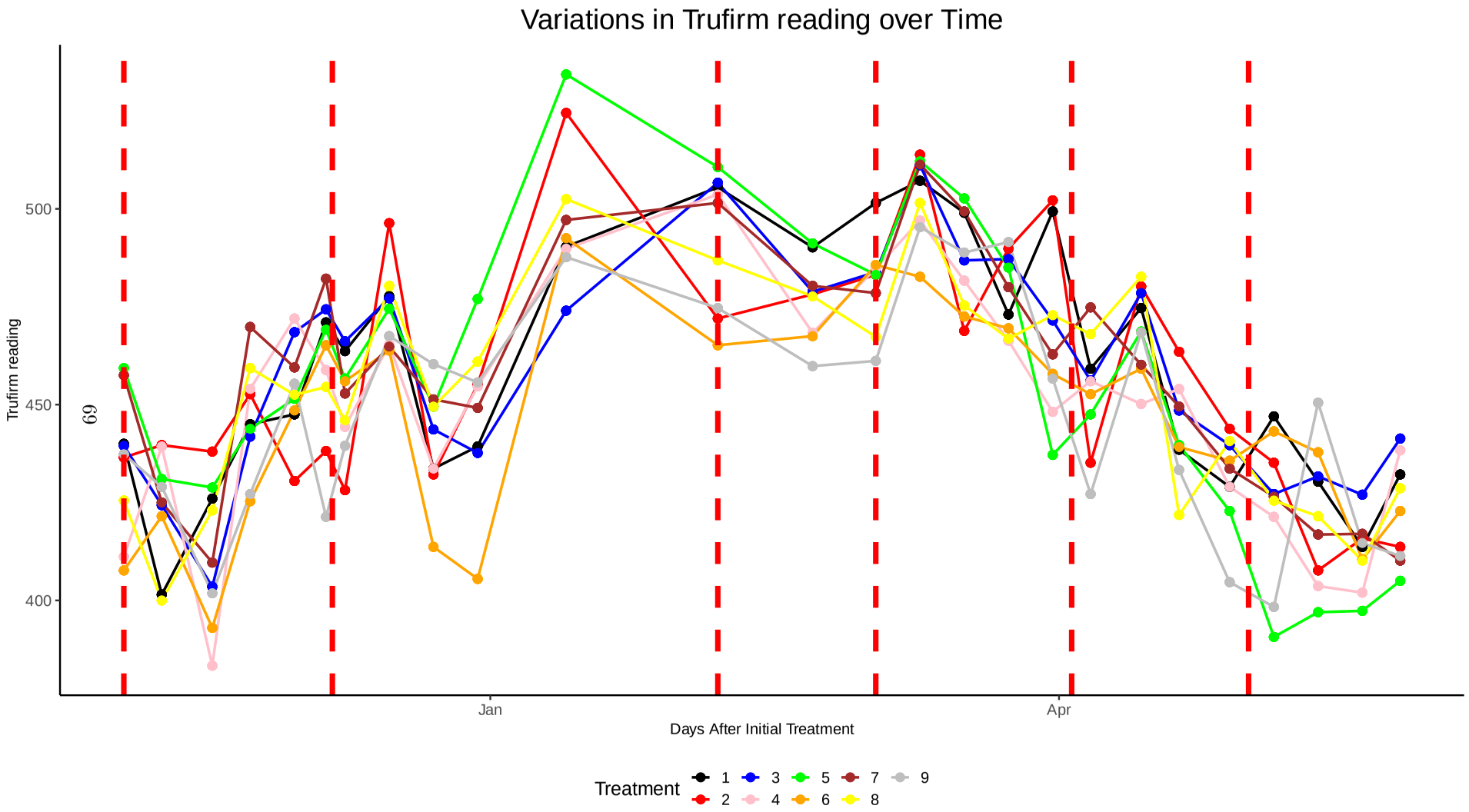


The significance of these results is shown graphically below compared to the untreated control.All Treatments gave significantly higher leaf areas.



Over the duration of the trial the general trend was for the greens to become softer when using soil wetting agents.


Comparative variations in Trufirm over Time
Trufirm Reading
500
400
300
Jan
Apr
Date
Treatment
1
2
3
4
5
6
7
8
9


Variations in Trufirm reading over Time
Trufirm reading
500
450
400
69
Jan
Apr
Days After Initial Treatment
Treatment
1
2
3
4
5
6
7
8
9

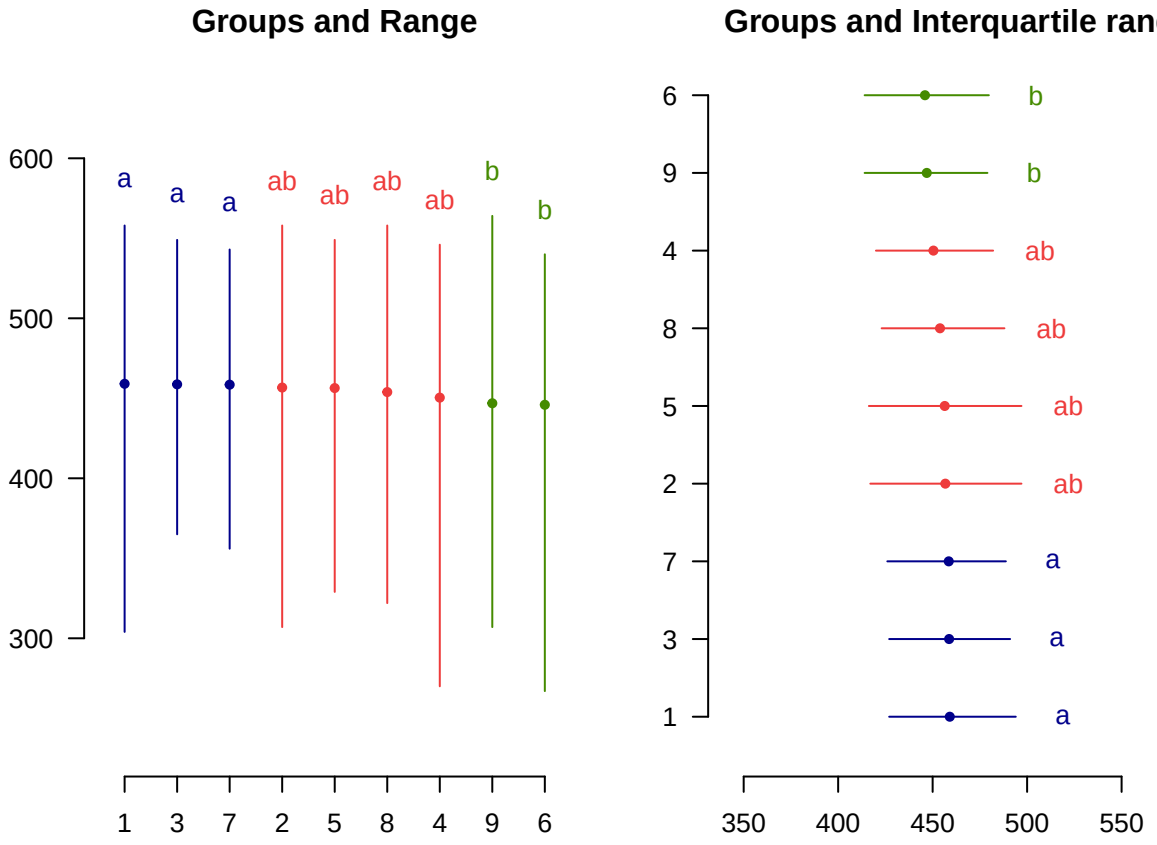
Analysis showed that the Treatment has a significant effect in relation to surface hardness.

Table 36: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(Treatment)	8	32727	4091	1.94	0.05073
Residuals	1395	2942393	2109	NA	NA

Table 37: Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	5	64083	12817	6.217	1.037e-05
Treatment	8	32727	4091	1.985	0.04503
Date	1	2812	2812	1.364	0.243
Treatment:Date	8	28679	3585	1.739	0.08515
Residuals	1381	2846819	2061	NA	NA



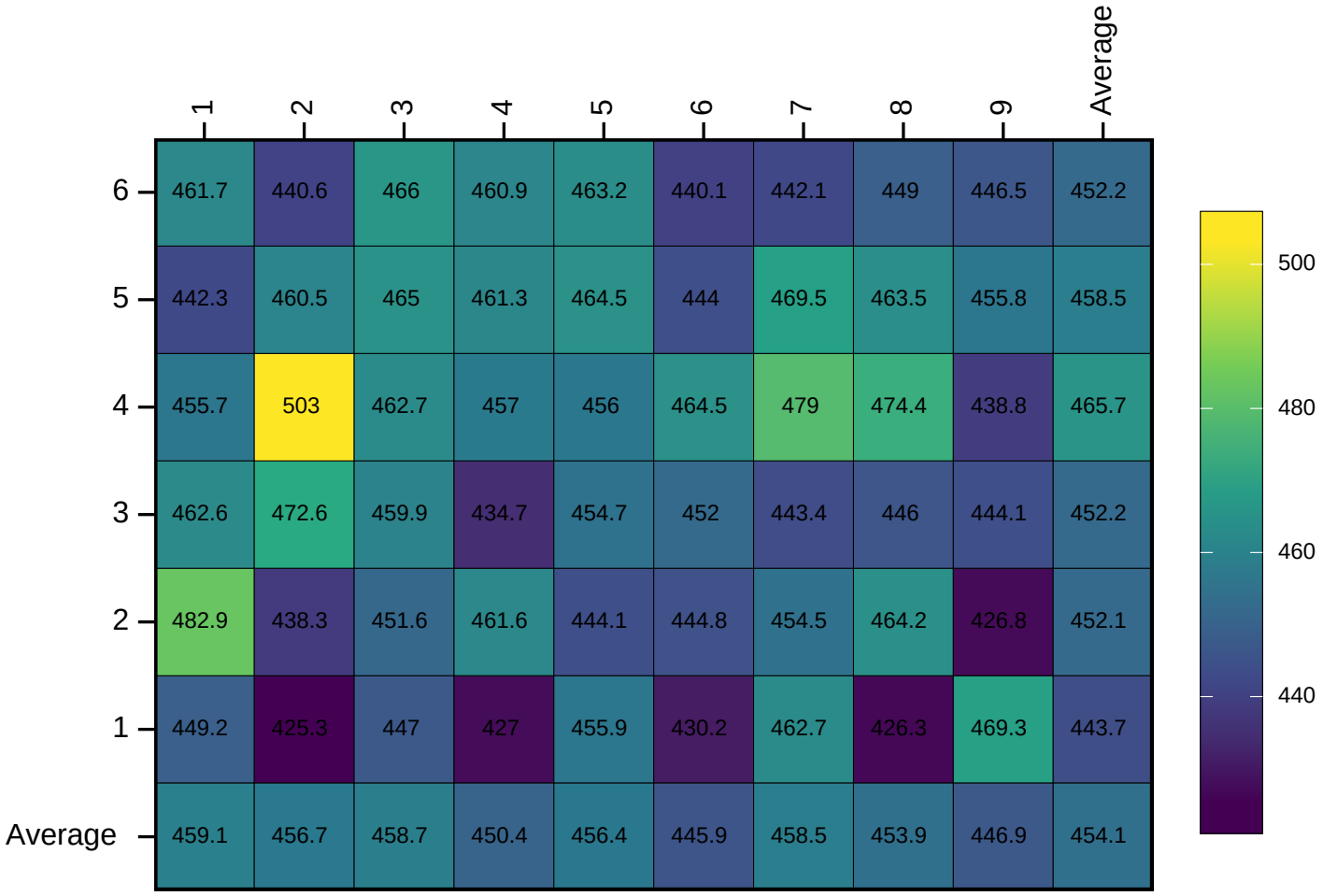
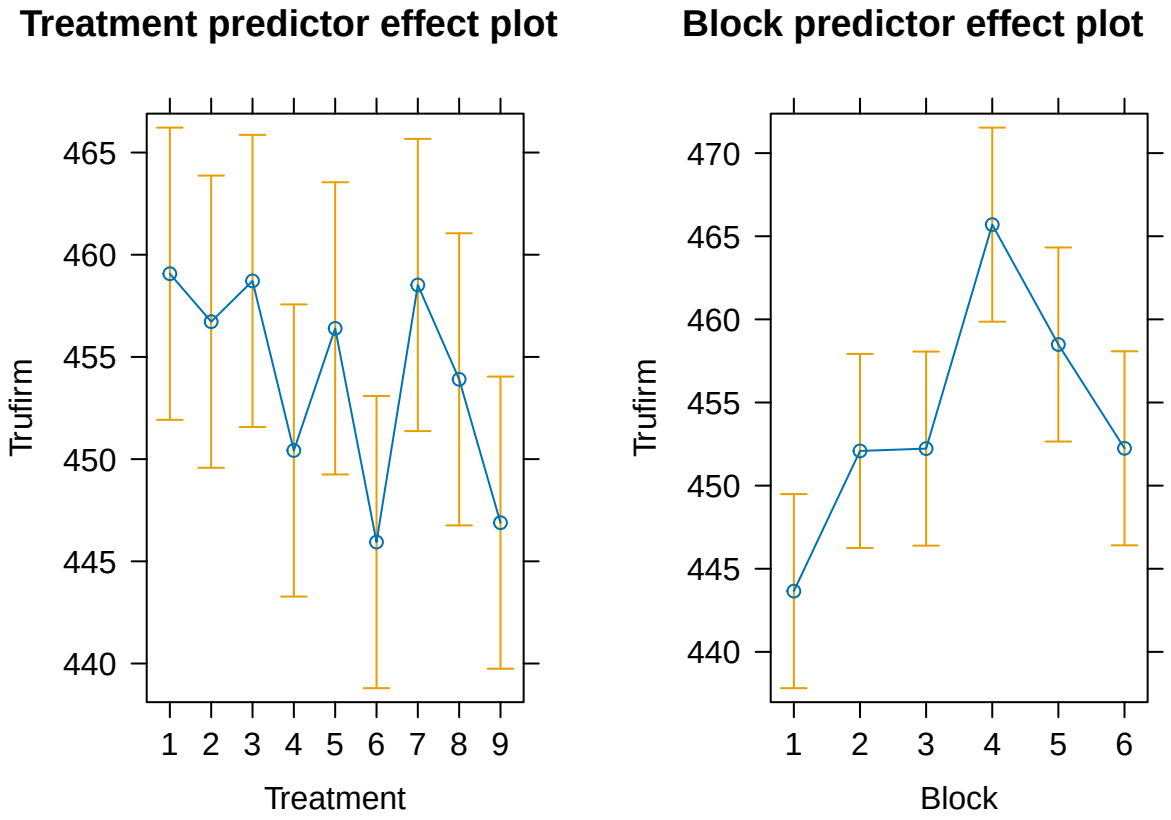


Figure 14: Trufirm plot means for Treatment and Block

11 Block Effect with Treatment on Trufirm



There was a significant variation in Trufirm readings over the blocks with Block 4 being the softest and Block 1 the hardest.

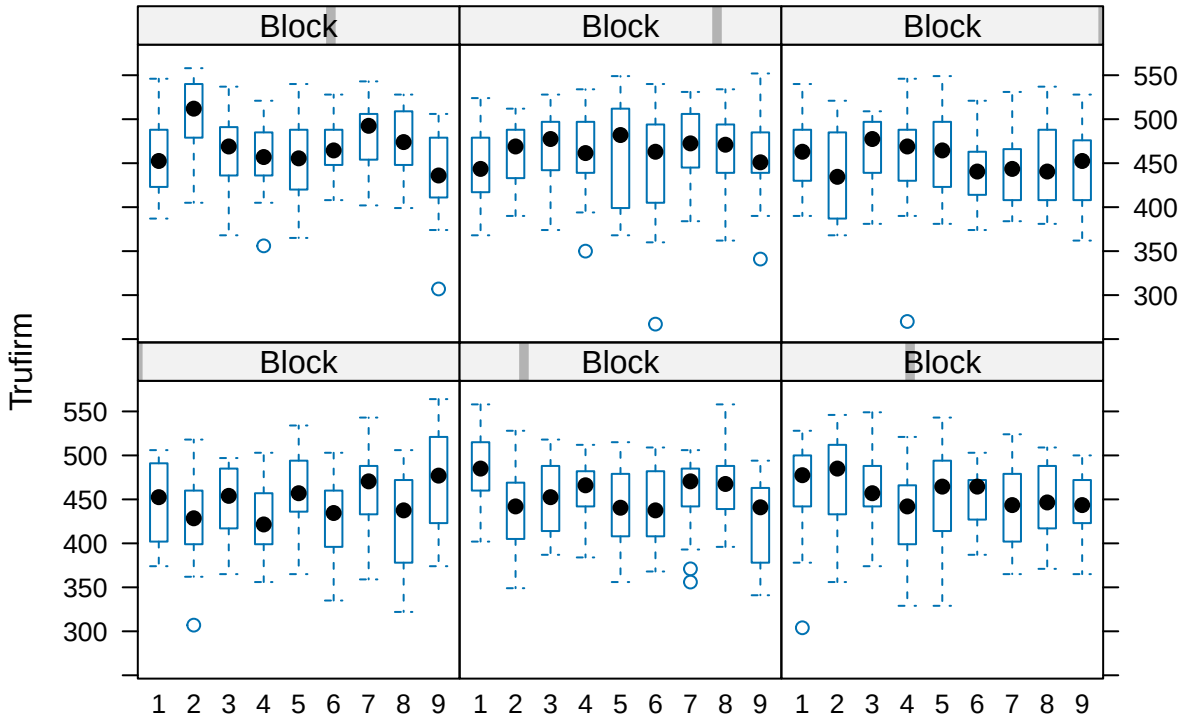


Table 38: Significance of Results by Treatment, Block and Days after Initial Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	1	19118	19118	13.22	0.0002897
Treatment	8	32727	4091	2.828	0.004123
DAT	25	991477	39659	27.42	4.492e-99
Treatment:DAT	200	240739	1204	0.8321	0.949
Residuals	1169	1691058	1447	NA	NA

11.1 Trufirm Reading Pre Treatment (2022-11-04)

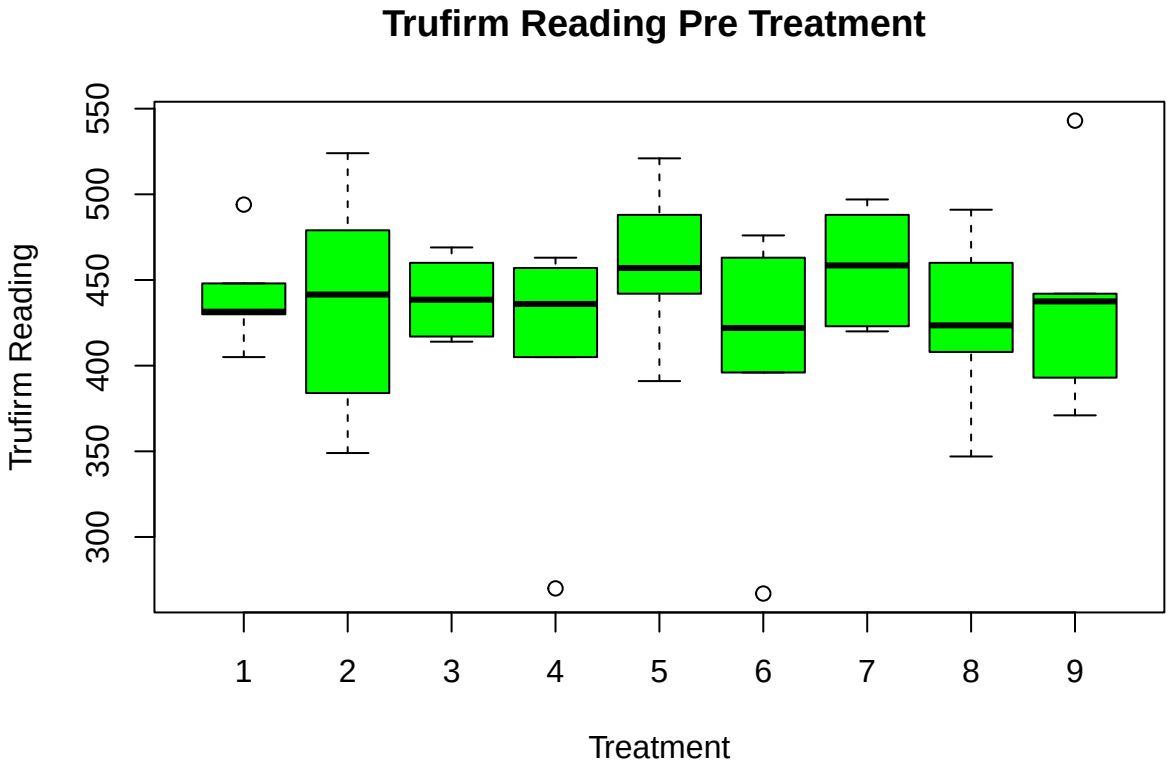


Table 39: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	15340	1917	0.6791	0.7073
Residuals	45	127059	2824	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

11.2 Trufirm Reading 3 Days Post Treatment (2022-11-10)

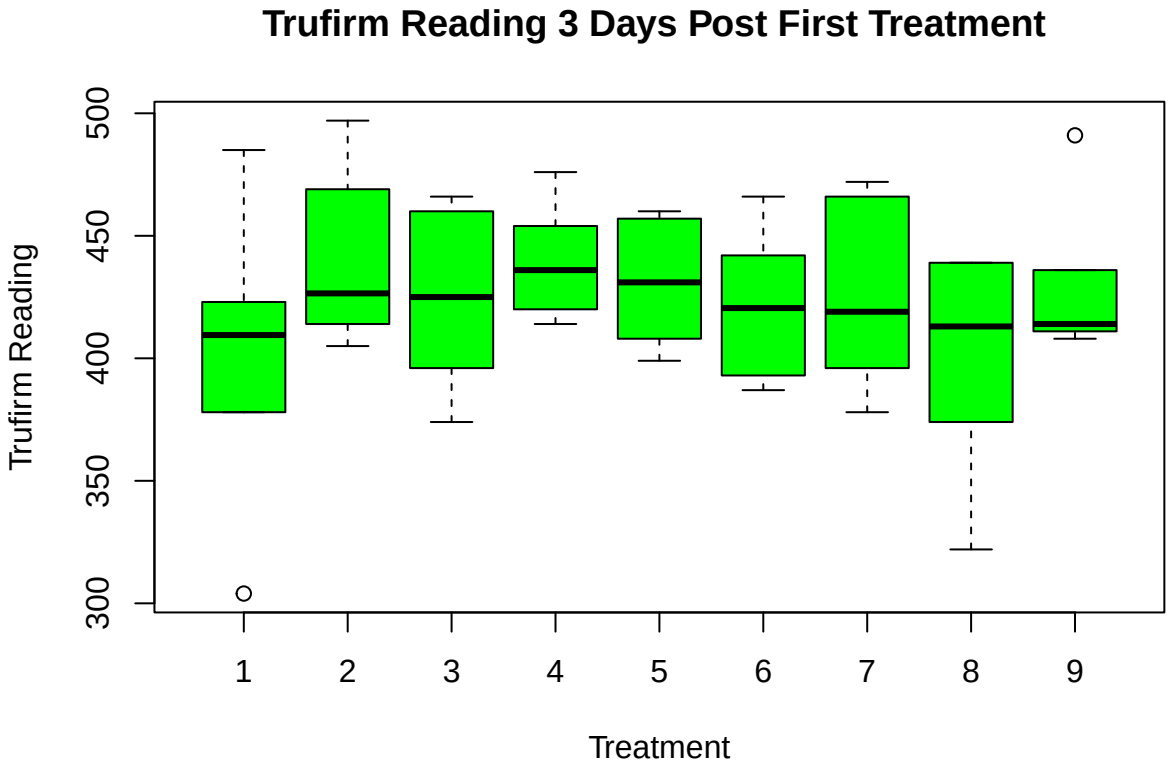


Table 40: Analysis of Variance Model Day 3

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	9850	1231	0.8441	0.5694
Residuals	45	65643	1459	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between Treatments after 3 days.

11.3 Trufirm Reading 11 Days Post Treatment (2022-11-18)

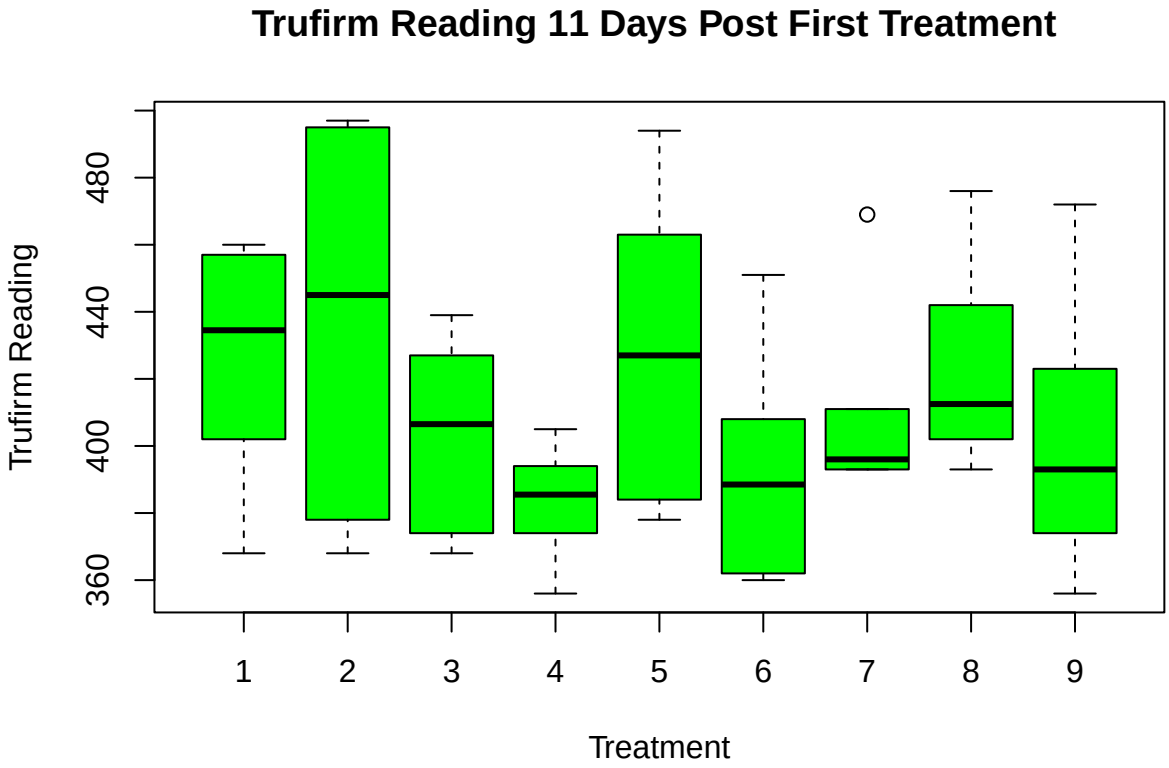


Table 41: Analysis of Variance Model Day 11

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	15841	1980	1.464	0.1972
Residuals	45	60850	1352	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments 11 days after.

11.4 Trufirm Reading 17 Days Post Treatment (2022-11-17)

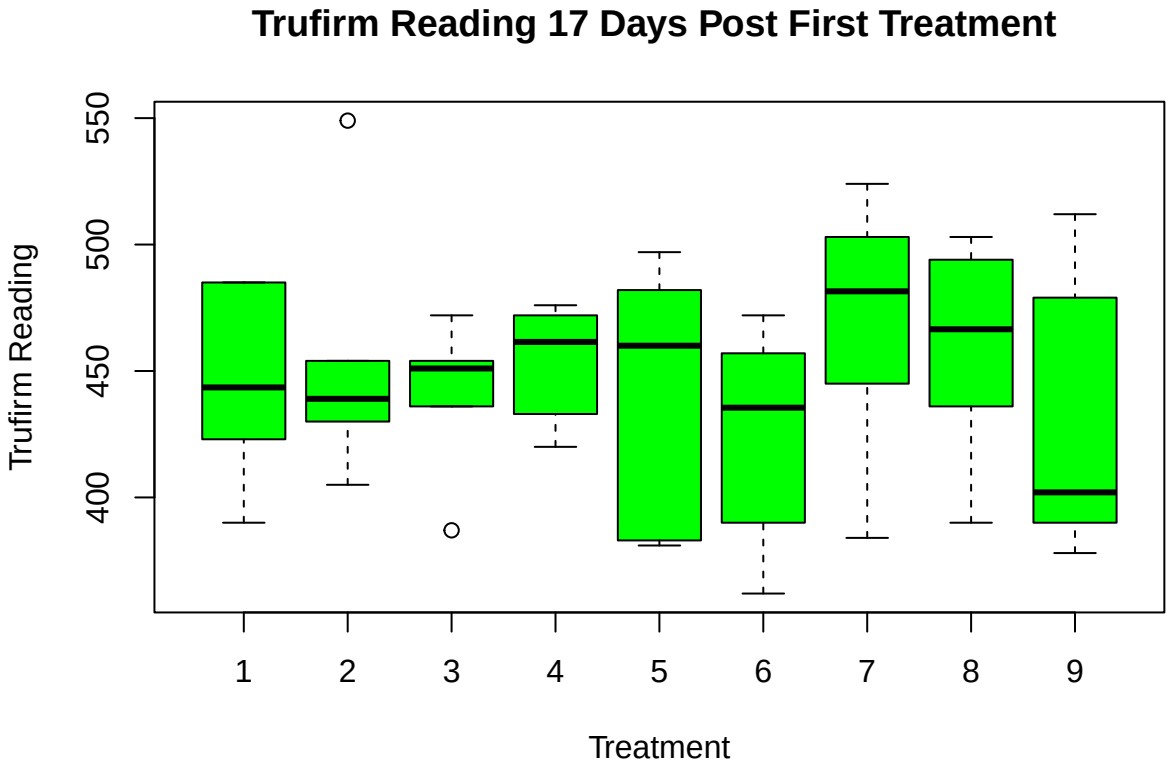


Table 42: Analysis of Variance Model Day 17

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	9938	1242	0.6595	0.7237
Residuals	45	84761	1884	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.5 Trufirm Reading 24 Days Post Treatment (2022-12-01)

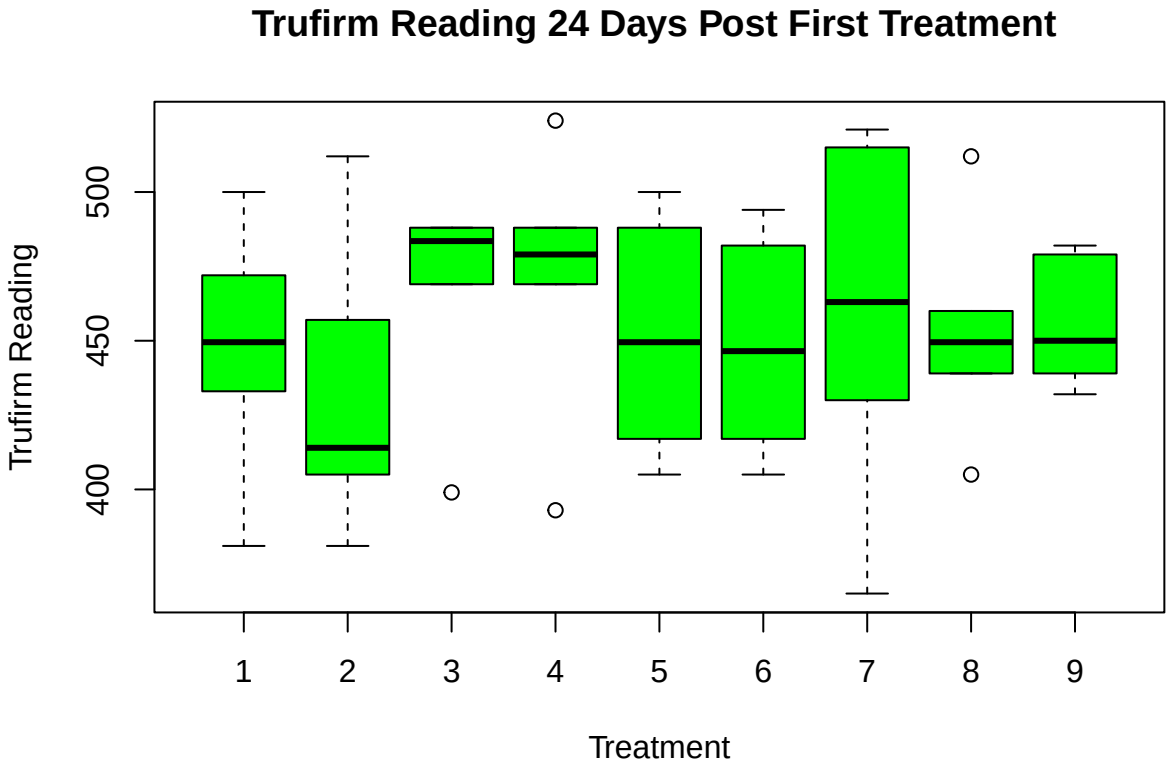


Table 43: Analysis of Variance Model Day 24

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	7197	899.6	0.555	0.8085
Residuals	45	72946	1621	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.6 Trufirm Reading 29 Days Post Treatment (2022-12-06)

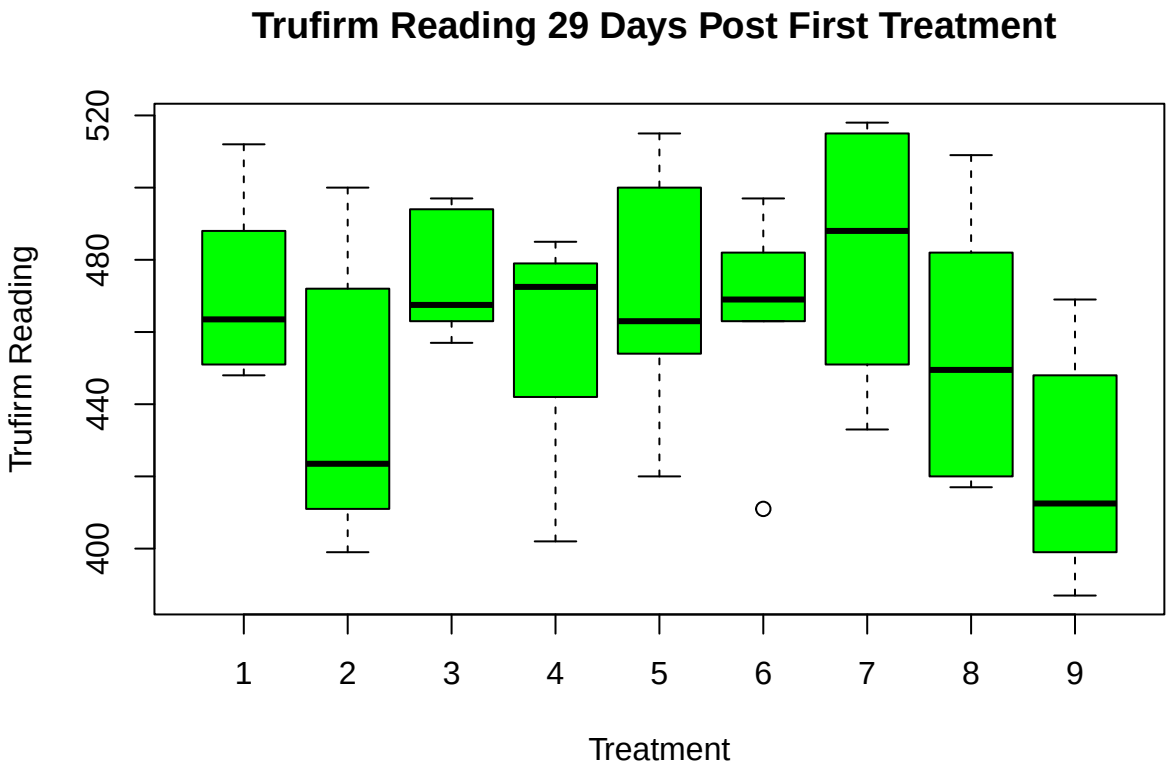
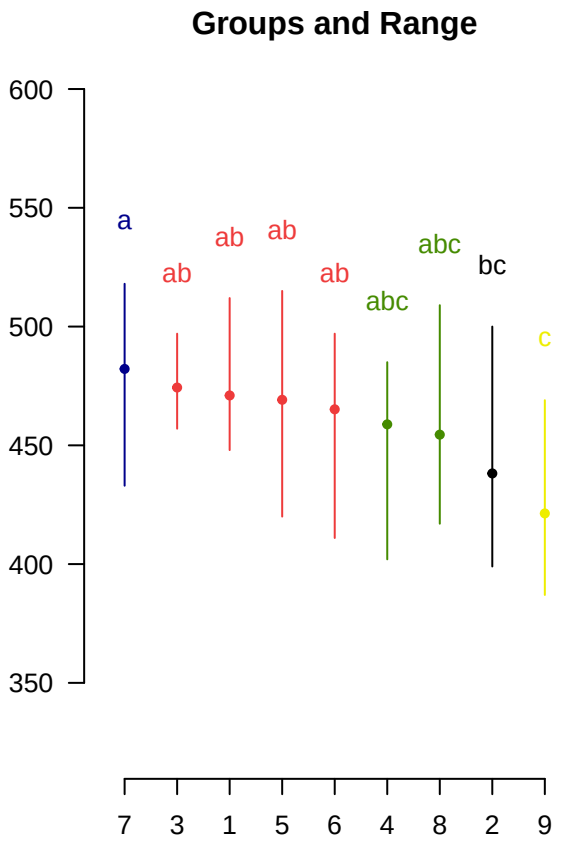


Table 44: Analysis of Variance Model Day 29

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	17573	2197	2.203	0.04506
Residuals	45	44872	997.2	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels. This was the day before the second application. Although no significant difference existed between the Treatments and the untreated control Treatment 7 was significantly softer than Treatment 9.


Groups and Range
600
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500
450
400
350
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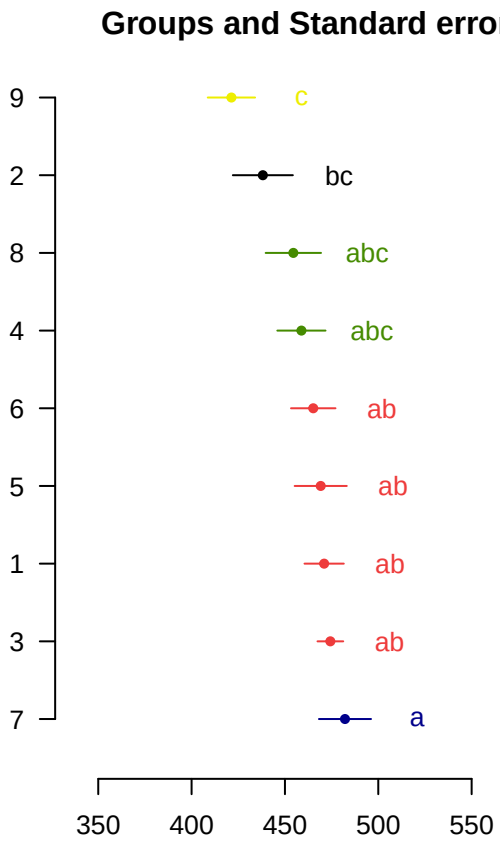
9


Groups and Standard error
9
2
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350
400
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11.7 Trufirm Reading 32 Days Post Treatment (2022-12-09)

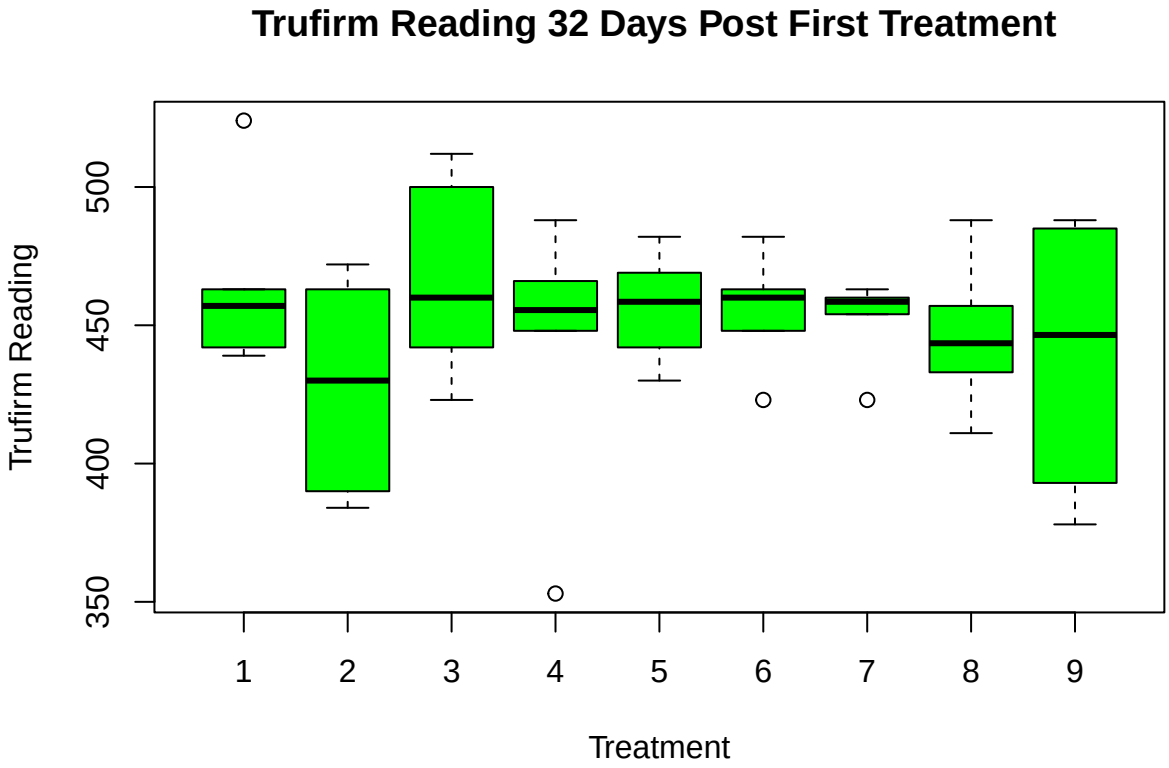


Table 45: Analysis of Variance Model Day 32

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	7023	877.8	0.8364	0.5757
Residuals	45	47226	1049	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.8 Trufirm Reading 39 Days Post Treatment (2022-12-09)

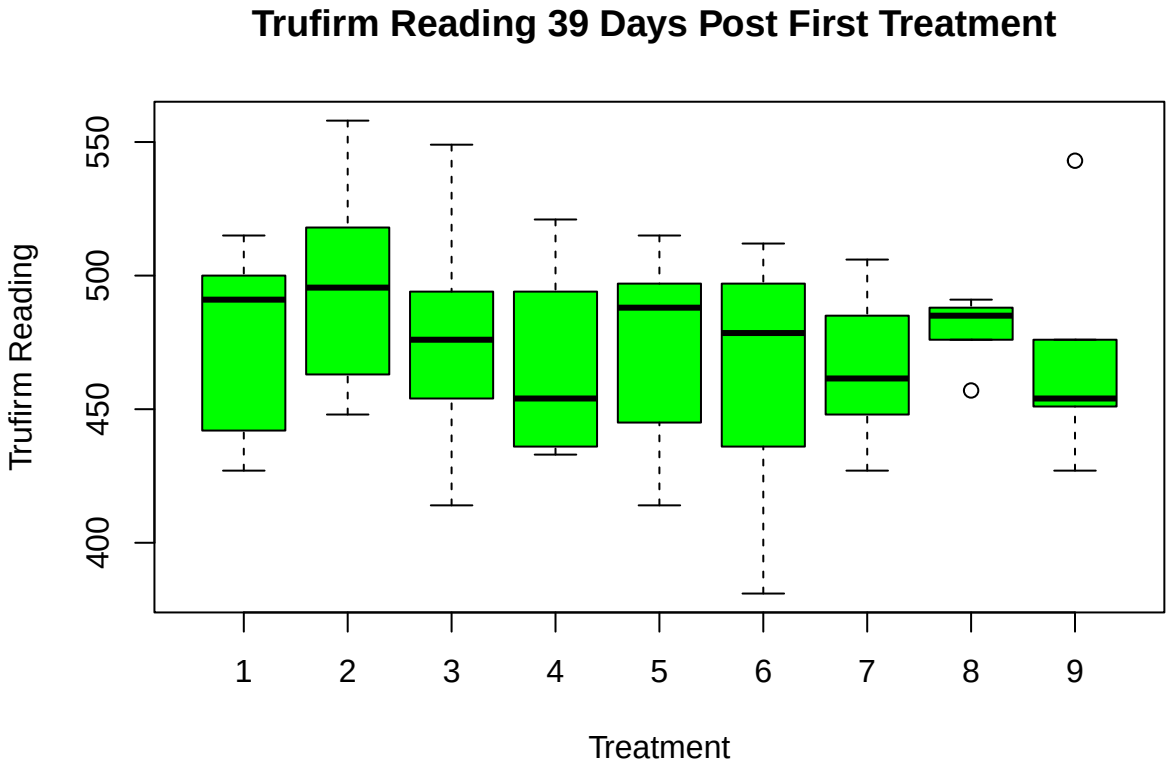


Table 46: Analysis of Variance Model Day 39

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5203	650.3	0.4723	0.8691
Residuals	45	61957	1377	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between Treatment factor levels.

11.9 Trufirm Reading 46 Days Post Treatment (2022-12-23)

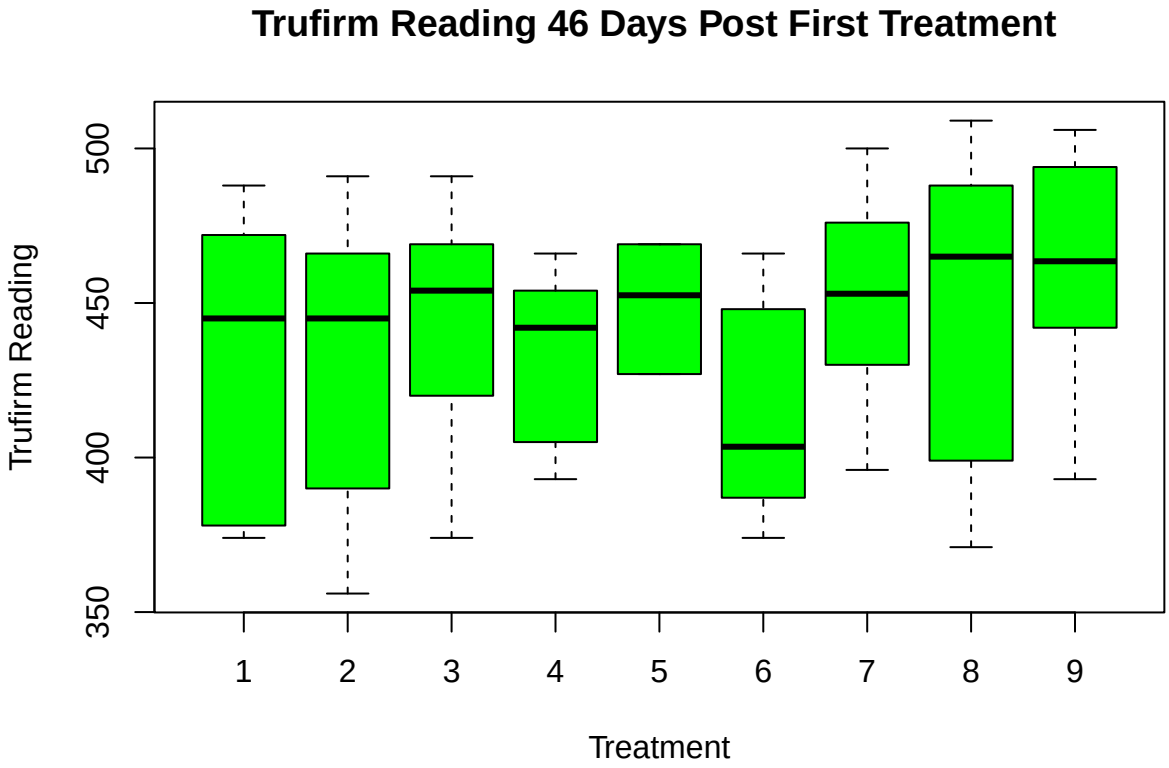


Table 47: Analysis of Variance Model Day 46

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	9388	1173	0.6837	0.7034
Residuals	45	77234	1716	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.10 Trufirm Reading 53 Days Post Treatment (2022-12-30)

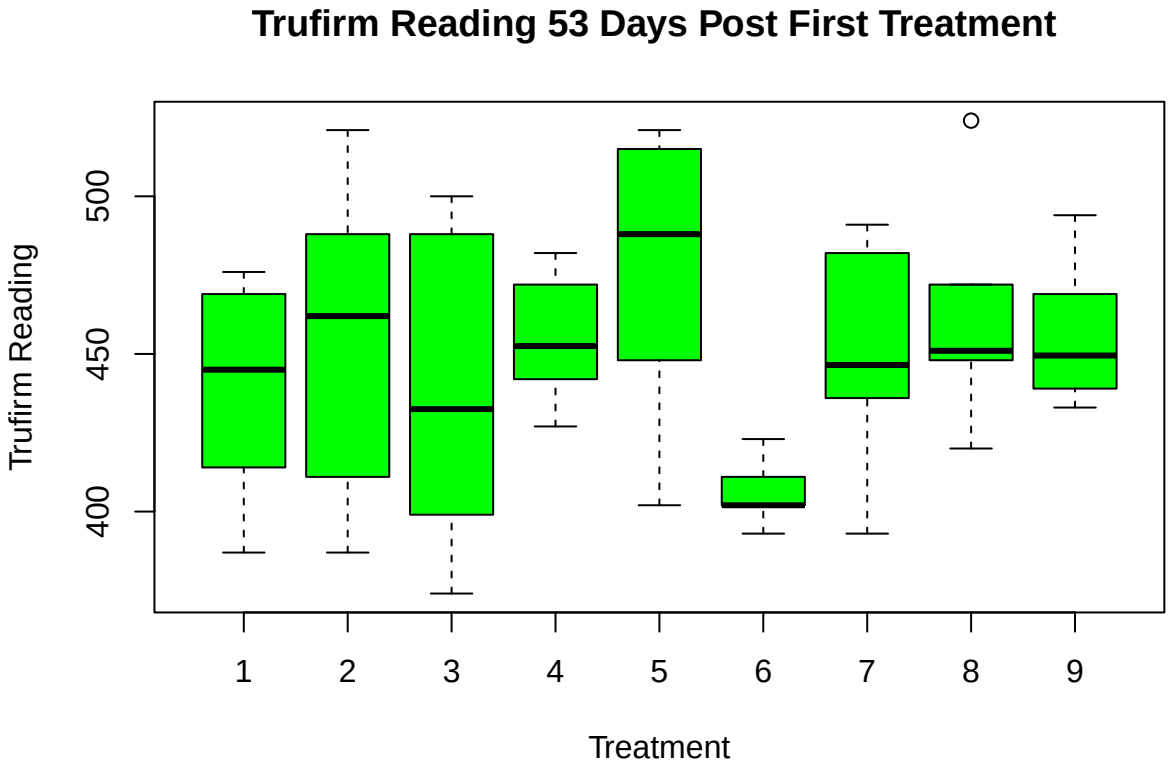


Table 48: Analysis of Variance Model Day 53

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	18918	2365	1.783	0.1057
Residuals	45	59682	1326	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.11 Trufirm Reading 67 Days Post Treatment (2023-01-13)

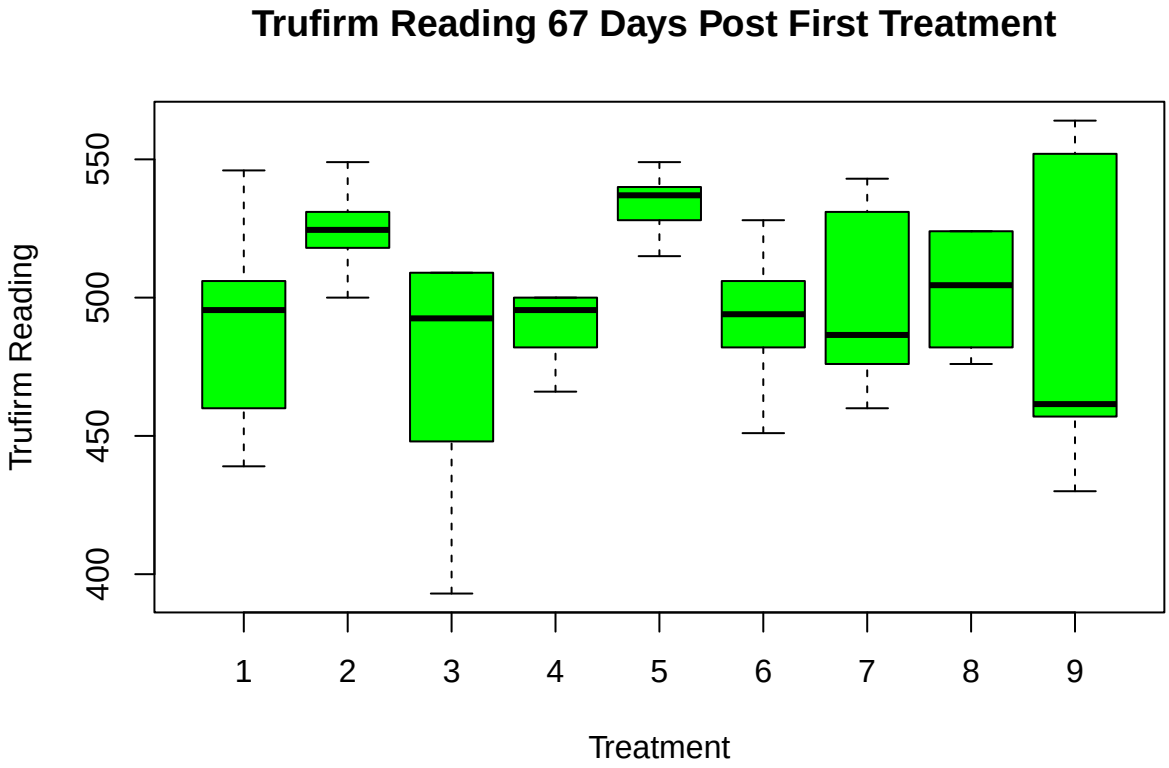
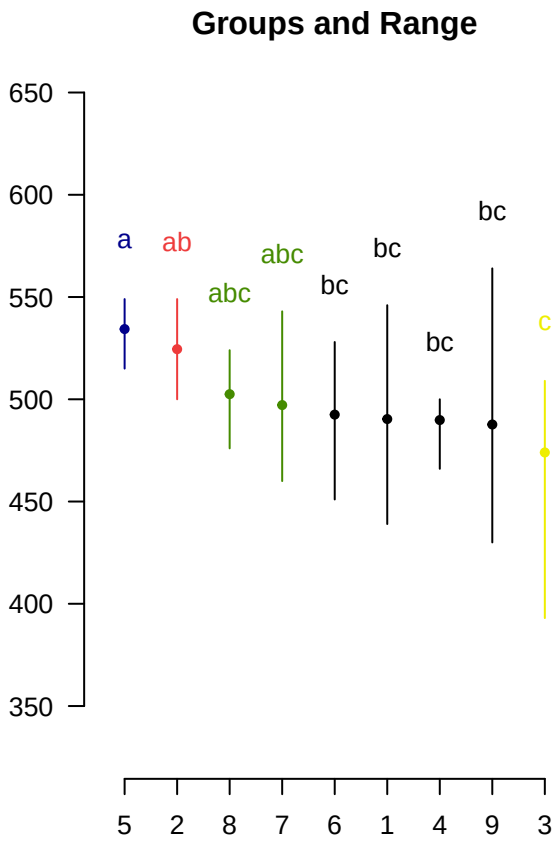


Table 49: Analysis of Variance Model Day 67

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	17213	2152	2.079	0.05803
Residuals	45	46564	1035	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
650
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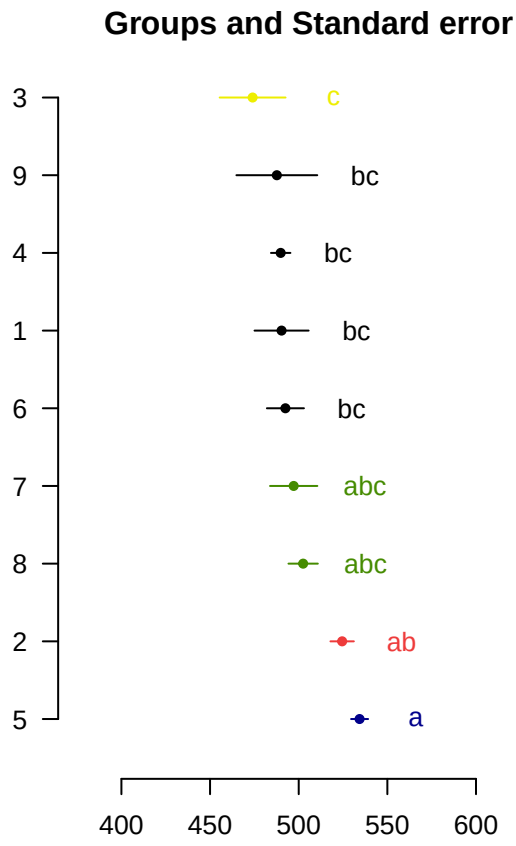
Groups and Standard error
3
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11.12 Trufirm Reading 91 Days Post Treatment (2022-02-06)

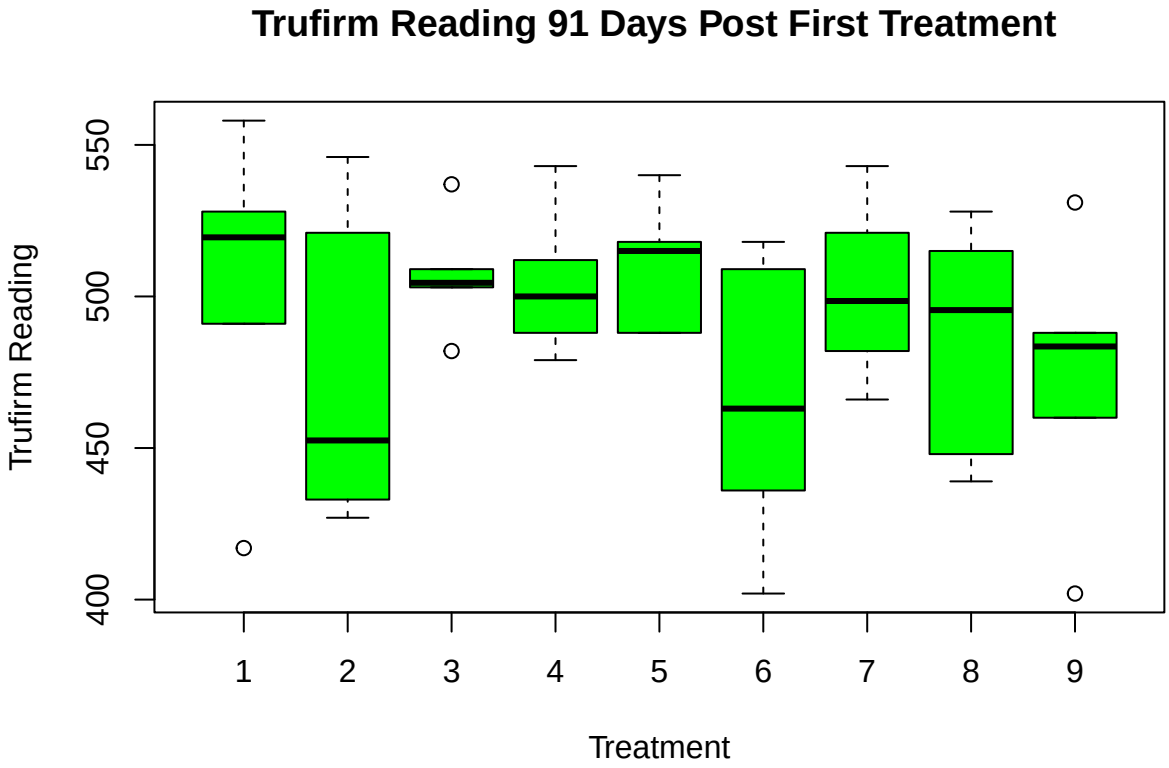


Table 50: Analysis of Variance Model Day 91

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	14515	1814	1.367	0.237
Residuals	45	59746	1328	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.13 Trufirm Reading 106 Days Post Treatment (2022-02-21)

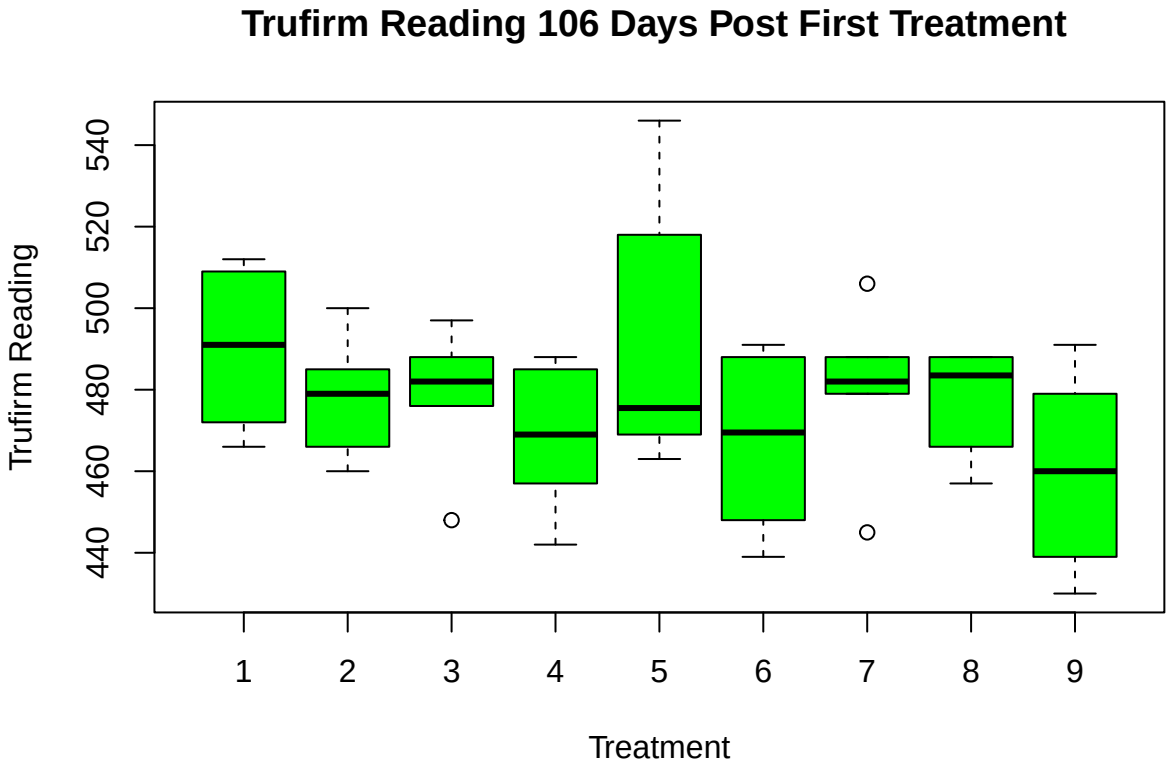


Table 51: Analysis of Variance Model Day 106

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5102	637.7	1.484	0.1901
Residuals	45	19344	429.9	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.14 Trufirm Reading 116 Days Post Treatment (2022-03-03)

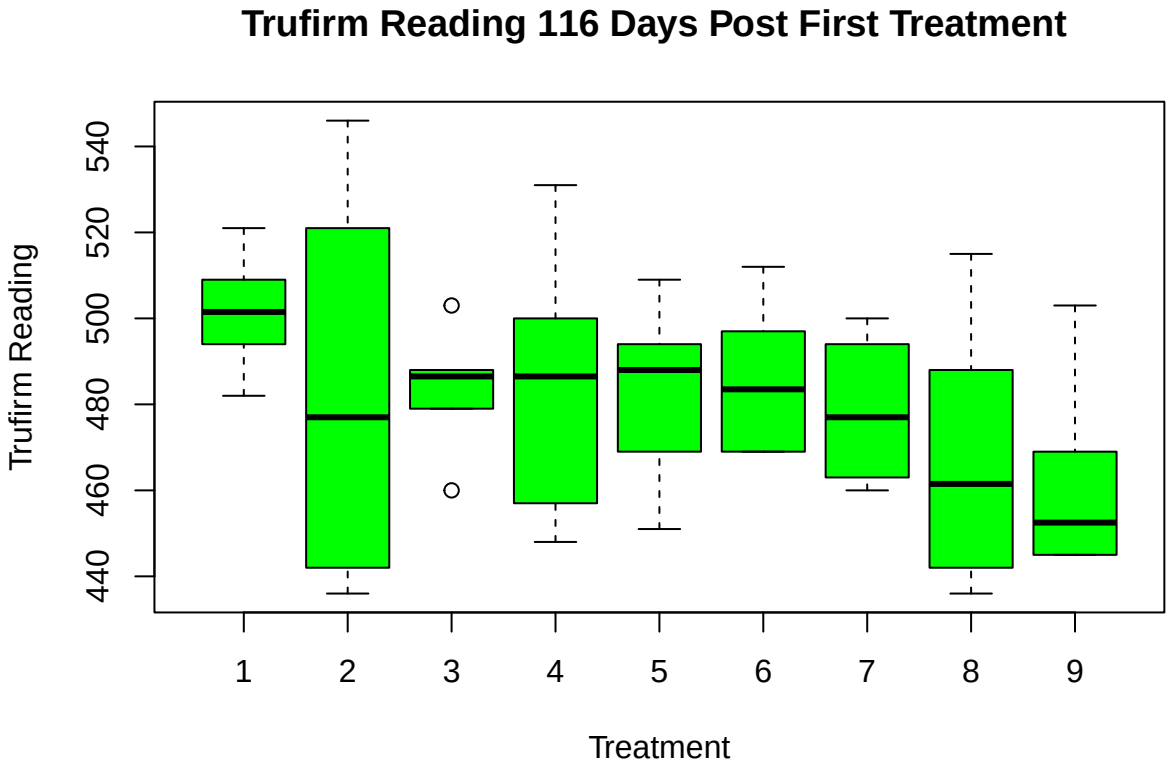


Table 52: Analysis of Variance Model Day 116

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6363	795.4	1.239	0.2994
Residuals	45	28898	642.2	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.15 Trufirm Reading 123 Days Post Treatment (2022-03-10)

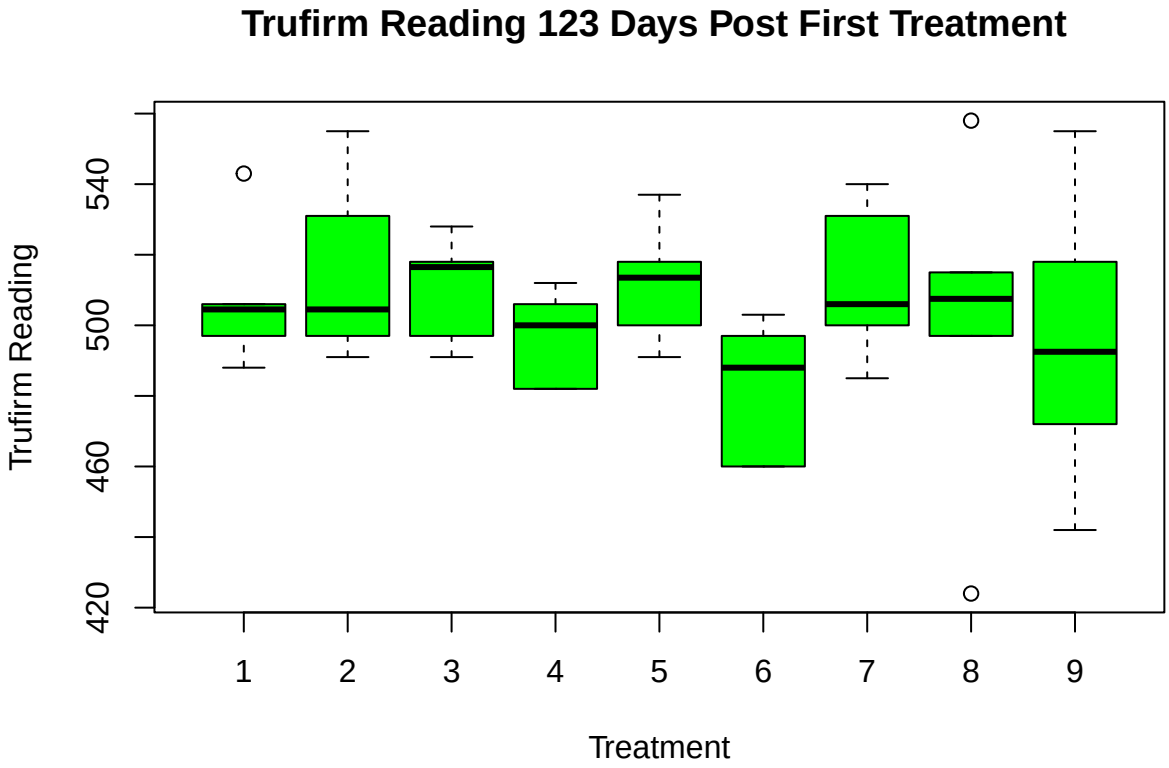


Table 53: Analysis of Variance Model Day 123

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5174	646.8	1.016	0.4381
Residuals	45	28653	636.7	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.16 Trufirm Reading 130 Days Post Treatment (2022-03-17)

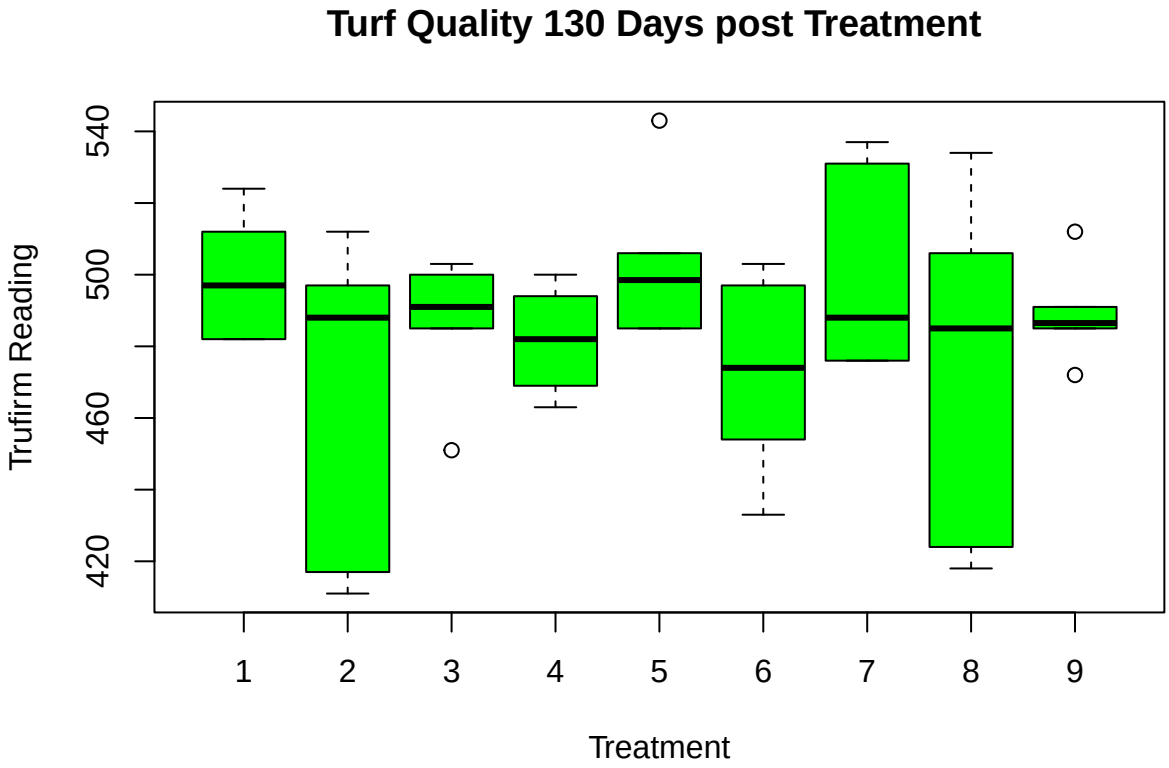


Table 54: Analysis of Variance Model 130 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	7456	932	1.199	0.3214
Residuals	45	34987	777.5	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.17 Trufirm Reading 137 Days Post Treatment (2022-03-24)

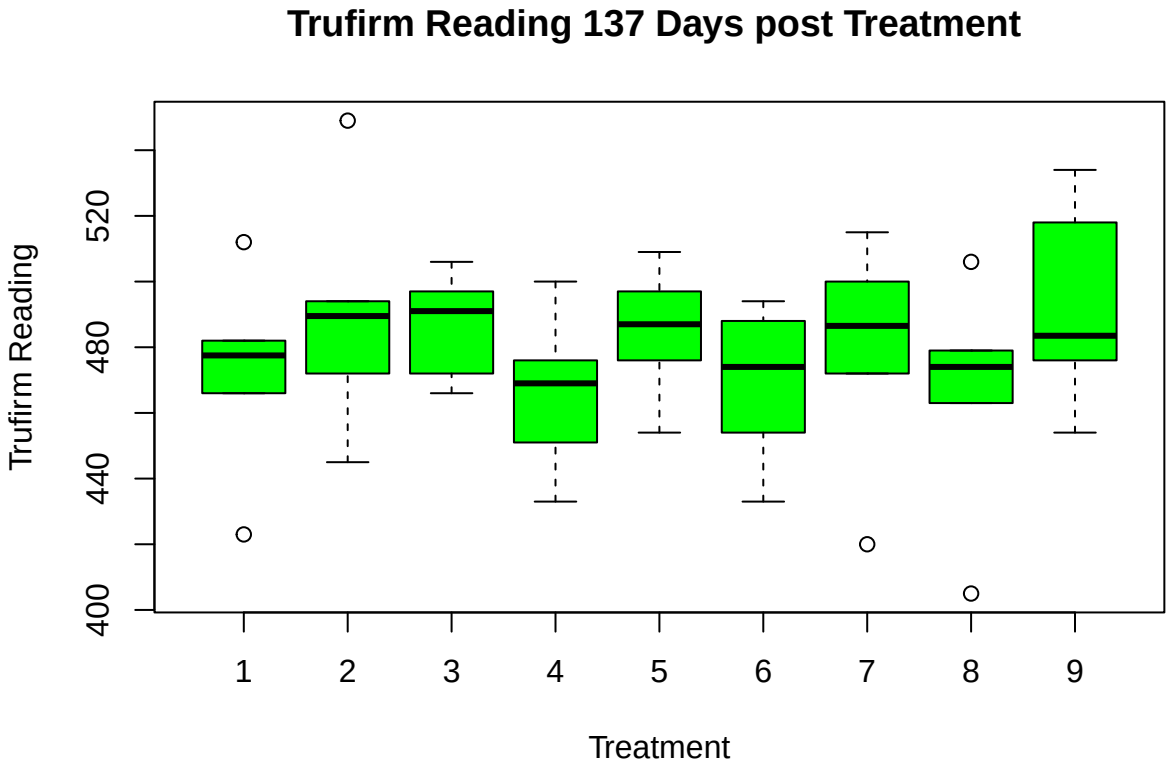


Table 55: Analysis of Variance Model 137 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	4870	608.7	0.8079	0.5991
Residuals	45	33905	753.4	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.18 Trufirm Reading 144 Days Post Treatment (2022-03-31)

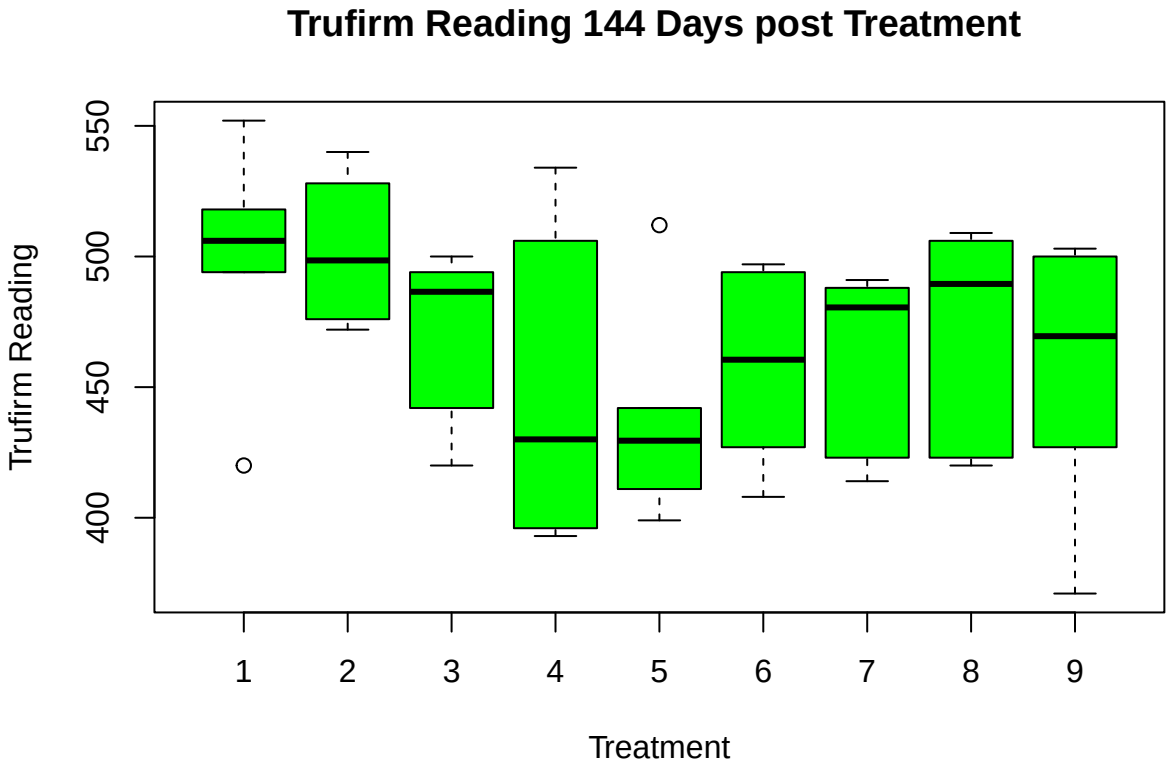


Table 56: Analysis of Variance Model 144 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	22716	2839	1.603	0.151
Residuals	45	79731	1772	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.19 Trufirm Reading 151 Days Post Treatment (2022-04-06)

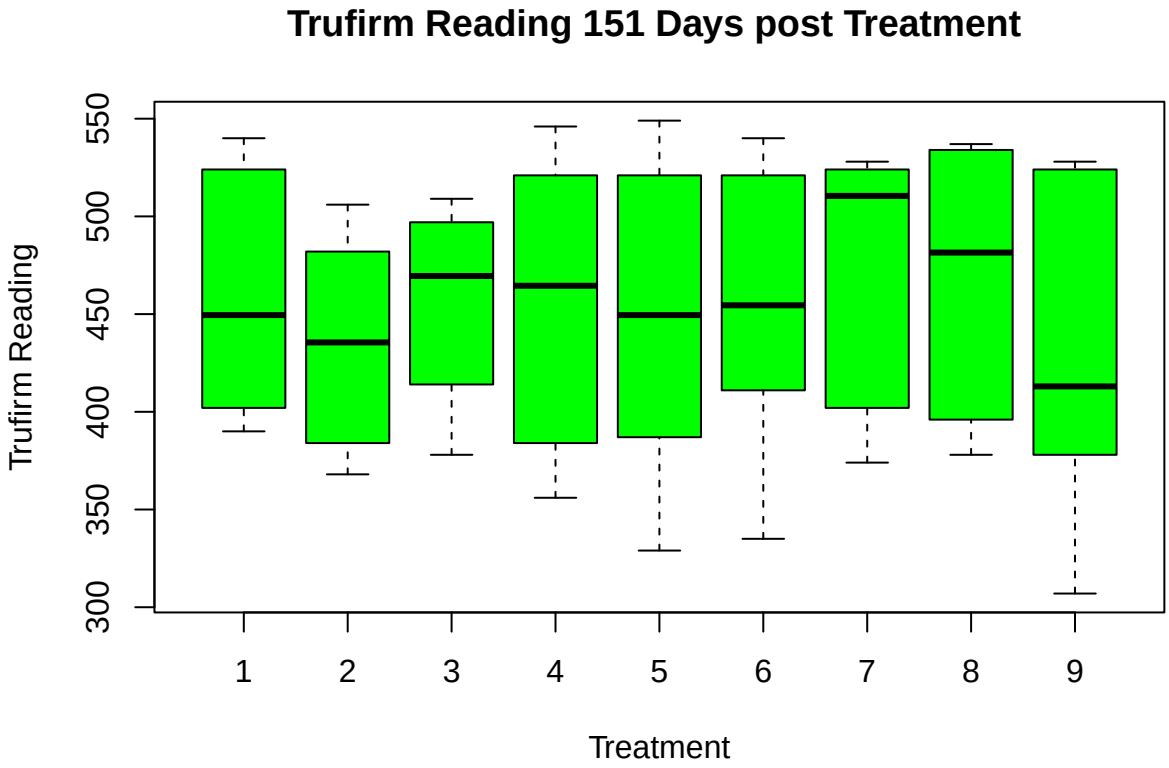


Table 57: Analysis of Variance Model 151 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	10647	1331	0.2506	0.9782
Residuals	45	239009	5311	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.20 Trufirm Reading 159 Days Post Treatment (2022-04-14)

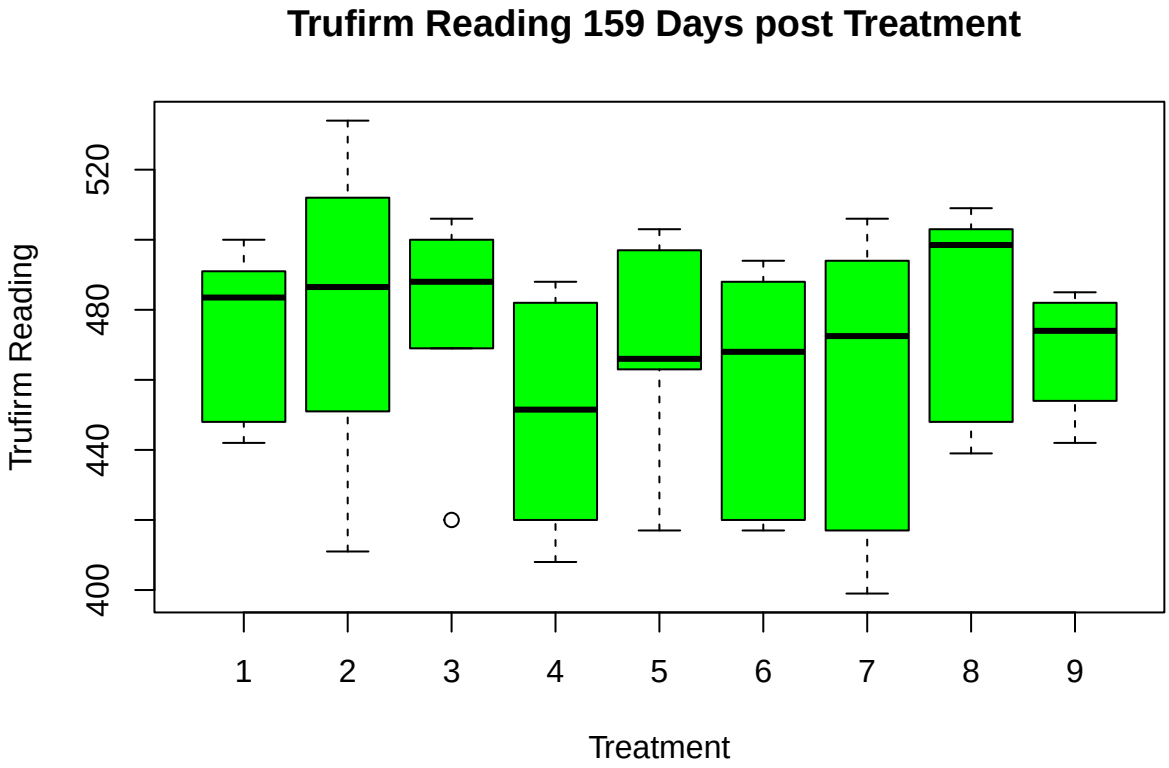


Table 58: Analysis of Variance Model 159 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	5780	722.5	0.6562	0.7264
Residuals	45	49544	1101	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.21 Trufirm Reading 165 Days Post Treatment (2022-04-20)

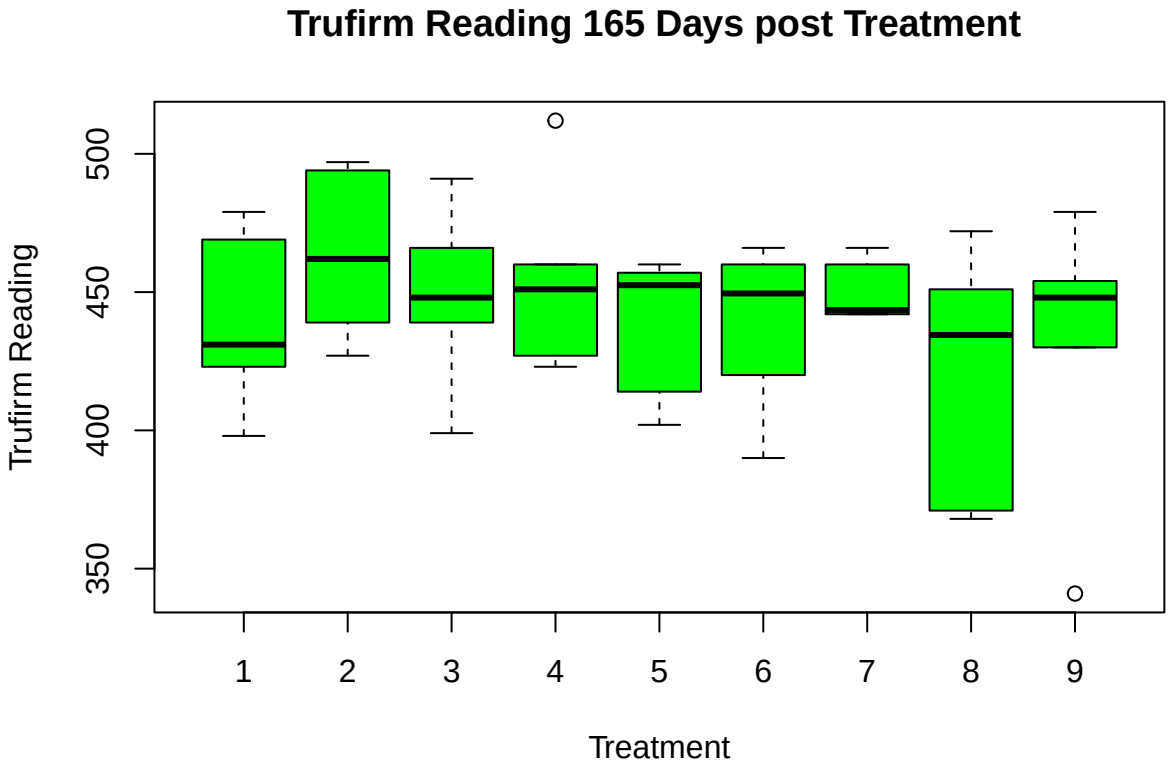


Table 59: Analysis of Variance Model 165 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	7207	900.9	0.8491	0.5654
Residuals	45	47744	1061	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.22 Trufirm Reading 173 Days Post Treatment (2022-04-28)

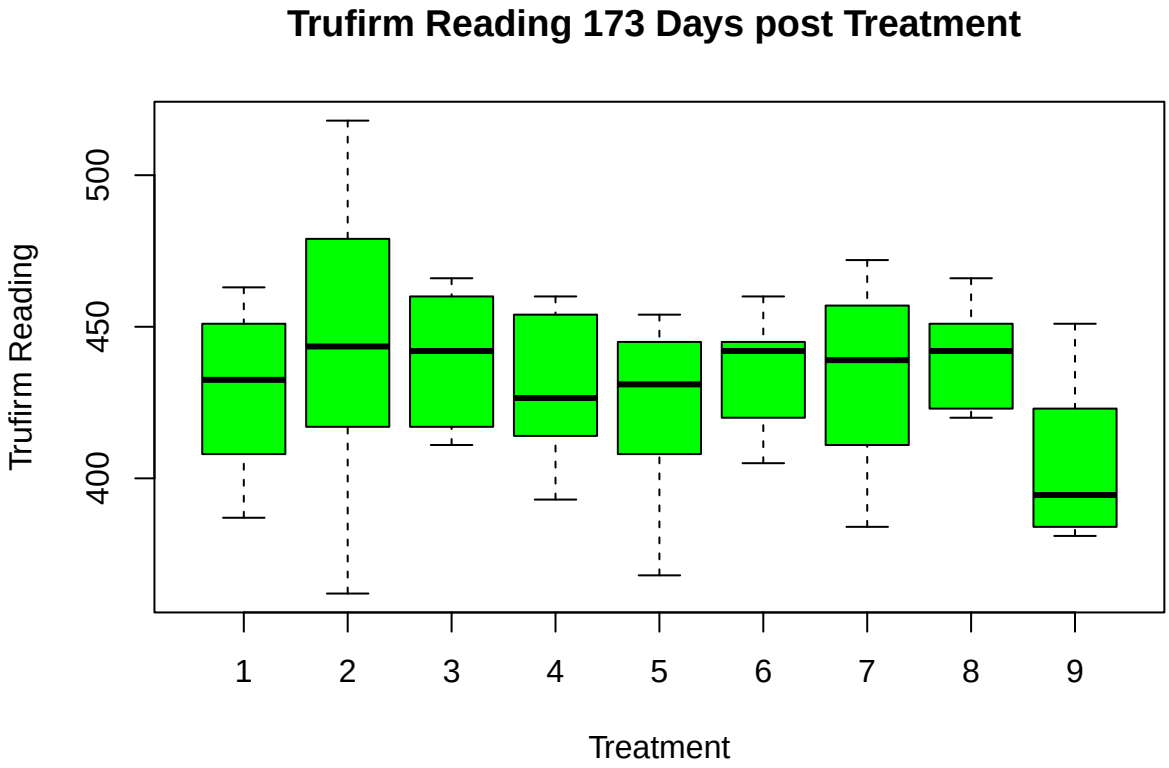


Table 60: Analysis of Variance Model 173 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6782	847.7	0.9064	0.5197
Residuals	45	42084	935.2	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.23 Trufirm Reading 180 Days Post Treatment (2022-05-05)

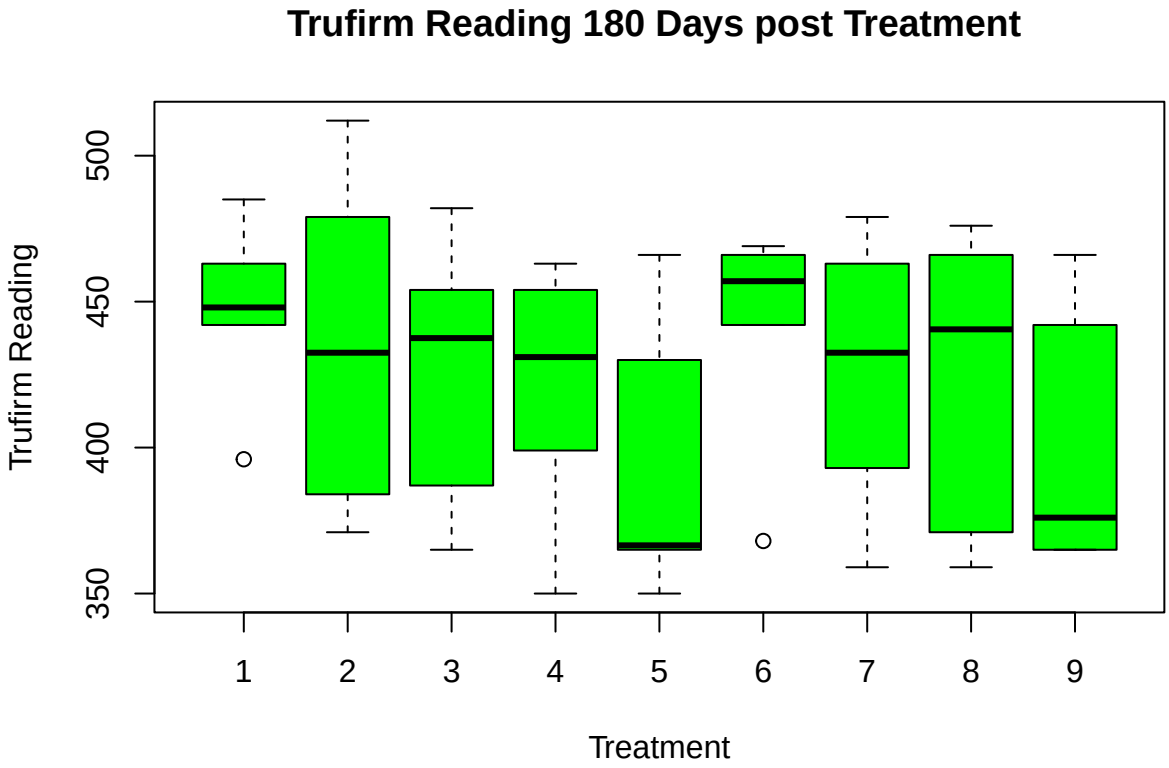


Table 61: Analysis of Variance Model 180 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	16899	2112	1.057	0.4096
Residuals	45	89941	1999	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.24 Trufirm Reading 187 Days Post Treatment (2022-05-12)

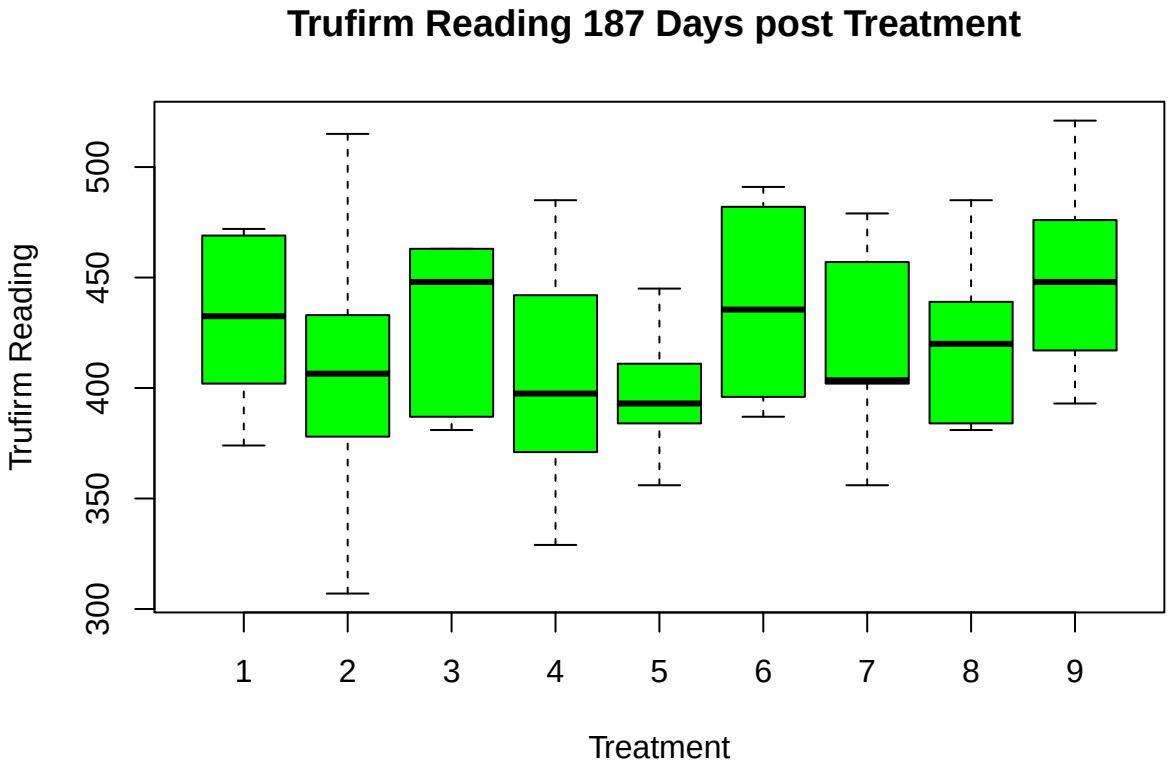


Table 62: Analysis of Variance Model 187 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	14515	1814	0.8428	0.5705
Residuals	45	96876	2153	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.25 Trufirm Reading 194 Days Post Treatment (2022-05-19)

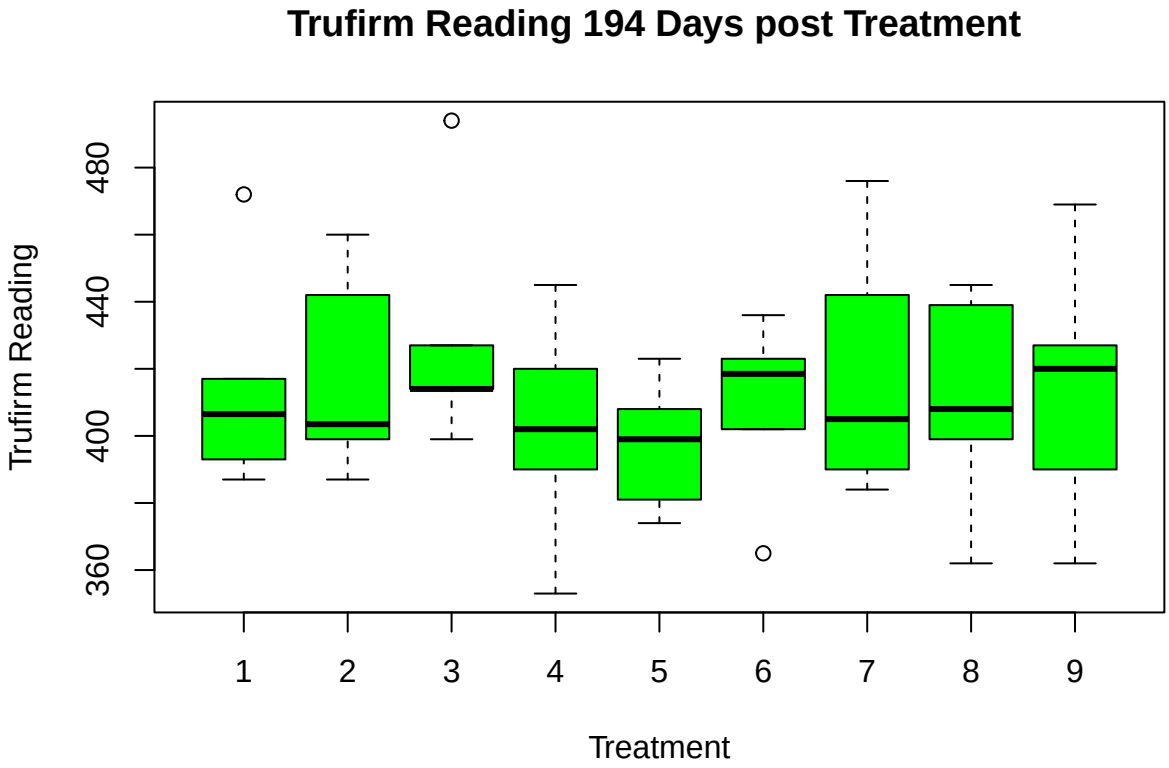


Table 63: Analysis of Variance Model 194 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	3572	446.5	0.4854	0.8601
Residuals	45	41393	919.8	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

11.26 Trufirm Reading 200 Days Post Treatment (2022-05-25)

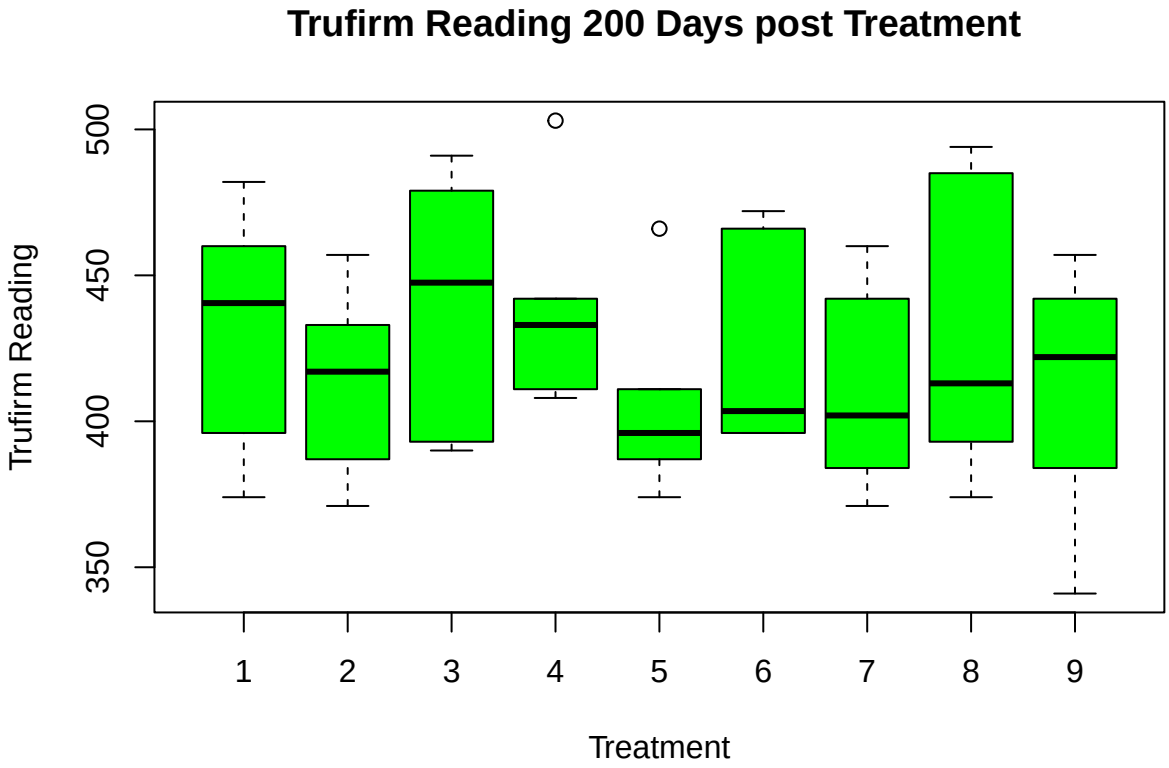


Table 64: Analysis of Variance Model 200 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	8388	1048	0.6786	0.7077
Residuals	45	69525	1545	NA	NA

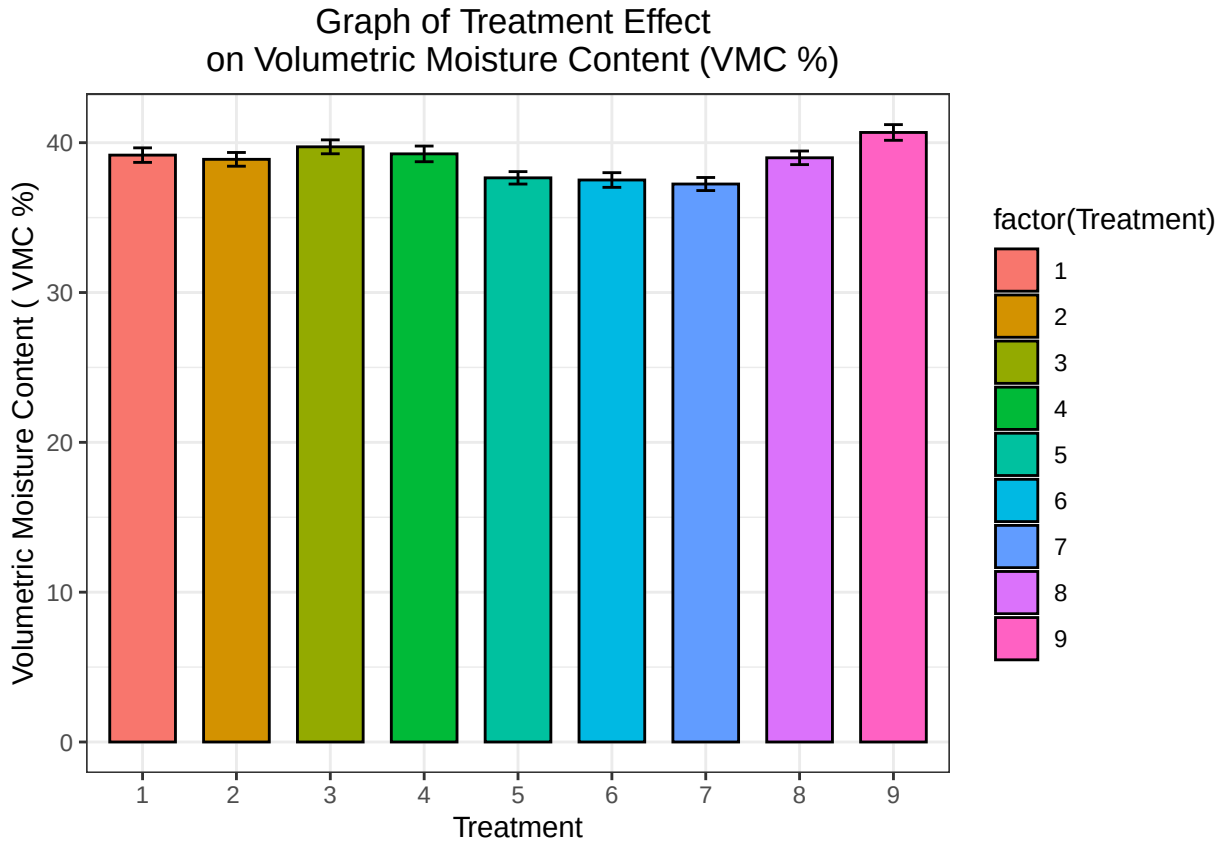
In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

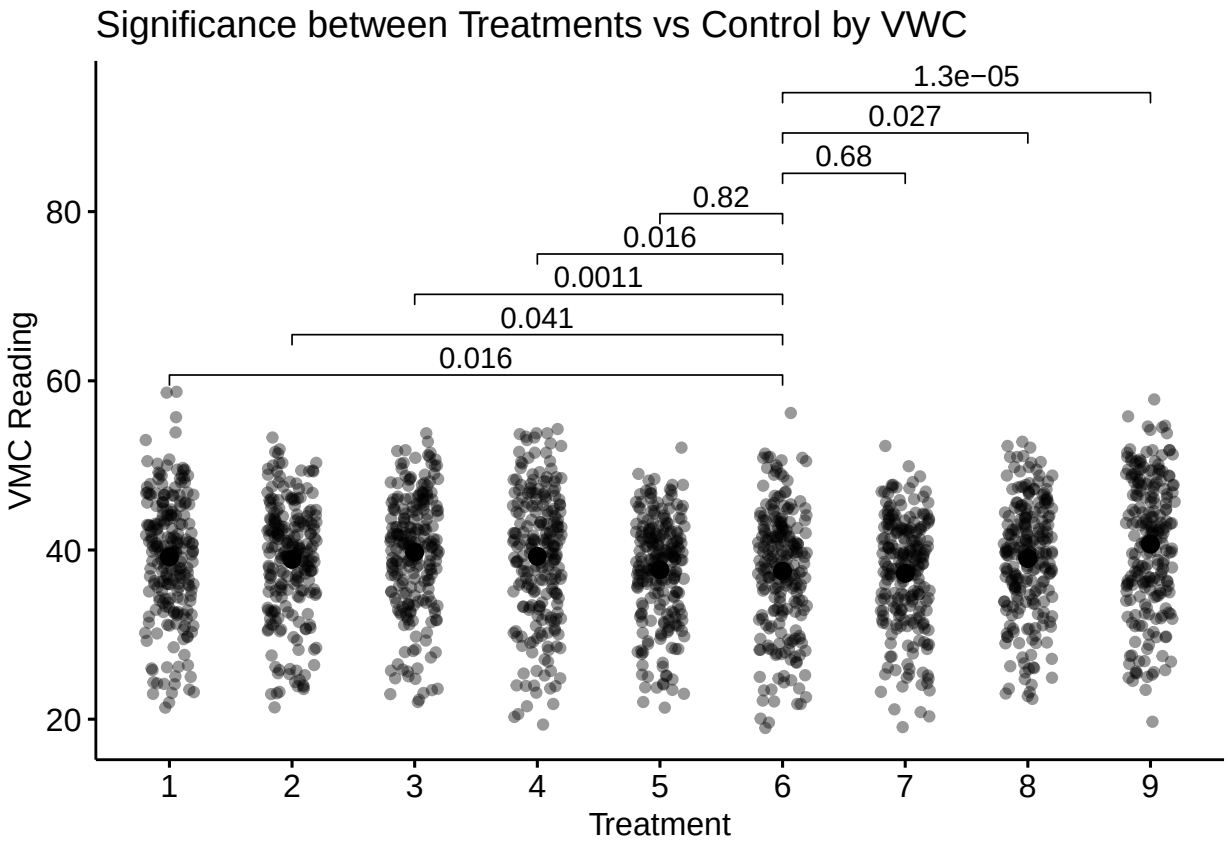
12 Volumetric Moisture Content (VMC %)

Table 65: Volumetric Moisture Content % by Treatment

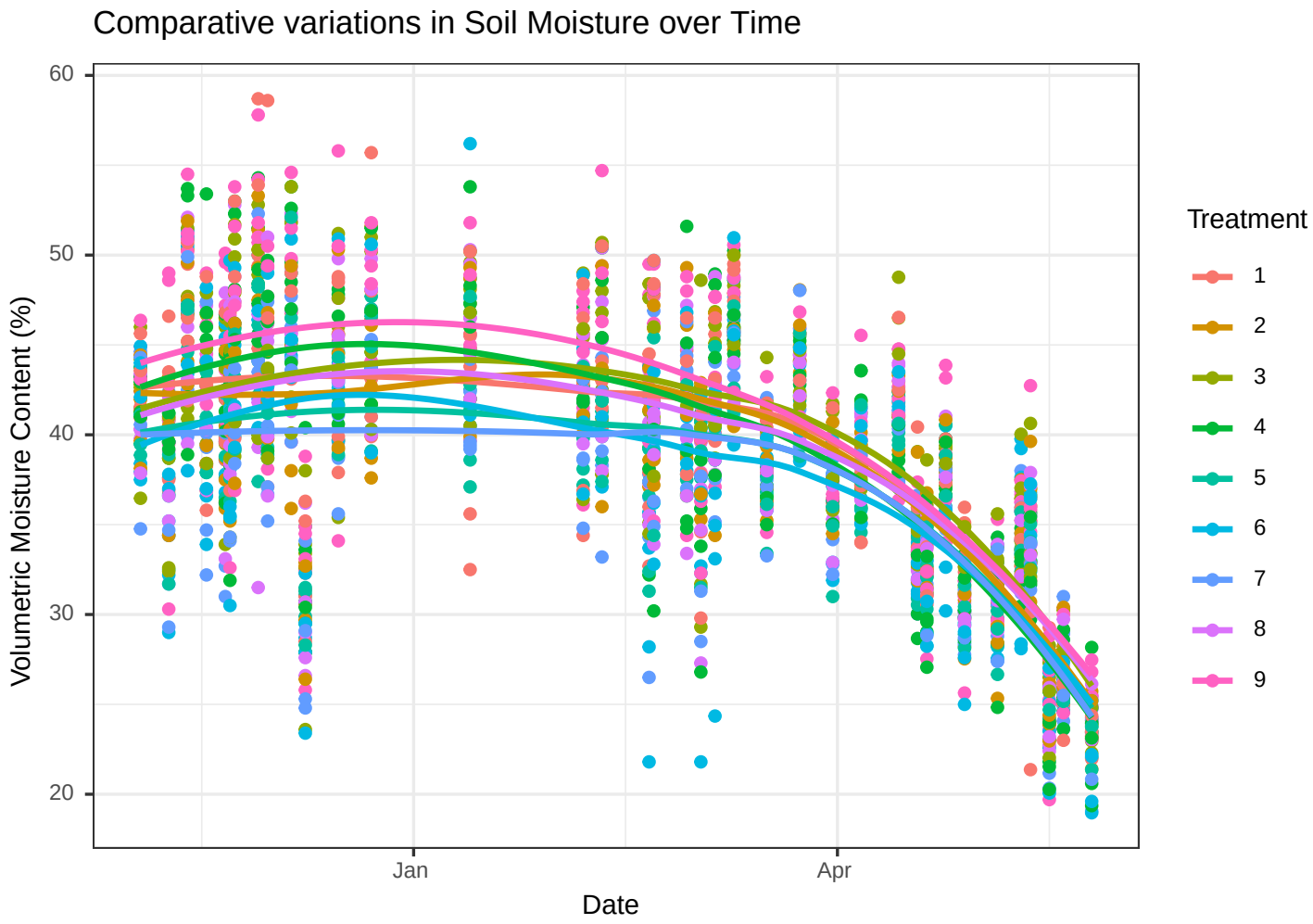
Treatment	n	VWC	sd	se	ci
1	222	39.17	7.224	0.4849	0.9556
2	222	38.89	6.839	0.459	0.9046
3	222	39.72	6.904	0.4633	0.9131
4	222	39.25	7.802	0.5237	1.032
5	222	37.65	6.184	0.415	0.818
6	222	37.51	7.311	0.4907	0.967
7	222	37.24	6.495	0.4359	0.8591
8	222	38.99	6.759	0.4536	0.894
9	222	40.68	7.82	0.5248	1.034

The lowest mean moisture content was Treatment 6 (untreated control) and the highest was Treatment 9.

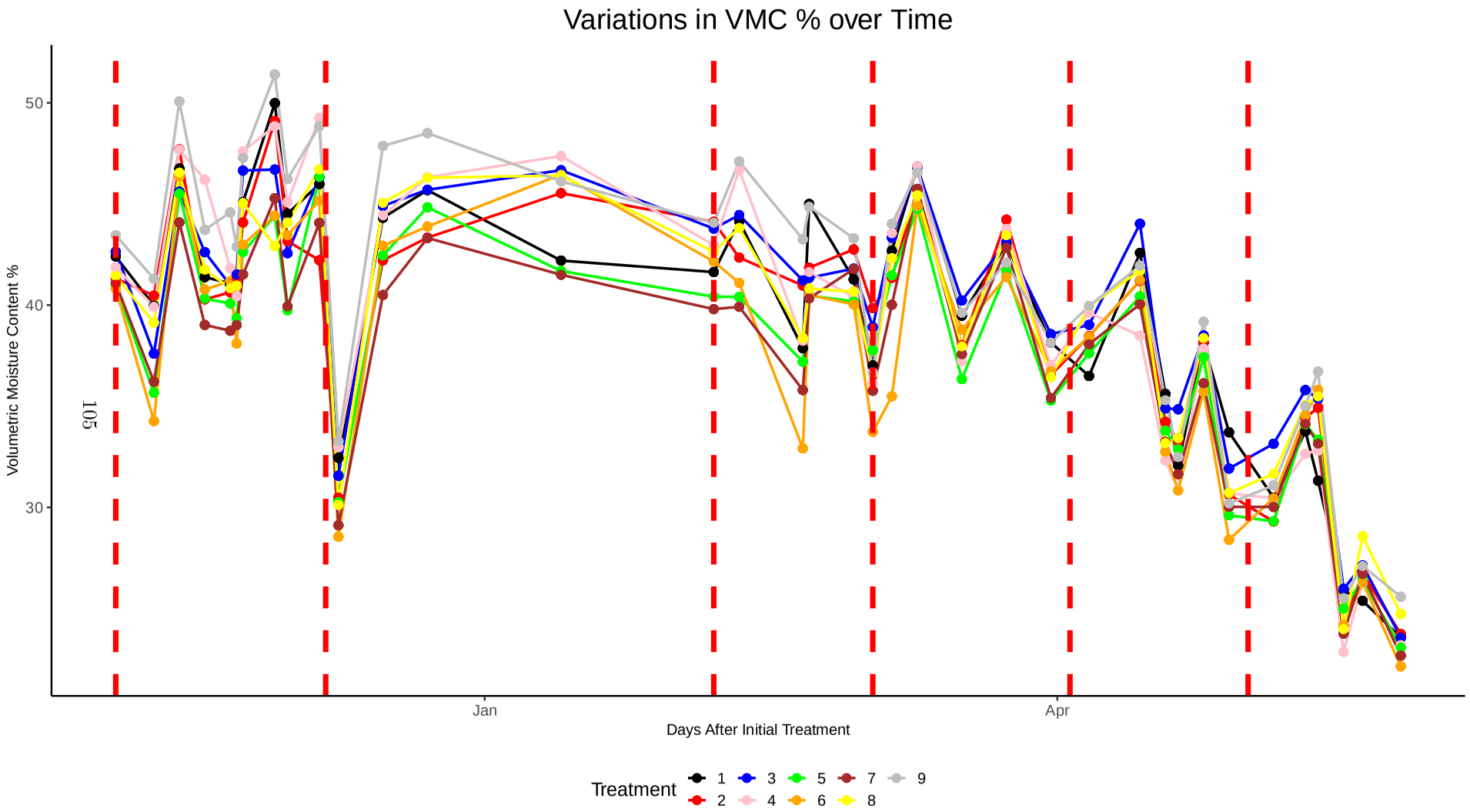




When we look at the between treatment effects we can see significant differences existed between all of the Treatments and the untreated control apart from Treatments 5 and Treatment 7 (half rates of Hydroforce Ultra).



Over the trial duration soil moisture contents all fell.


Variations in VMC % over Time
Volumetric Moisture Content %
50
40
30
105
Jan
Apr
Days After Initial Treatment
Treatment
1
2
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4
5
6
7
8
9

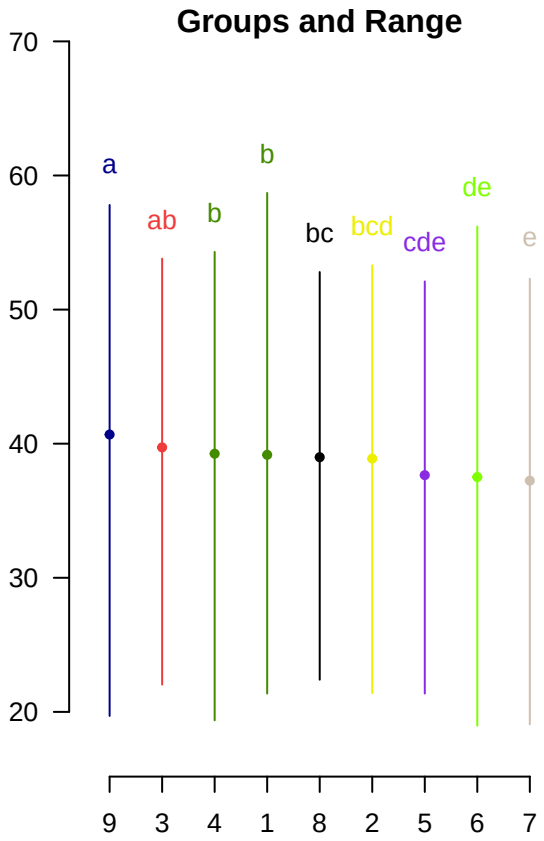
Analysis showed that the Treatment has a significant effect in relation to soil moisture content.

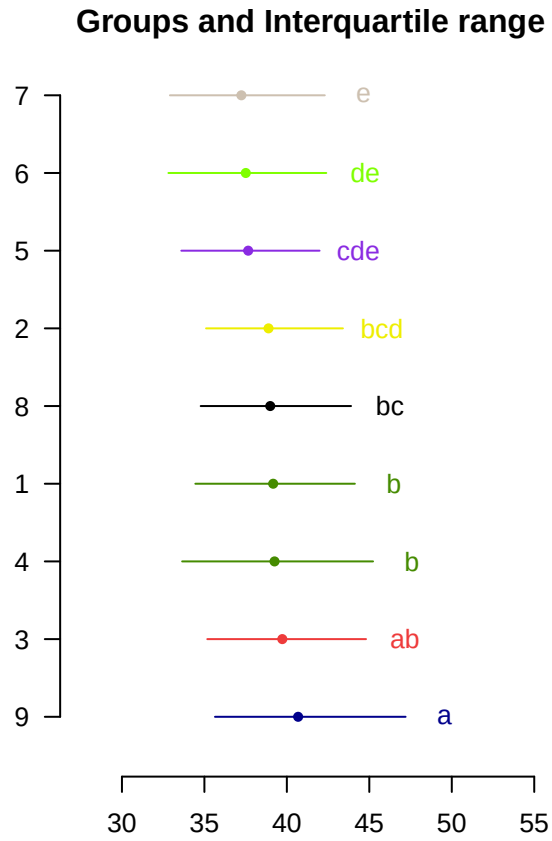
Table 66: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(Treatment)	8	2262	282.8	5.679	3.705e-07
Residuals	1989	99056	49.8	NA	NA

Table 67: Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	5	1122	224.3	7.047	1.54e-06
Treatment	8	2262	282.8	8.884	5.069e-12
Date	1	34457	34457	1083	1.126e-189
Treatment:Date	8	611.3	76.41	2.4	0.01413
Residuals	1975	62866	31.83	NA	NA





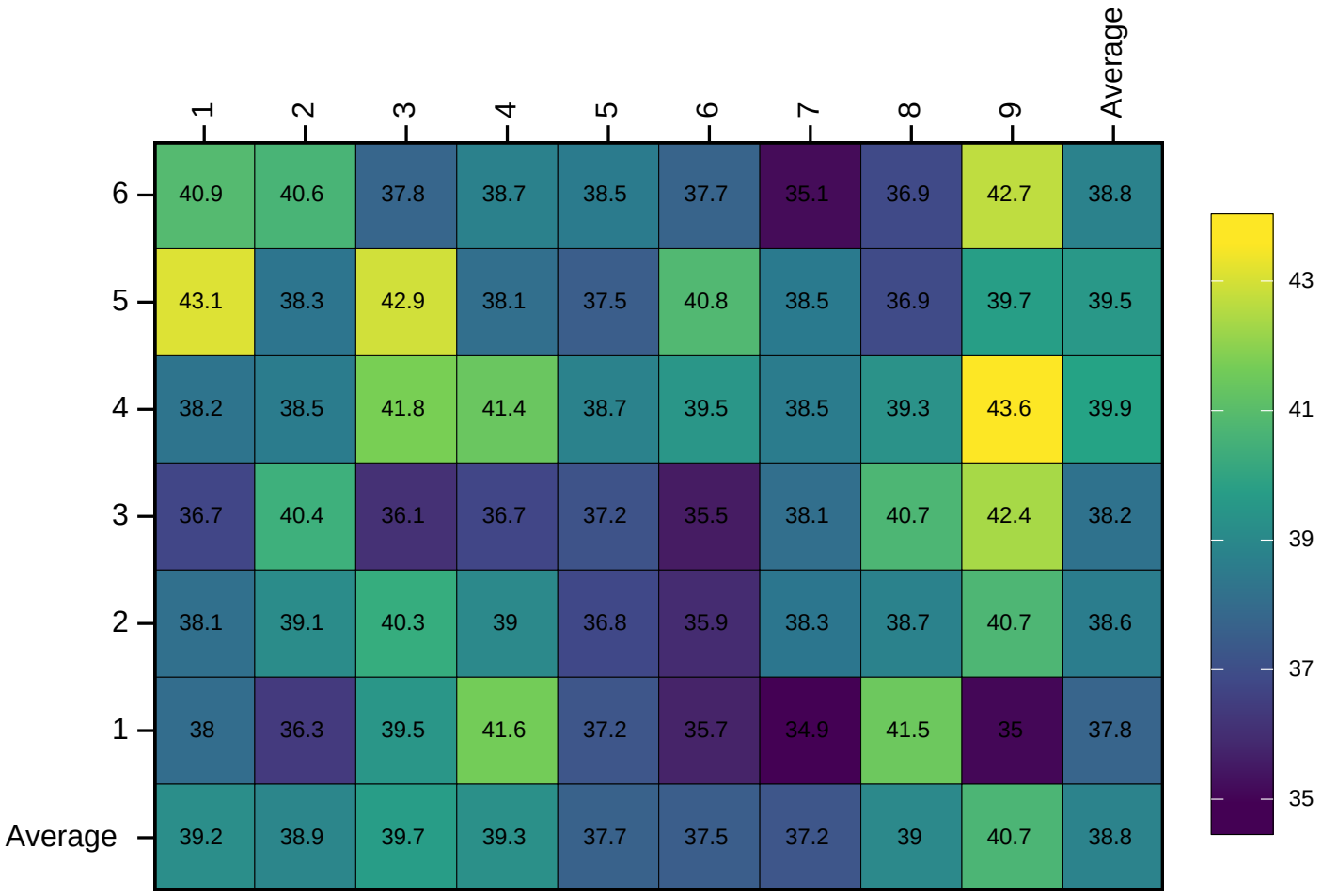
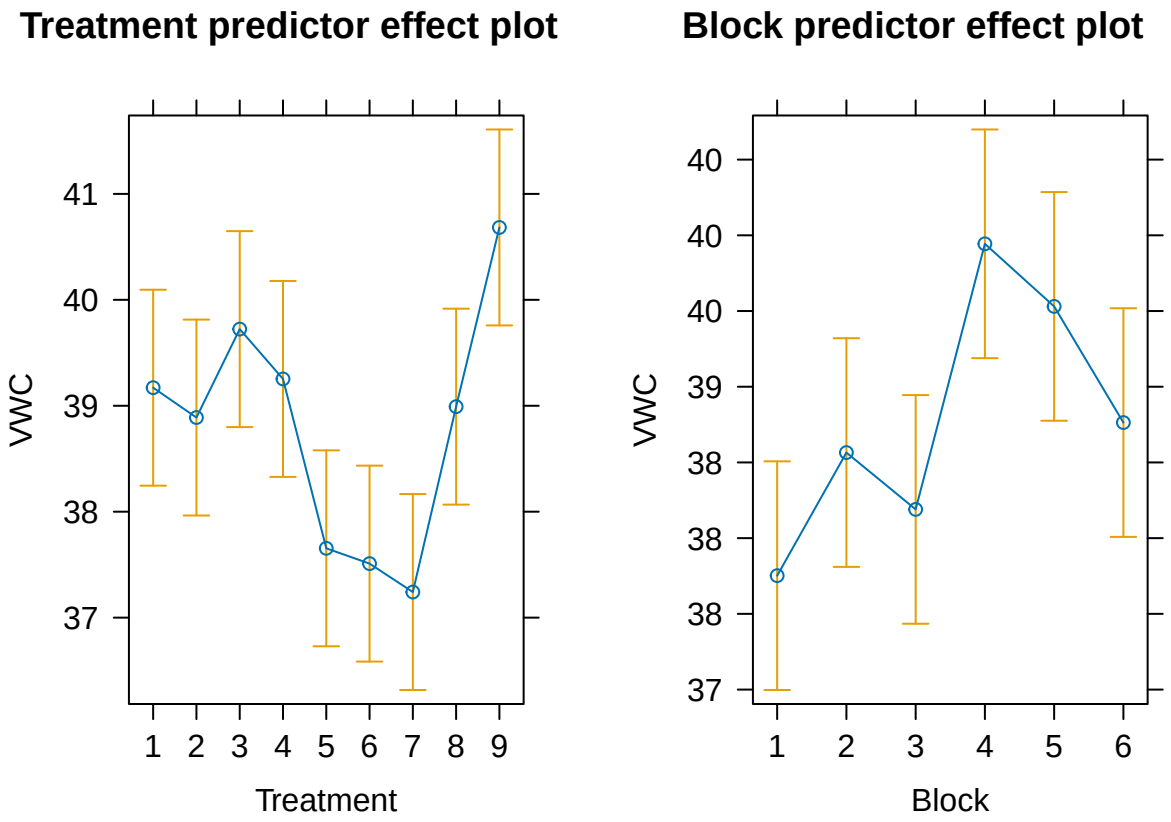
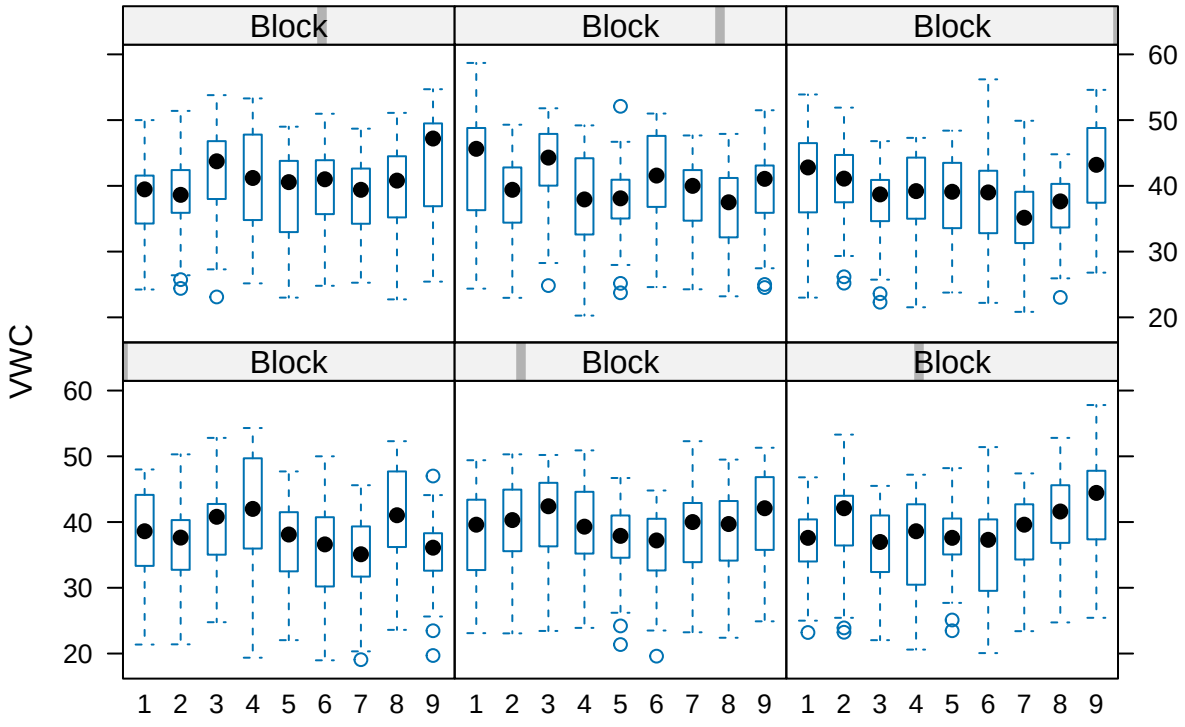


Figure 15: Volumetric Moisture Content plot means for Treatment and block

12.1 Block Effect with Treatment on VWC



In all the Blocks the distinct variations in soil moisture content were evident.



There appeared to be an interaction between both the Treatment and Block factors

Table 68: Significance of Results by Treatment, Block and Days after Initial Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	1	448.1	448.1	36.13	2.269e-09
Treatment	8	2262	282.8	22.8	2.505e-33
DAT	36	74760	2077	167.4	0
Treatment:DAT	288	3210	11.14	0.8985	0.8748
Residuals	1664	20639	12.4	NA	NA

12.2 VMC Reading 0 Days Pre Treatment (2022-11-04)

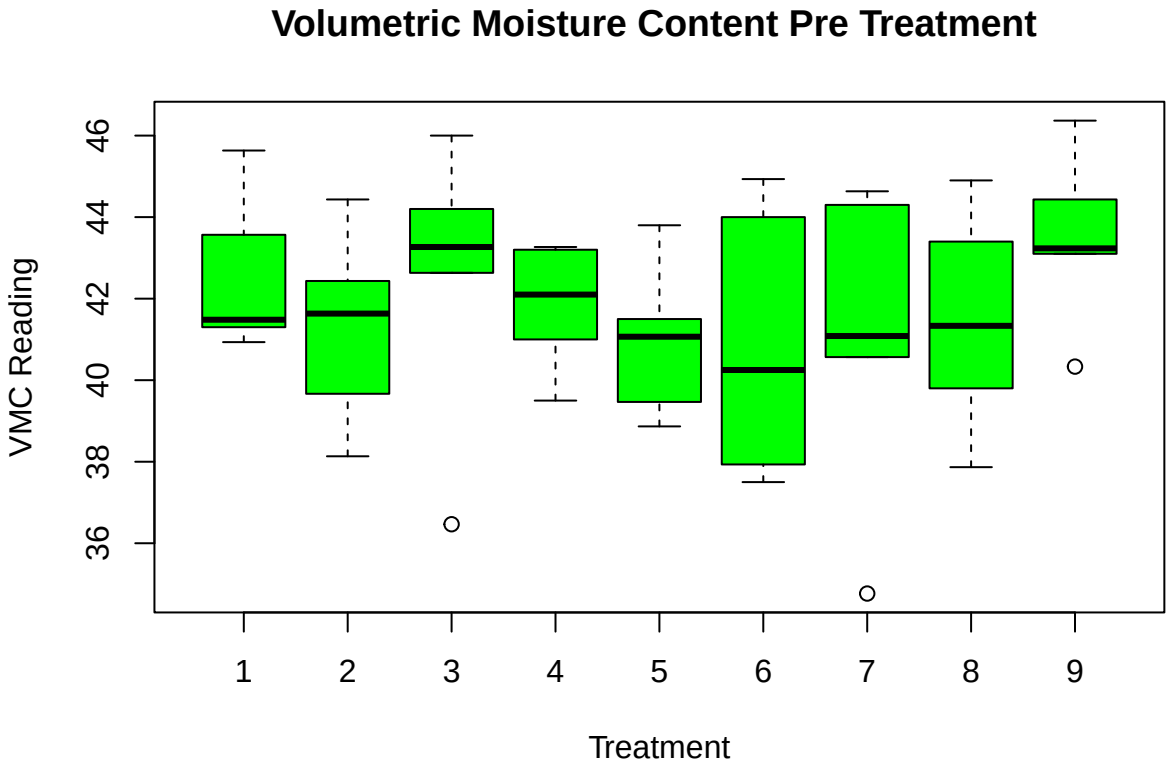


Table 69: Analysis of Variance Model Pre Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	38.12	4.765	0.7375	0.658
Residuals	45	290.7	6.461	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in soil moisture levels prior to treatment.

12.3 VMC Reading 3 Days Post Treatment (2022-11-10)

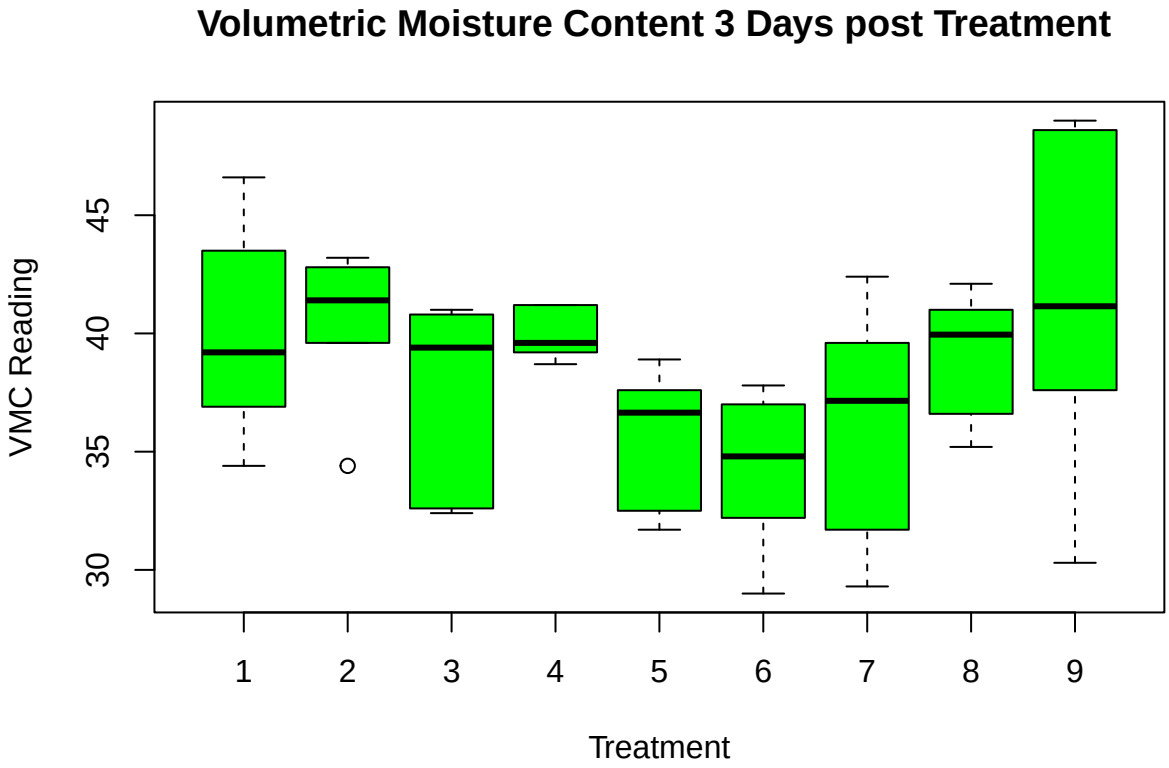
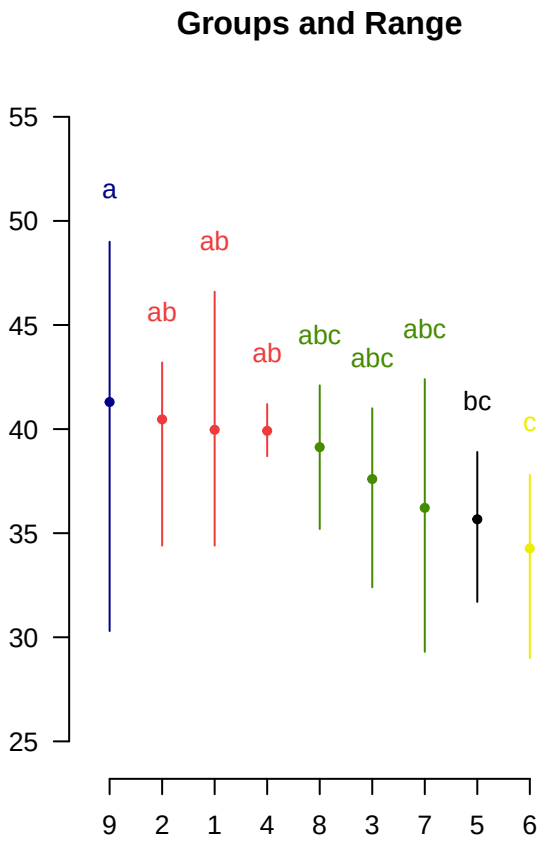


Table 70: Analysis of Variance Model 3 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	286.9	35.86	2.121	0.05324
Residuals	45	760.6	16.9	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
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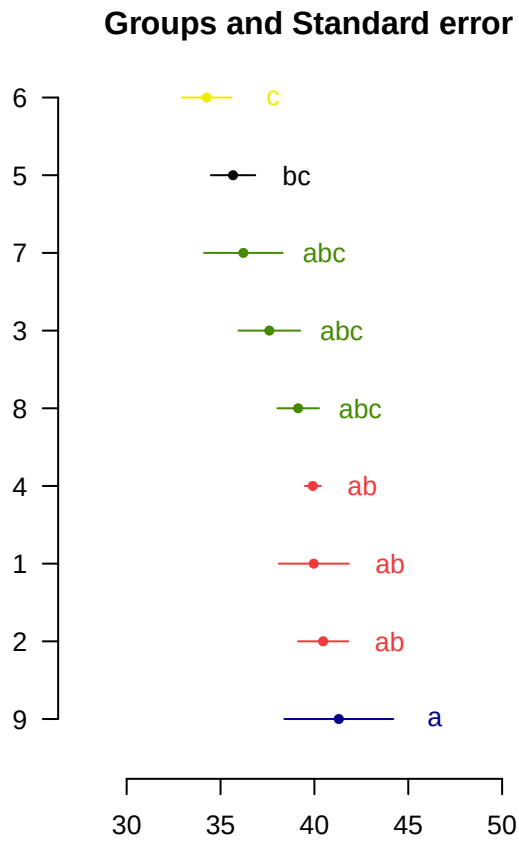
Groups and Standard error
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12.4 VMC Reading 7 Days Post Treatment (2022-11-14)

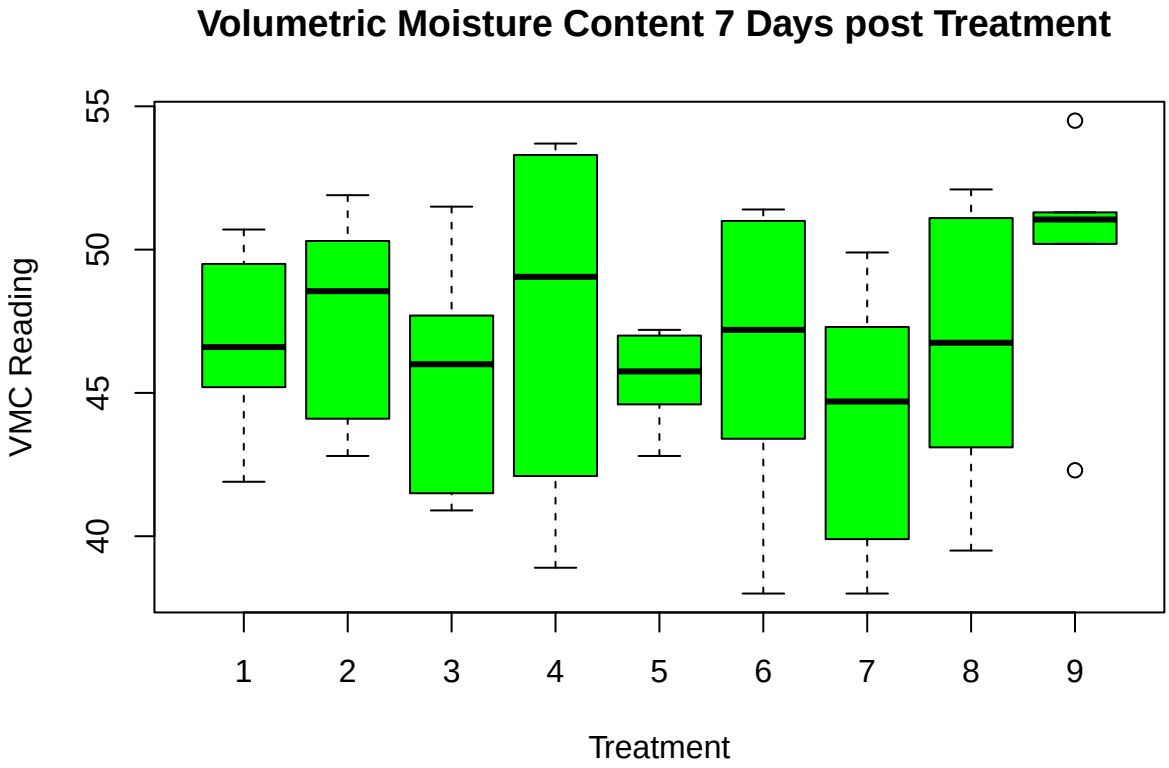


Table 71: Analysis of Variance Model 7 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	137.4	17.17	0.9075	0.5188
Residuals	45	851.4	18.92	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.5 VMC Reading 11 Days Post Treatment (2022-11-18)

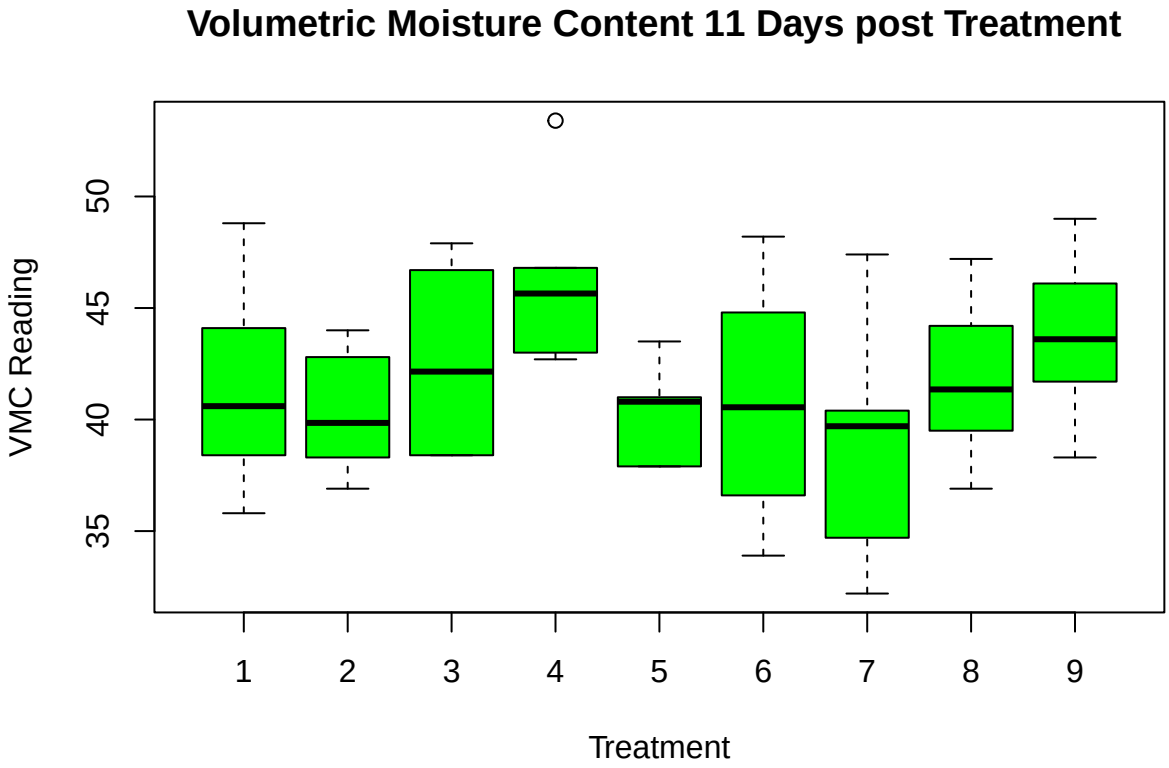


Table 72: Analysis of Variance Model 11 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	223.1	27.89	1.613	0.1479
Residuals	45	777.9	17.29	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.6 VMC Reading 15 Days Post Treatment (2022-11-22)

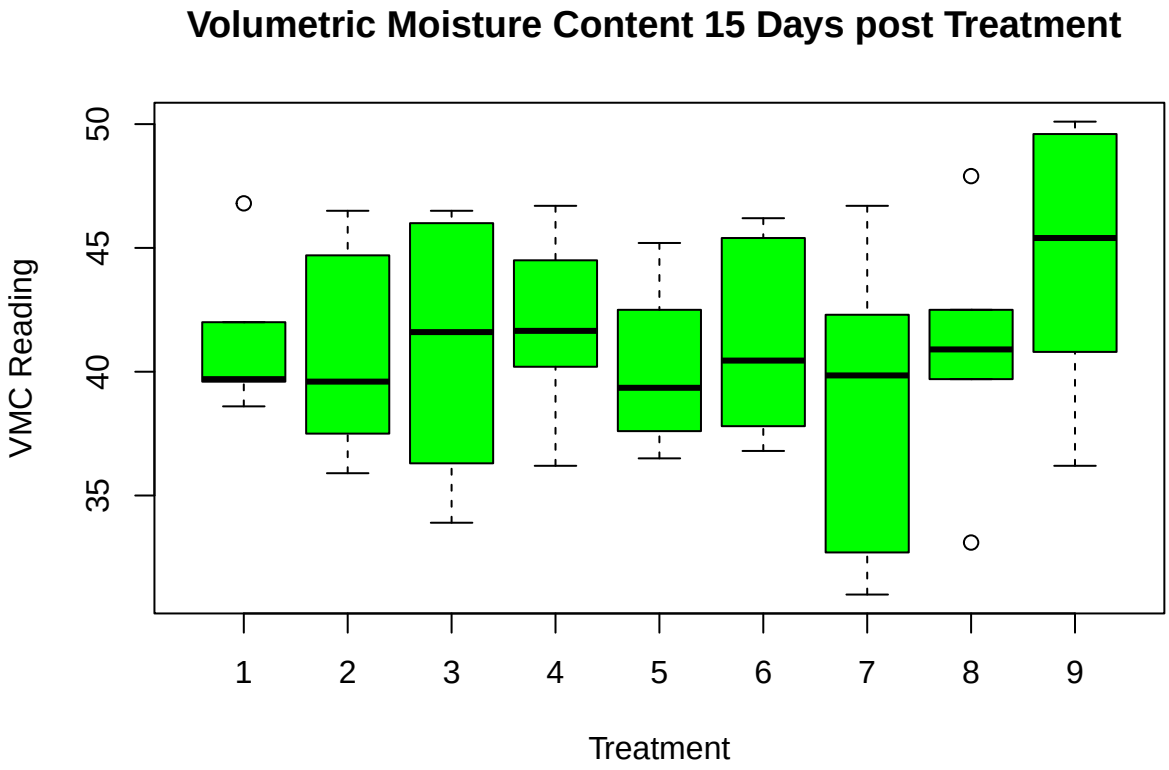


Table 73: Analysis of Variance Model 15 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	117.6	14.69	0.7271	0.6668
Residuals	45	909.4	20.21	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.7 VMC Reading 16 Days Post Treatment (2022-11-23)

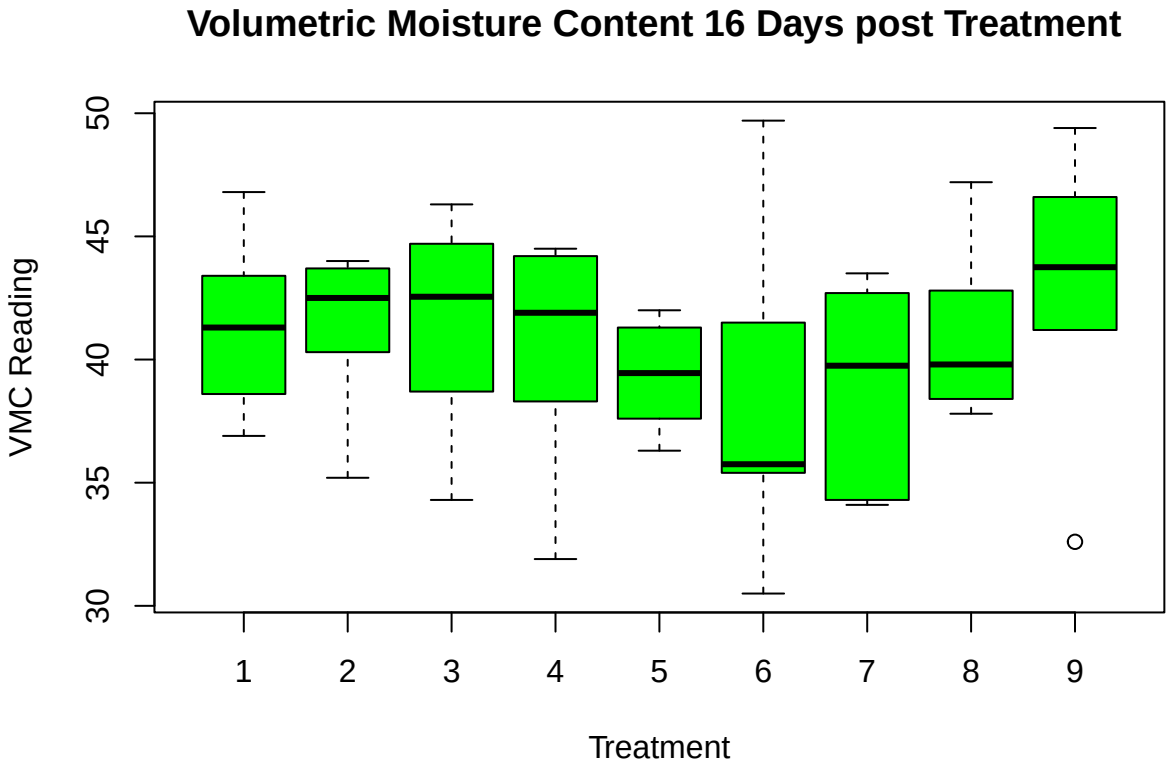


Table 74: Analysis of Variance Model Pre Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	106.3	13.29	0.666	0.7183
Residuals	45	897.8	19.95	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.8 VMC Reading 17 Days Post Treatment (2022-11-24)

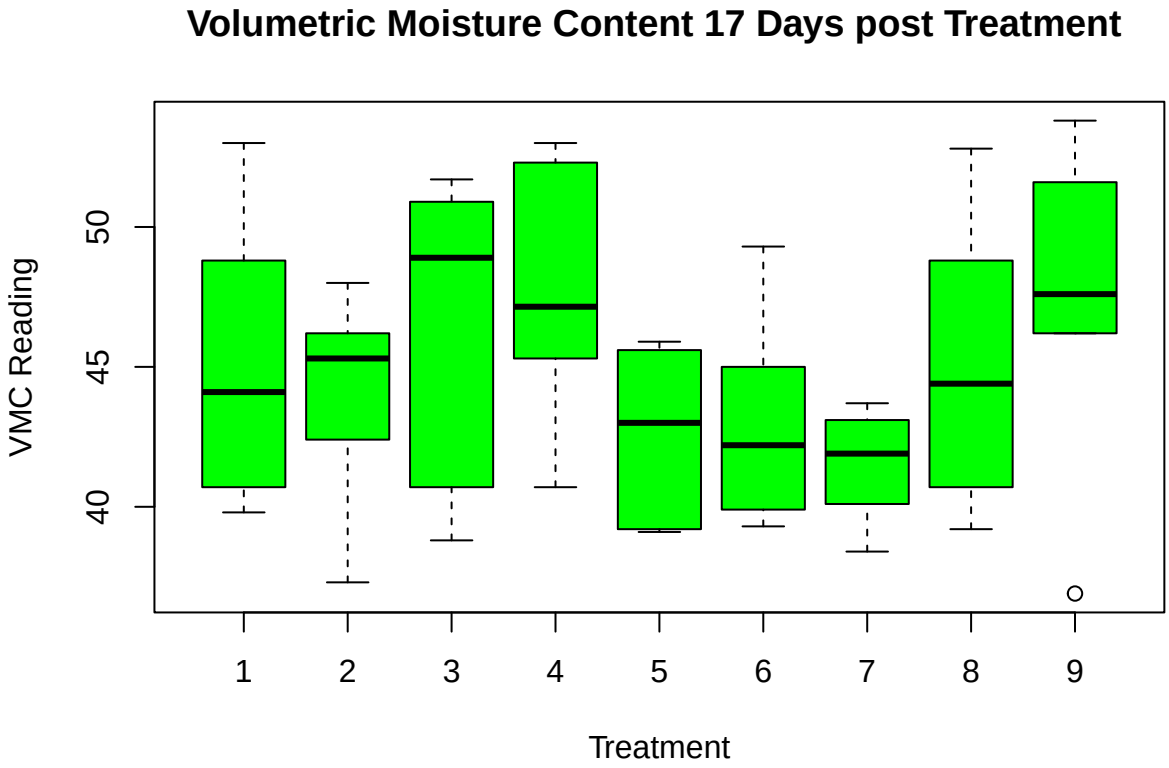


Table 75: Analysis of Variance Model 17 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	221.1	27.64	1.339	0.2495
Residuals	45	928.8	20.64	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.9 VMC Reading 22 Days Post Treatment (2022-11-29)

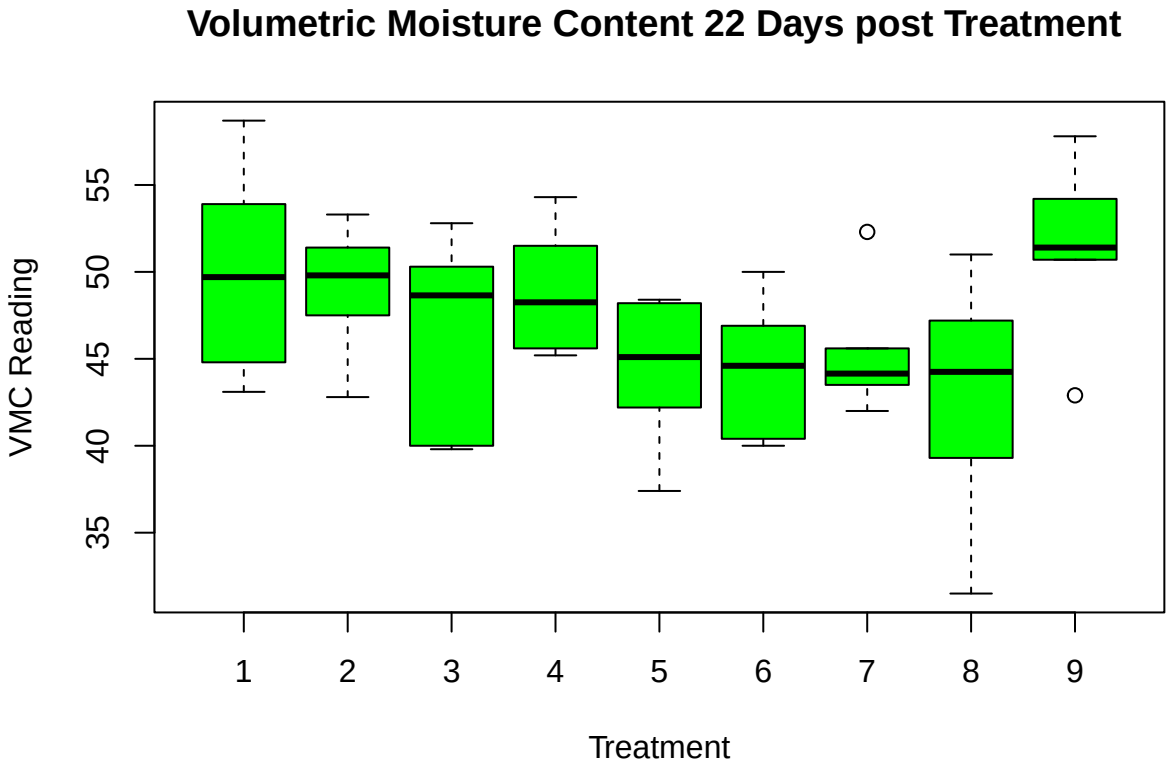
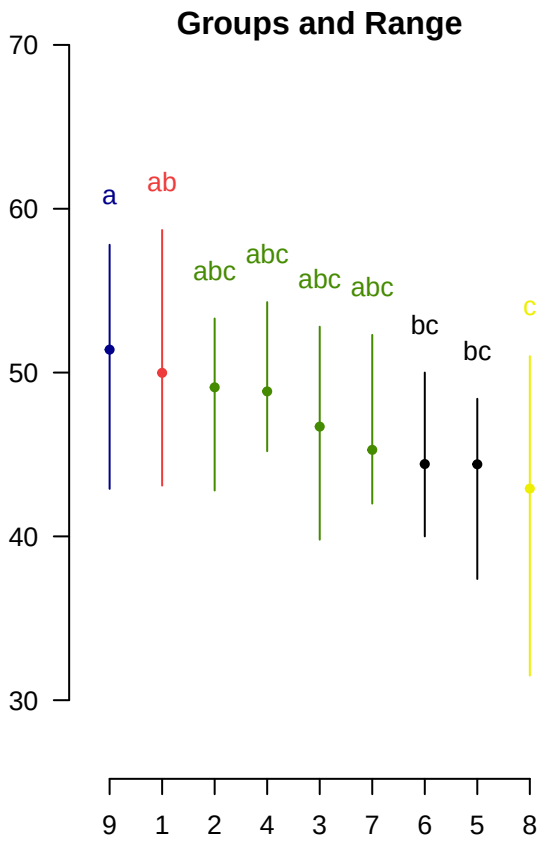


Table 76: Analysis of Variance Model 22 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	415.4	51.93	2.24	0.04177
Residuals	45	1043	23.18	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
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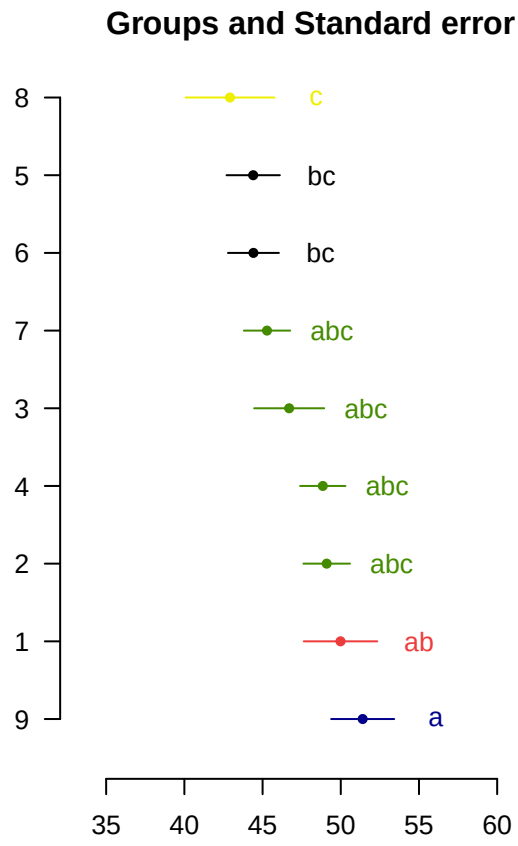
Groups and Standard error
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12.10 VMC Reading 24 Days Post Treatment (2022-12-01)

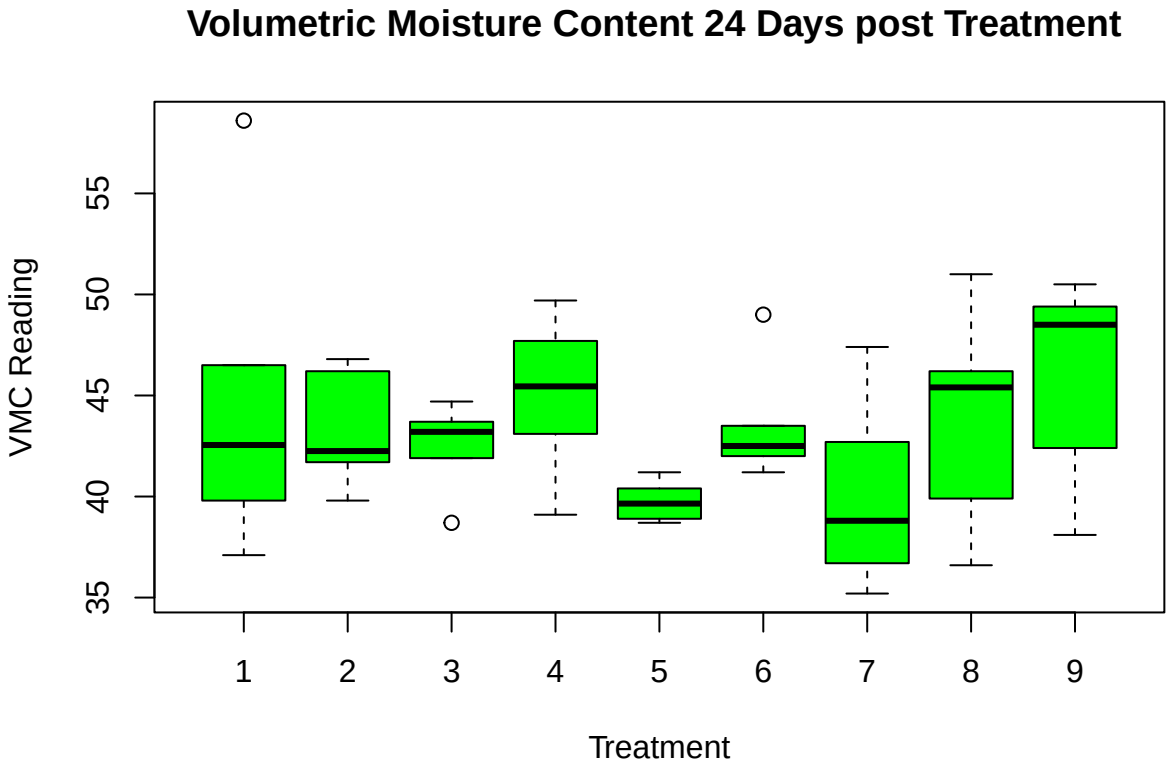


Table 77: Analysis of Variance Model 24 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	229.8	28.73	1.583	0.1569
Residuals	45	816.5	18.15	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.11 VMC Reading 29 Days Post Treatment (2022-12-06)

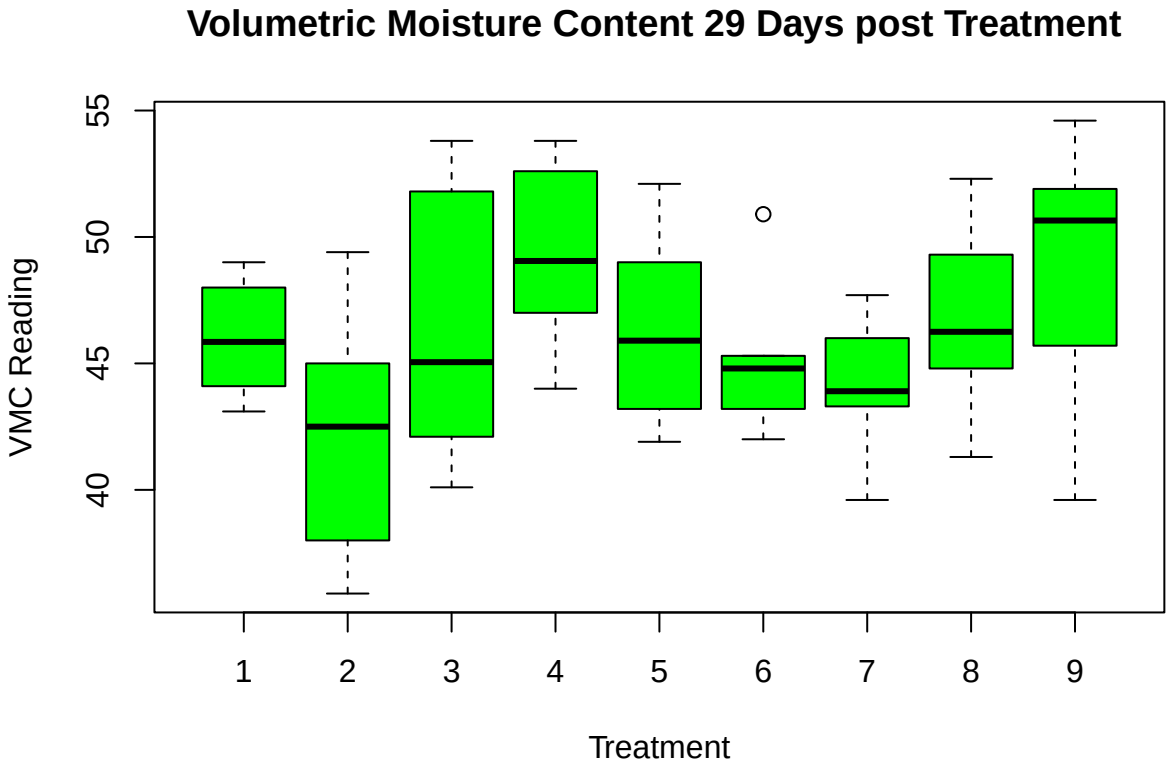


Table 78: Analysis of Variance Model 29 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	228.3	28.53	1.758	0.1111
Residuals	45	730.3	16.23	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.12 VMC Reading 32 Days Post Treatment (2022-12-09)

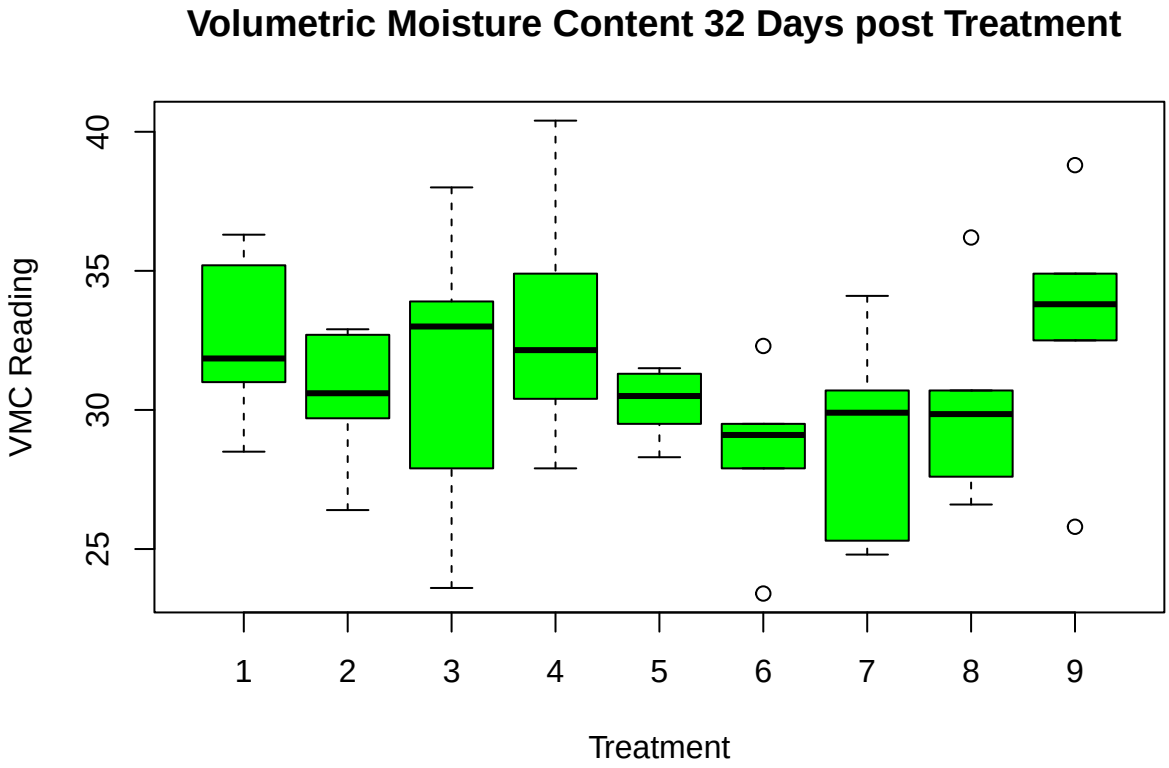


Table 79: Analysis of Variance Model 32 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	135.6	16.95	1.37	0.2357
Residuals	45	556.8	12.37	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.13 VMC Reading 39 Days Post Treatment (2022-12-16)

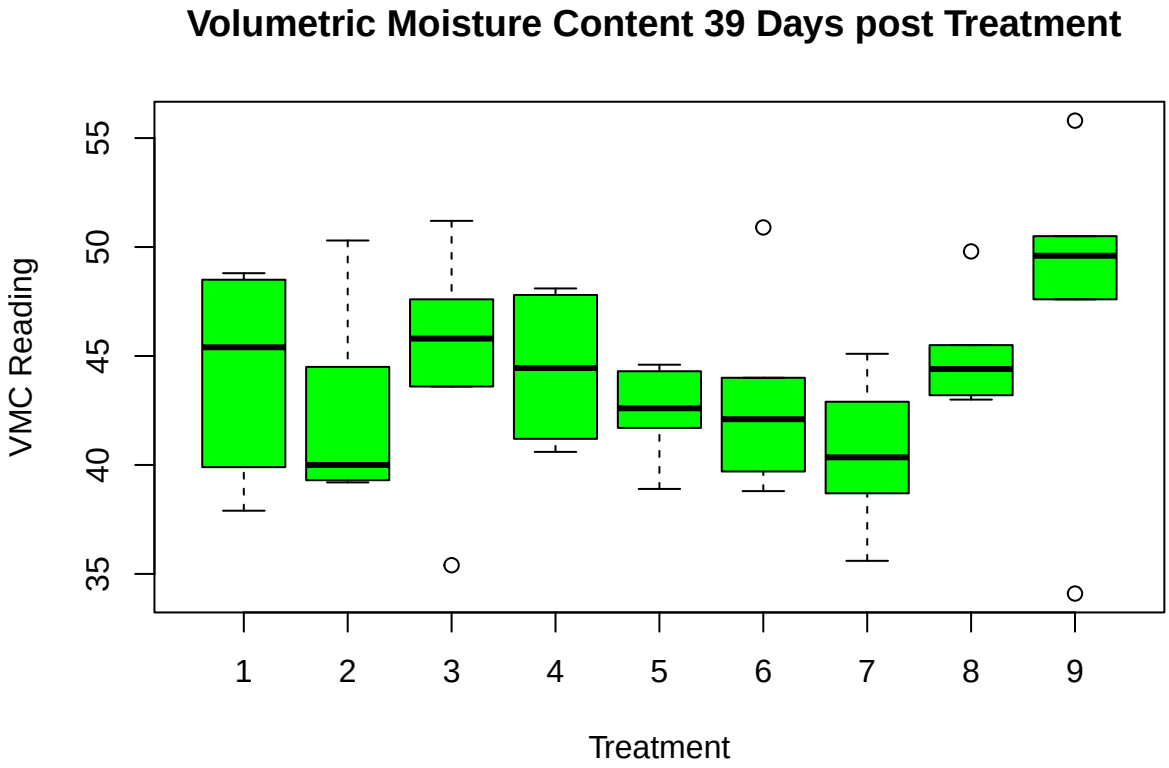


Table 80: Analysis of Variance Model 39 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	215.5	26.94	1.395	0.2246
Residuals	45	868.8	19.31	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.14 VMC Reading 46 Days Post Treatment (2022-12-23)

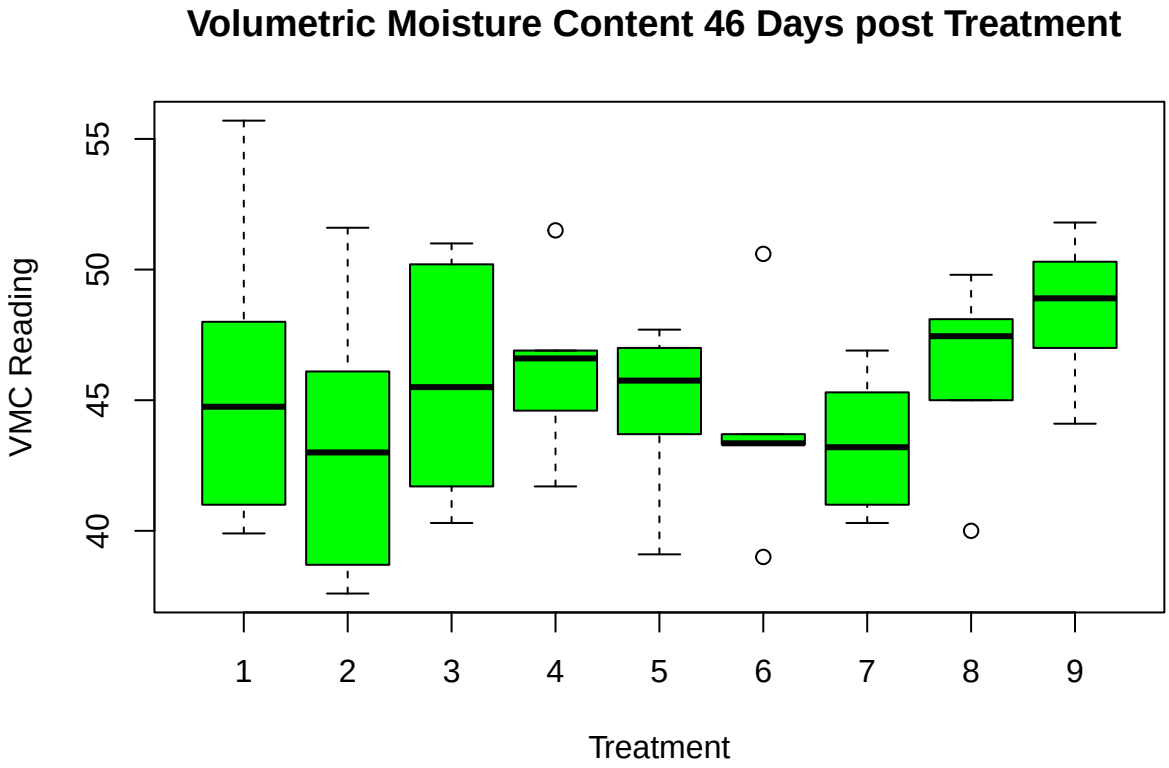


Table 81: Analysis of Variance Model 46 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	135.6	16.95	1.098	0.3825
Residuals	45	694.9	15.44	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.15 VMC Reading 67 Days Post Treatment (2023-01-13)

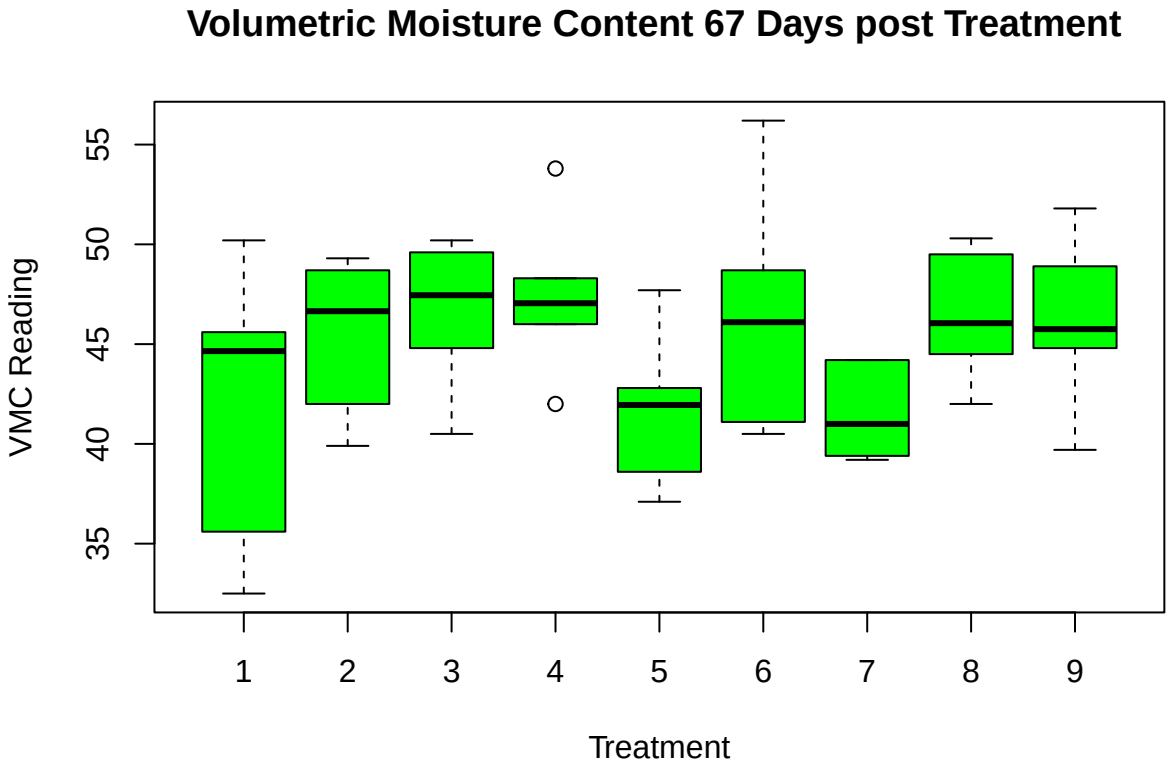


Table 82: Analysis of Variance Model 67 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	269.6	33.7	1.815	0.09911
Residuals	45	835.5	18.57	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.16 VMC Reading 91 Days Post Treatment (2022-02-06)

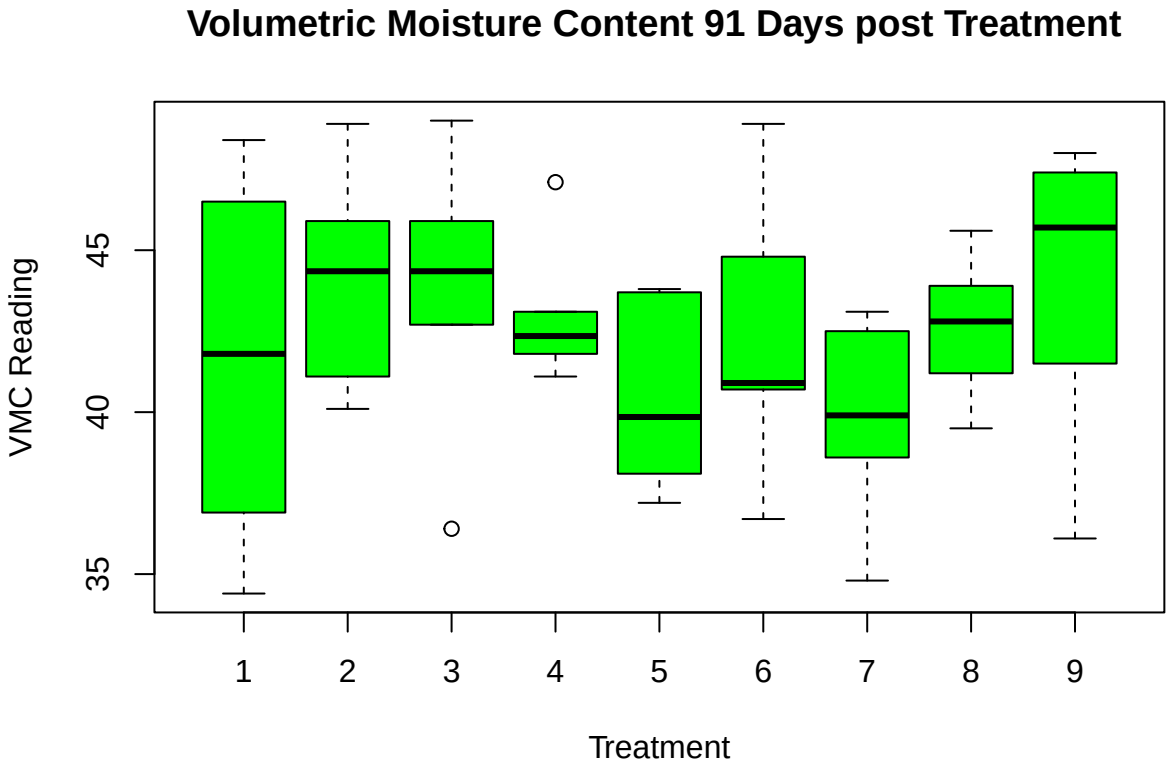


Table 83: Analysis of Variance Model 91 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	116.1	14.52	1.059	0.408
Residuals	45	616.7	13.71	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.17 VMC Reading 95 Days Post Treatment (2022-02-10)

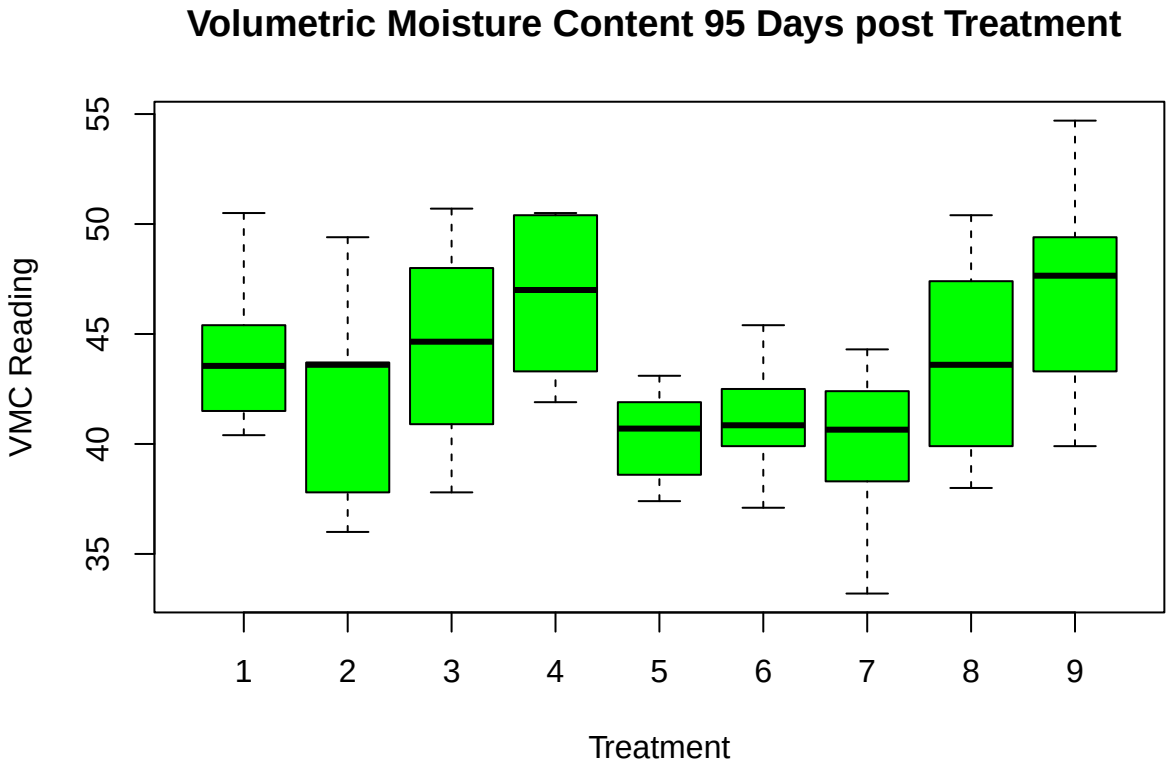
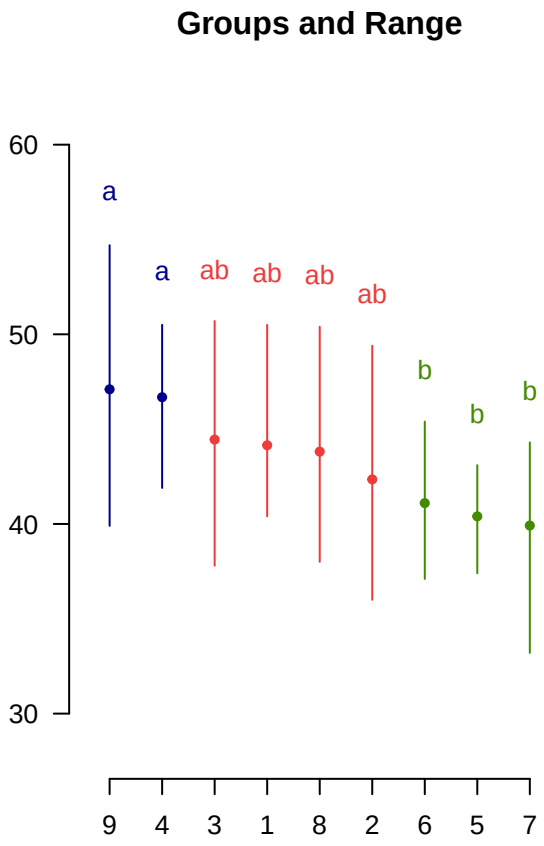


Table 84: Analysis of Variance Model 95 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	322.7	40.34	2.419	0.02886
Residuals	45	750.4	16.67	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.


Groups and Range
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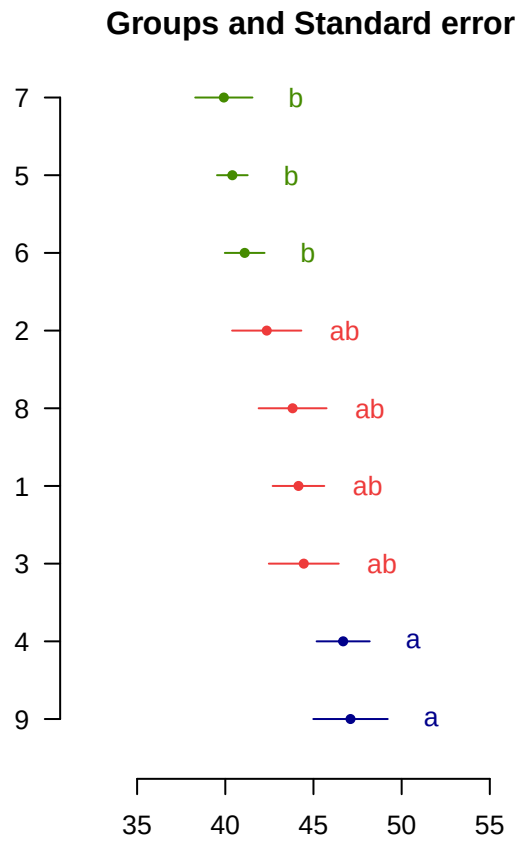
Groups and Standard error
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12.18 VMC Reading 105 Days Post Treatment (2022-02-20)

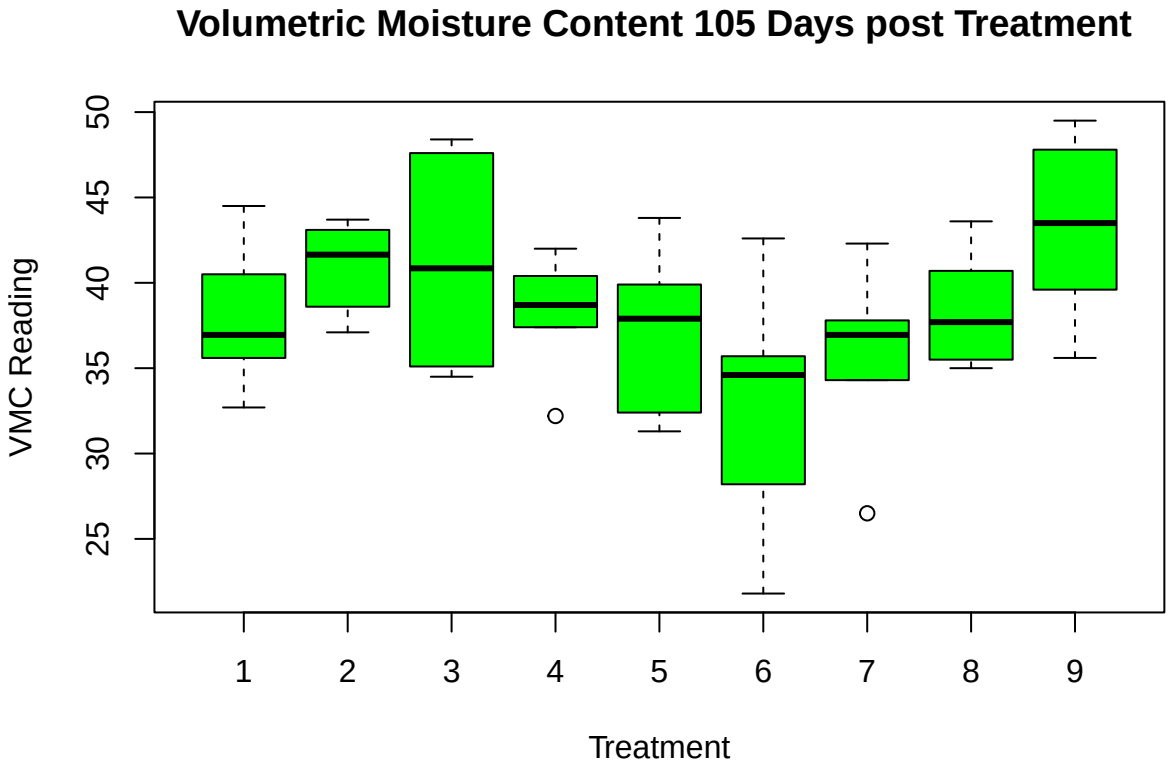
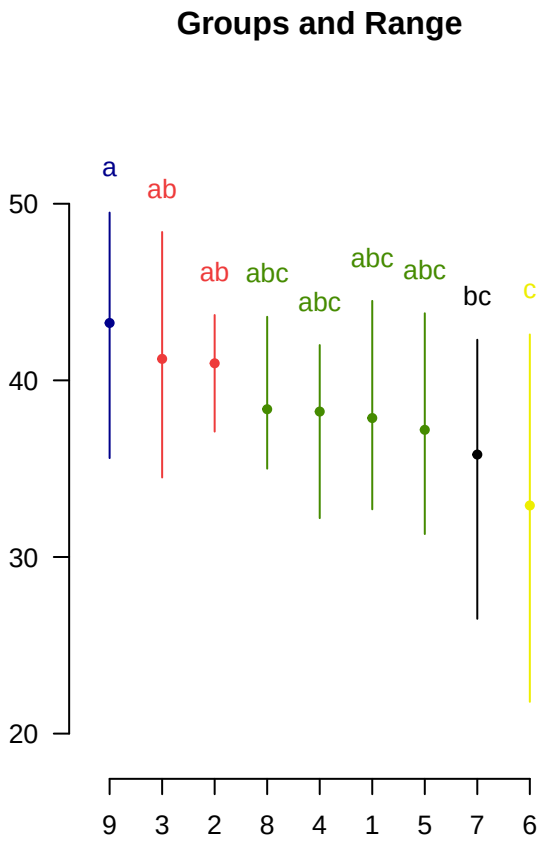


Table 85: Analysis of Variance Model 105 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	459.7	57.46	2.477	0.02564
Residuals	45	1044	23.2	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.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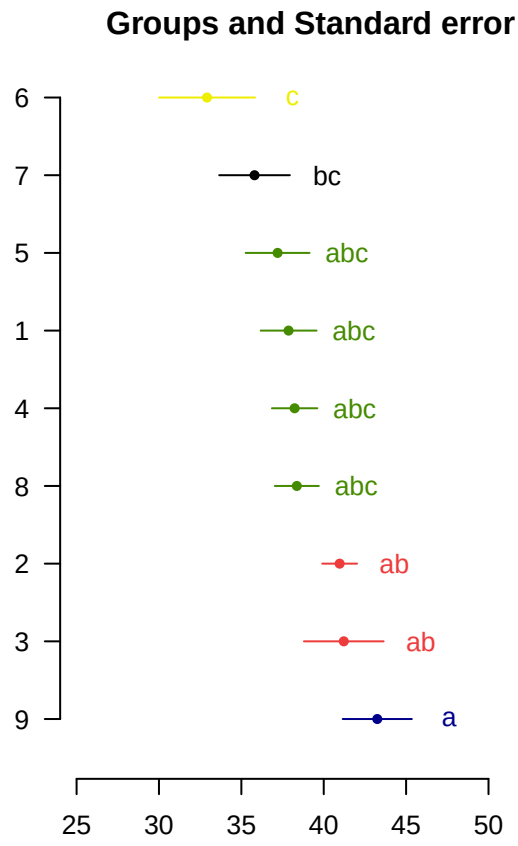
Groups and Standard error
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12.19 VMC Reading 106 Days Post Treatment (2022-02-21)

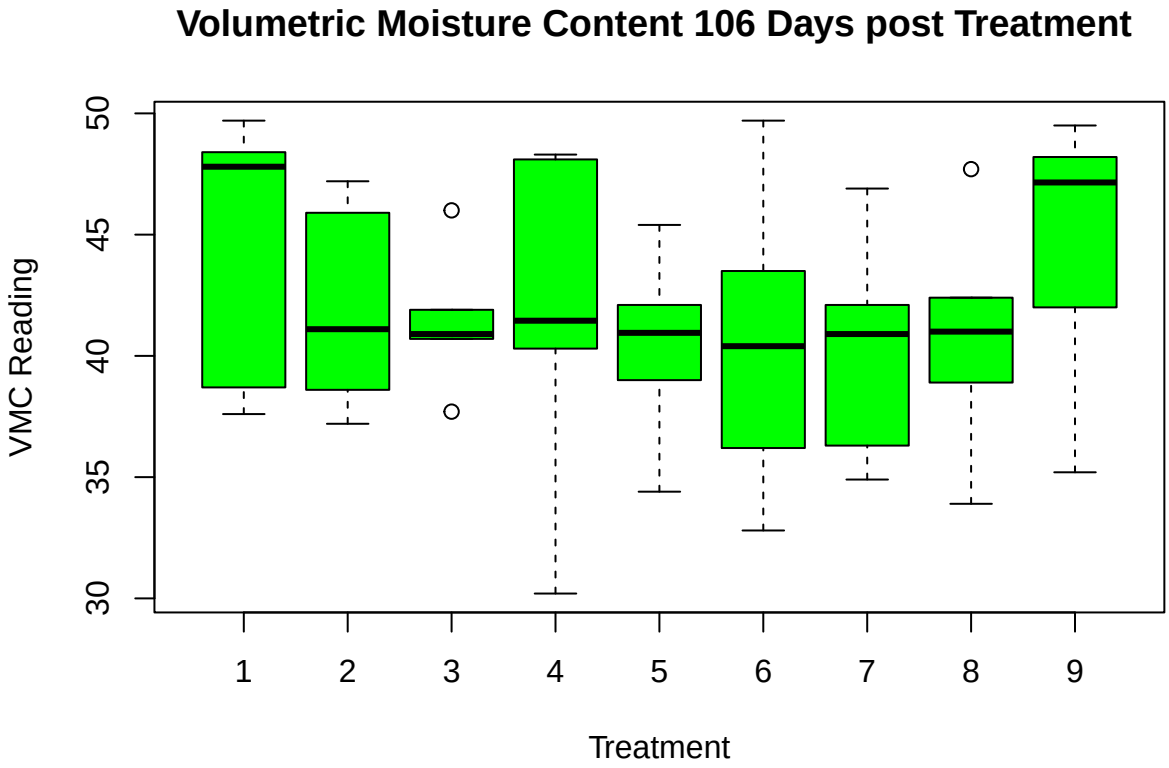


Table 86: Analysis of Variance Model 106 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	158.5	19.82	0.8371	0.5751
Residuals	45	1065	23.67	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.20 VMC Reading 113 Days Post Treatment (2022-02-28)

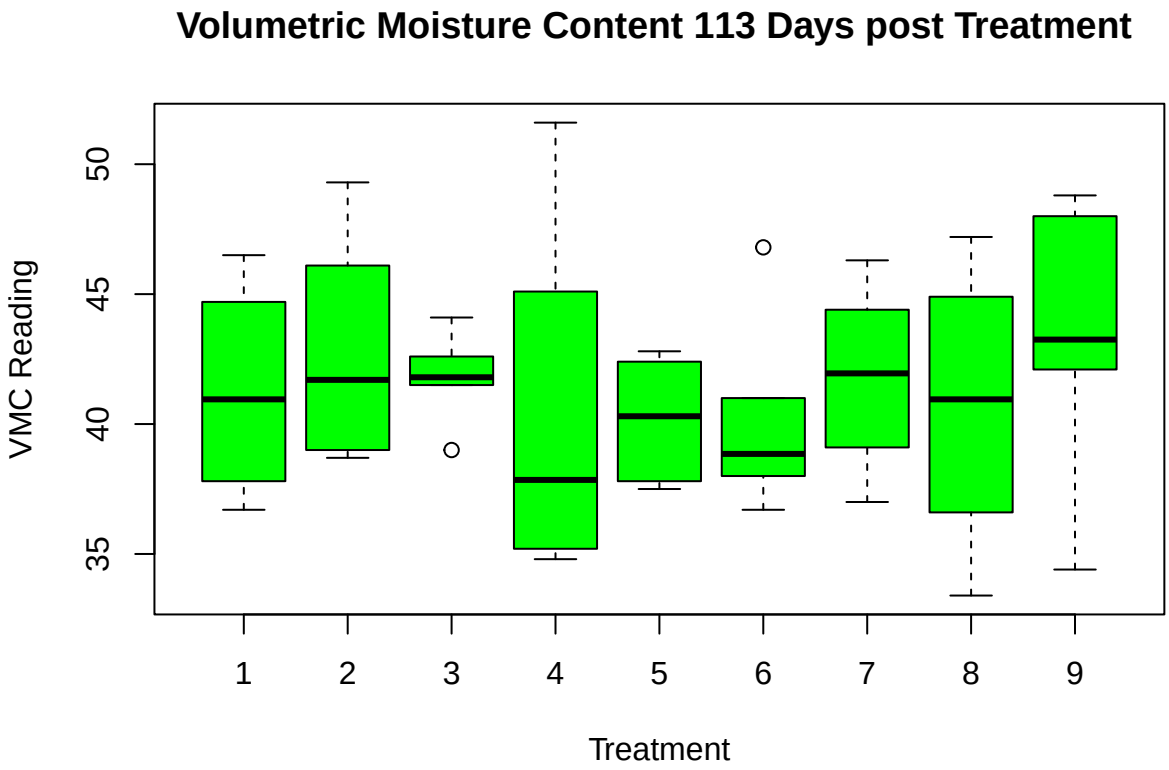


Table 87: Analysis of Variance Model 113 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	63.74	7.968	0.4286	0.8976
Residuals	45	836.5	18.59	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.21 VMC Reading 116 Days Post Treatment (2022-03-03)

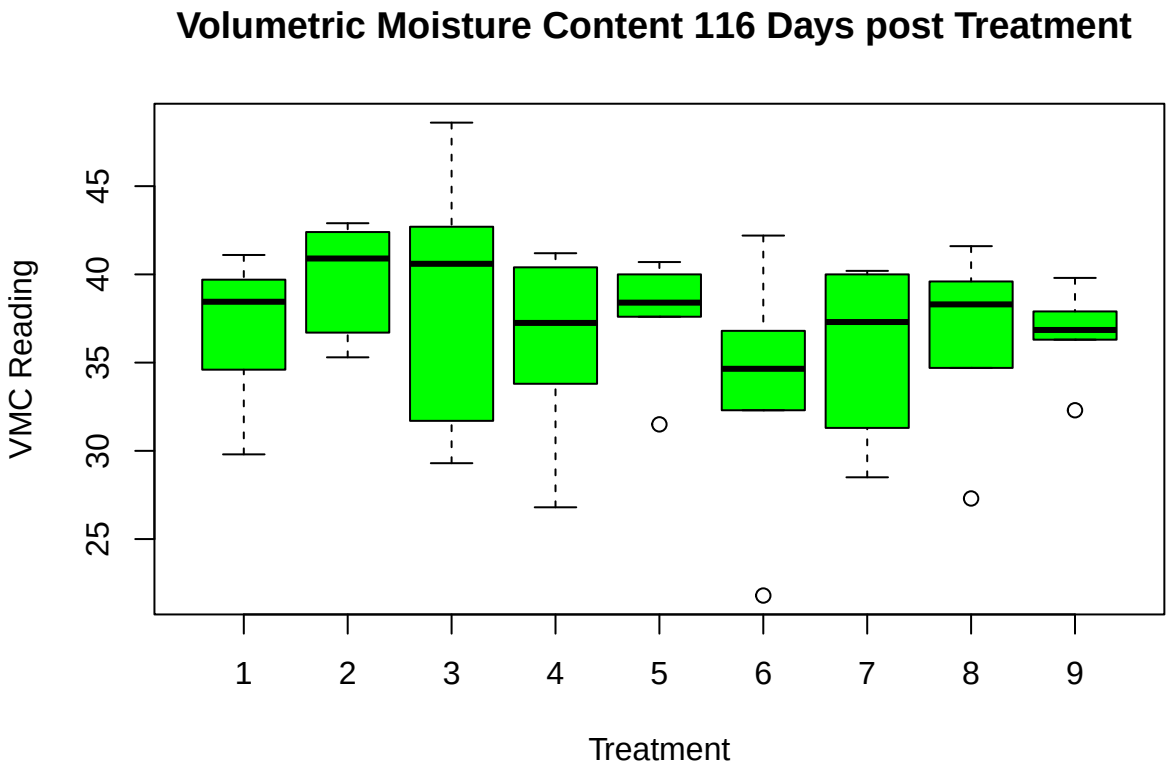


Table 88: Analysis of Variance Model 116 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	153.4	19.18	0.7795	0.6227
Residuals	45	1107	24.6	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.22 VMC Reading 123 Days Post Treatment (2022-03-10)

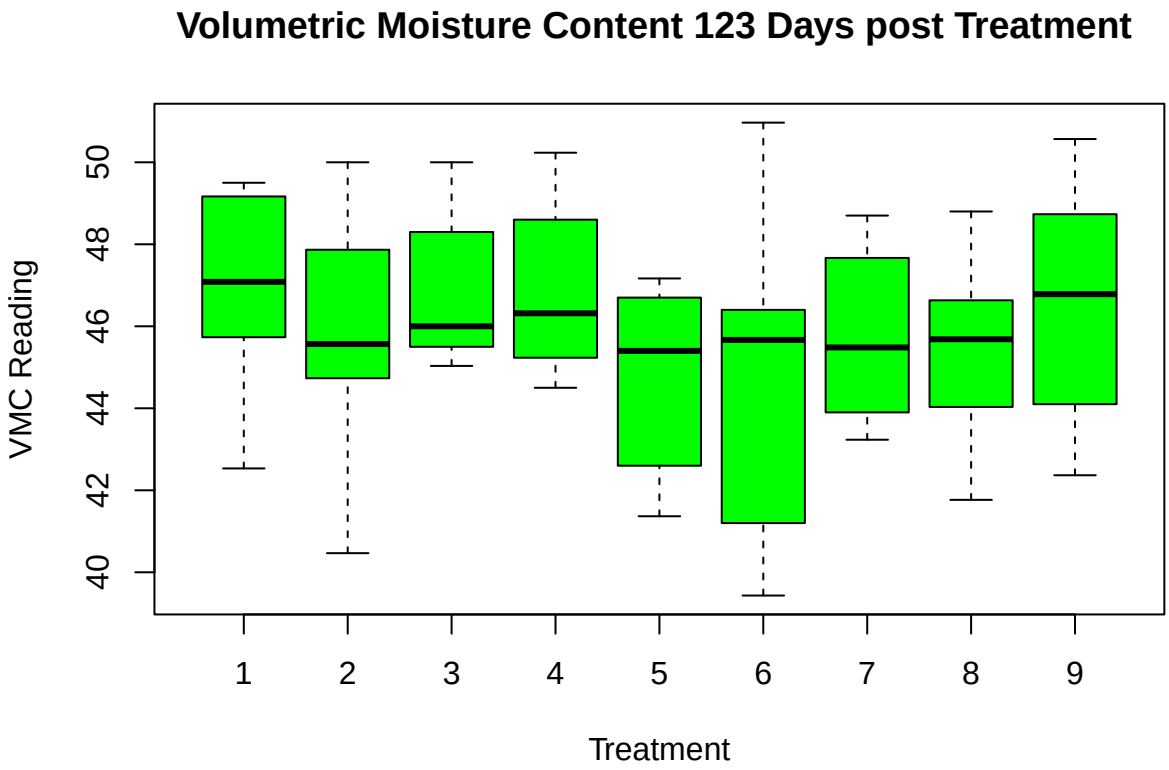


Table 89: Analysis of Variance Model 123 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	33.8	4.225	0.5681	0.7982
Residuals	45	334.7	7.437	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.23 VMC Reading 130 Days Post Treatment (2022-03-17)

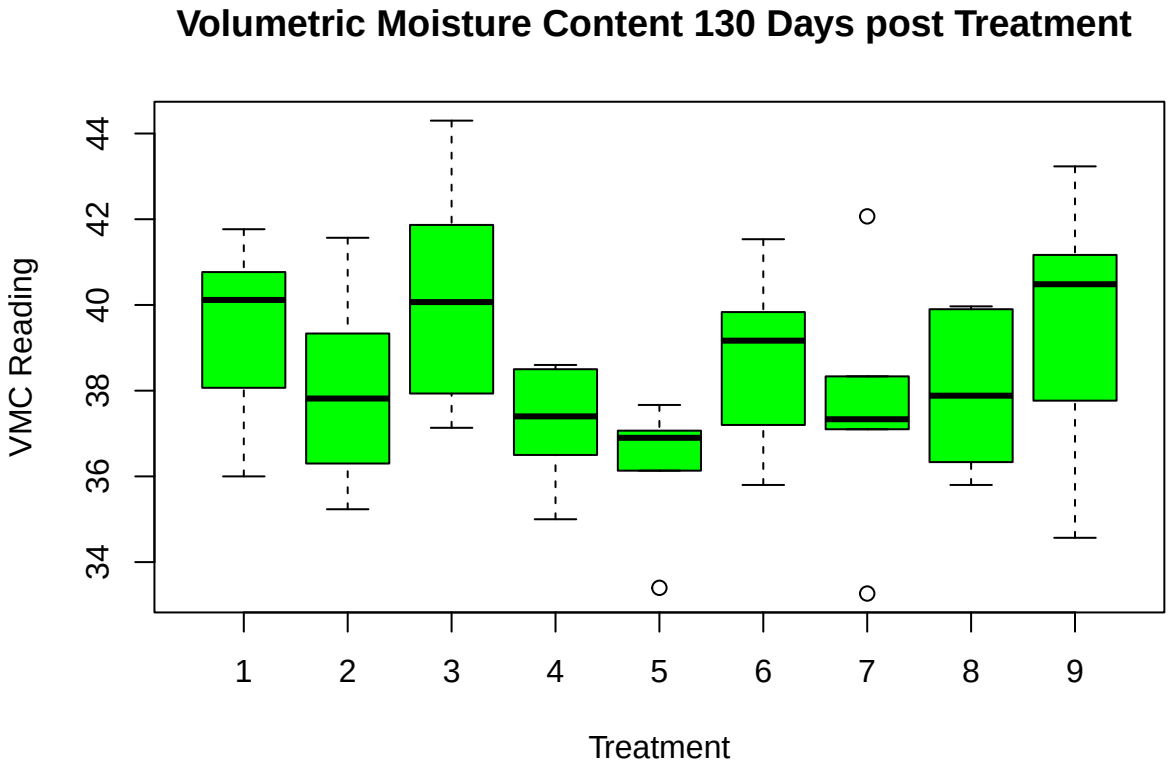


Table 90: Analysis of Variance Model 130 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	76.3	9.538	1.897	0.08399
Residuals	45	226.2	5.027	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.24 VMC Reading 137 Days Post Treatment (2022-03-24)

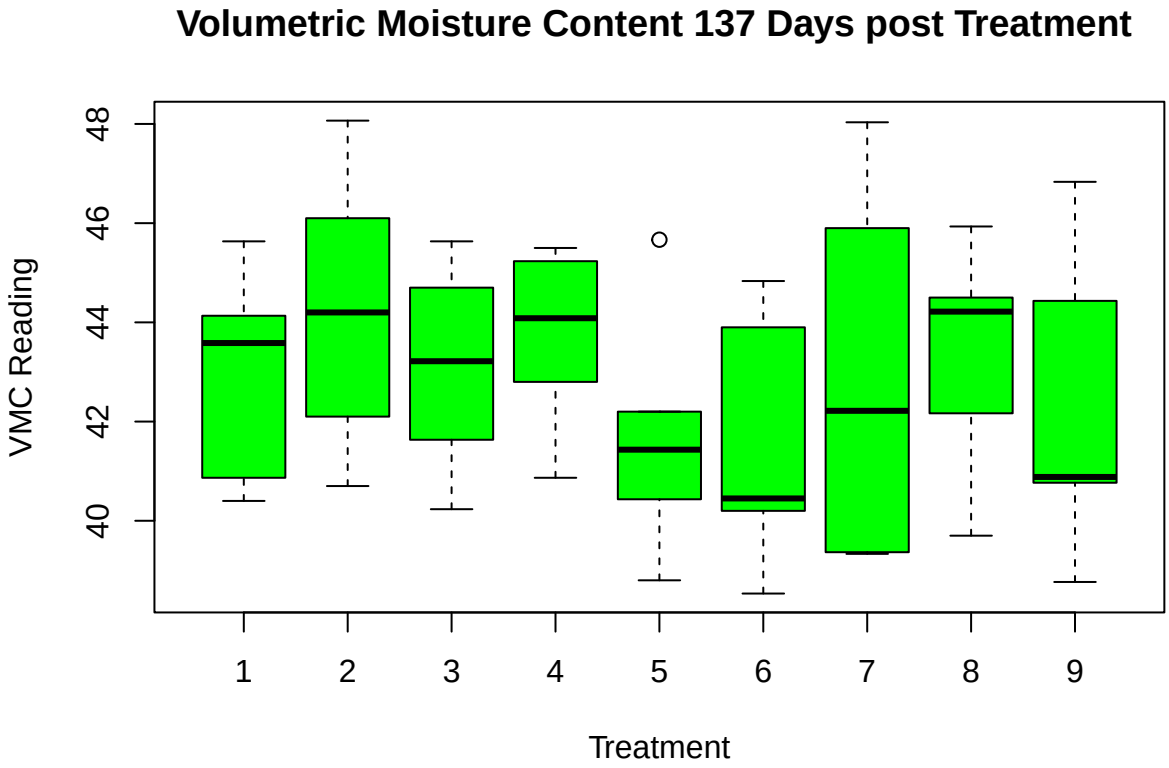


Table 91: Analysis of Variance Model 137 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	43.78	5.472	0.8768	0.5431
Residuals	45	280.9	6.241	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.25 VMC Reading 144 Days Post Treatment (2022-03-31)

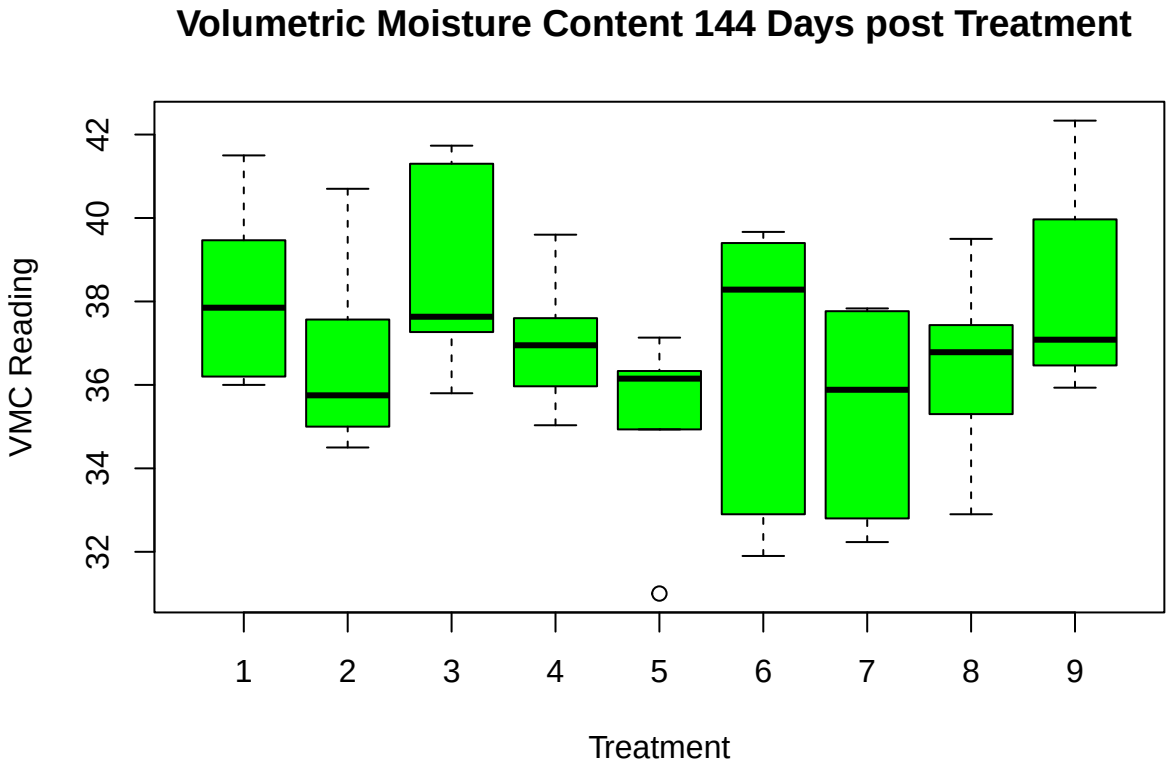


Table 92: Analysis of Variance Model 137 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	66.51	8.314	1.393	0.2255
Residuals	45	268.5	5.967	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.26 VMC Reading 151 Days Post Treatment (2022-04-06)

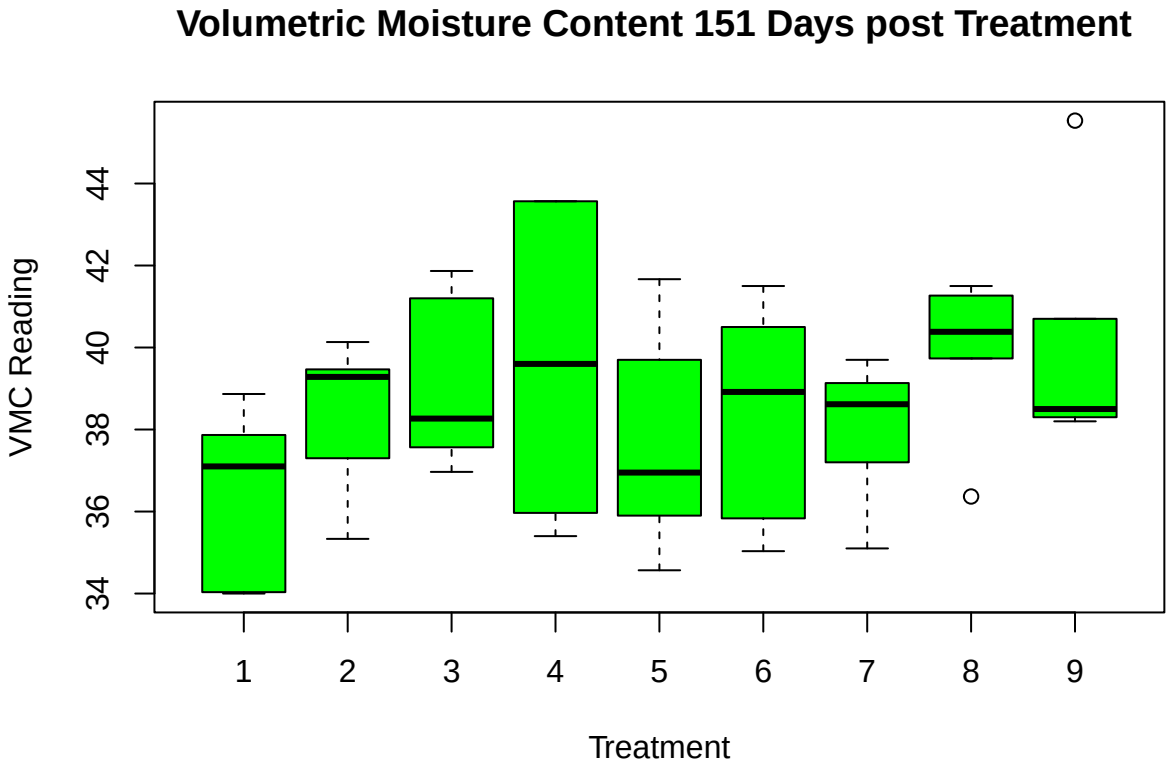


Table 93: Analysis of Variance Model 151 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	63.34	7.917	1.308	0.264
Residuals	45	272.4	6.053	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.27 VMC Reading 159 Days Post Treatment (2022-04-14)

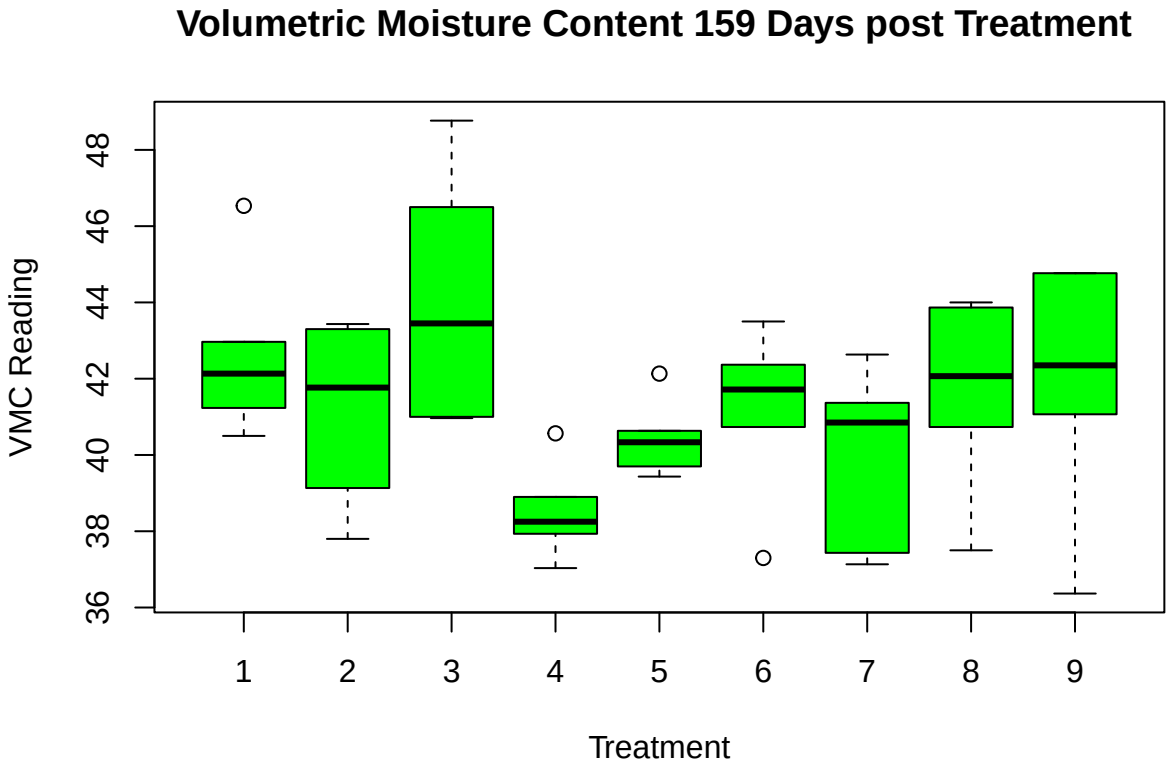
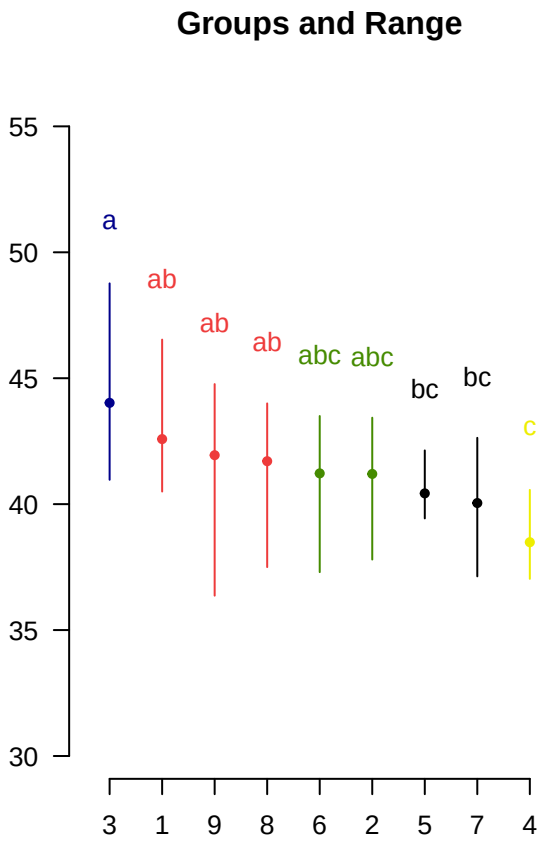


Table 94: Analysis of Variance Model 159 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	119.4	14.92	2.816	0.01277
Residuals	45	238.4	5.299	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.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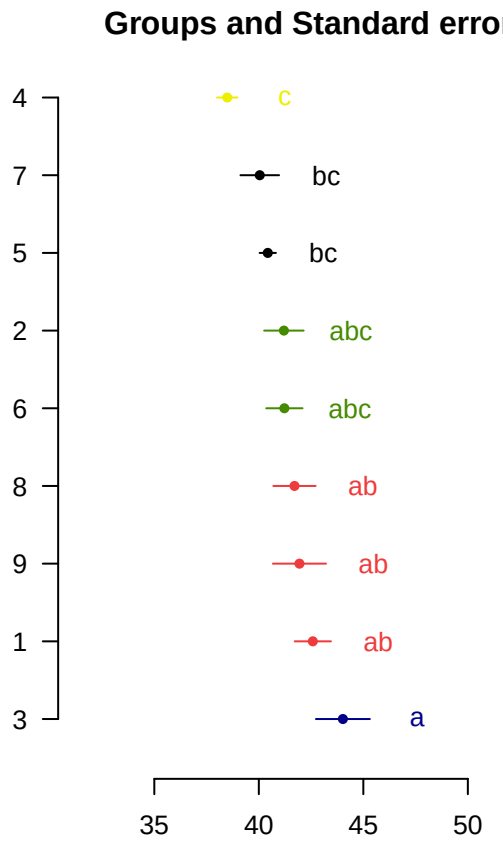
Groups and Standard error
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12.28 VMC Reading 163 Days Post Treatment (2022-04-18)

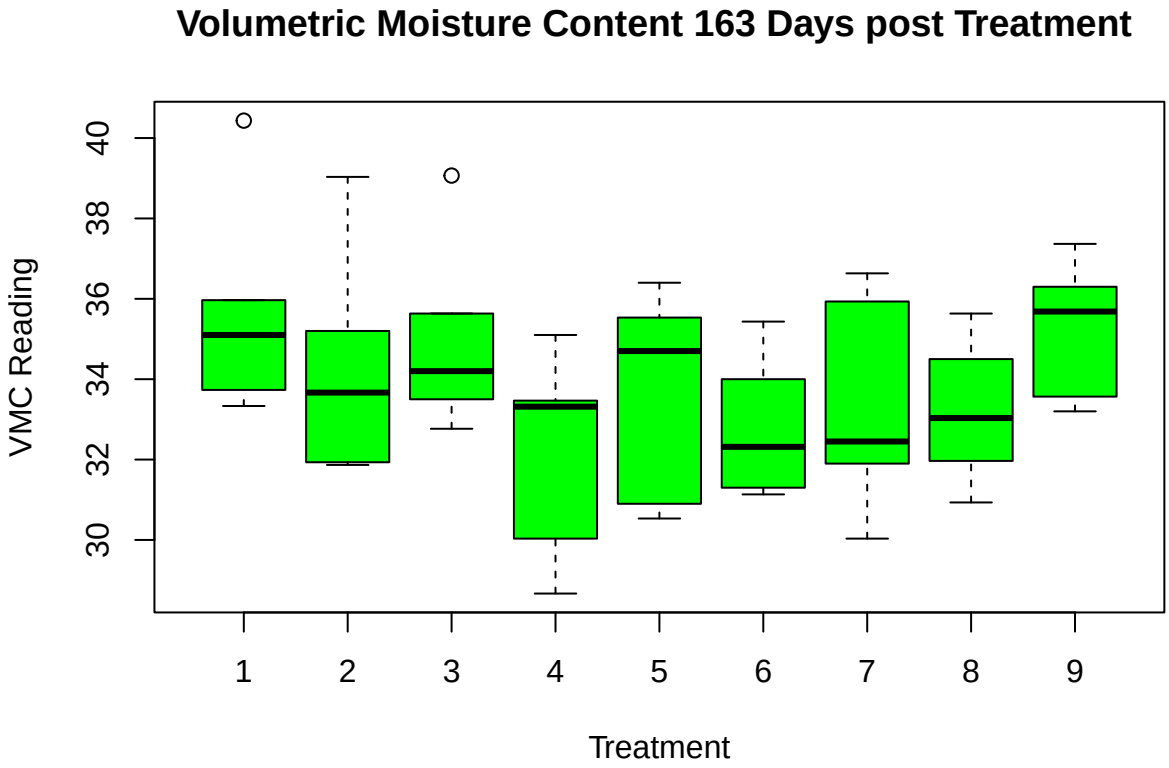


Table 95: Analysis of Variance Model 163 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	64.67	8.083	1.558	0.1648
Residuals	45	233.5	5.19	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.29 VMC Reading 165 Days Post Treatment (2022-04-20)

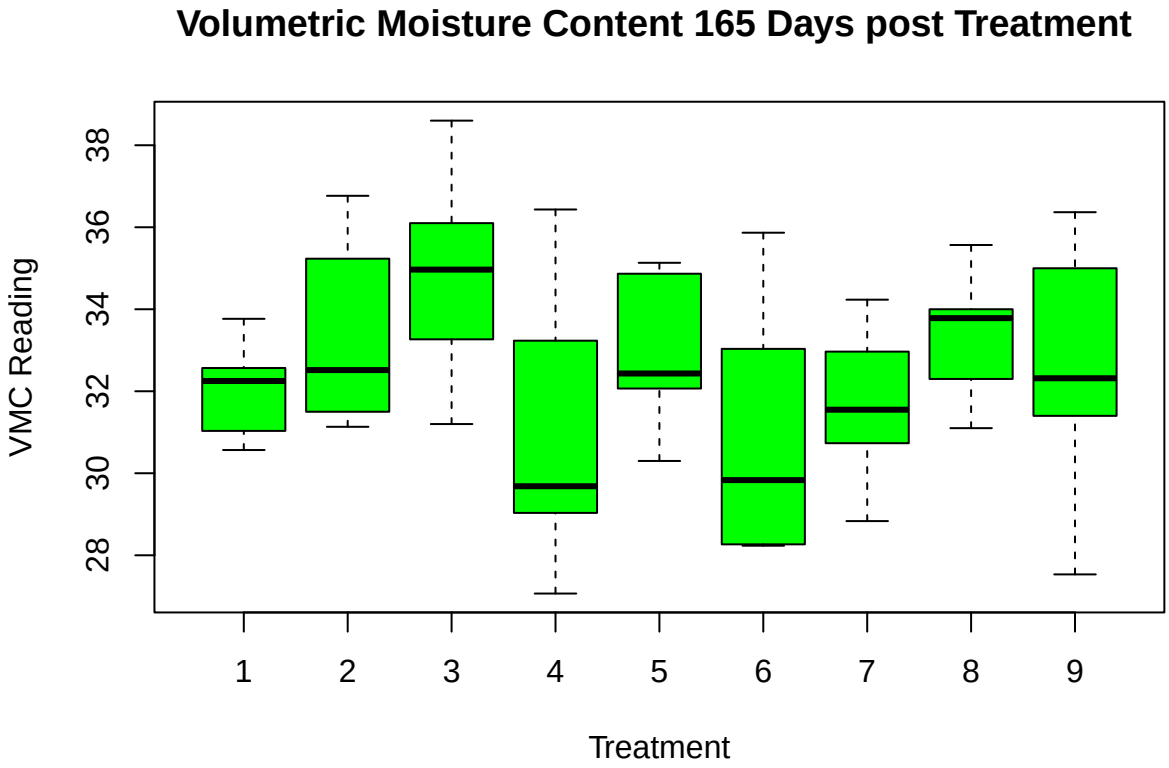


Table 96: Analysis of Variance Model 165 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	80.84	10.11	1.745	0.1139
Residuals	45	260.5	5.789	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.30 VMC Reading 169 Days Post Treatment (2022-04-24)

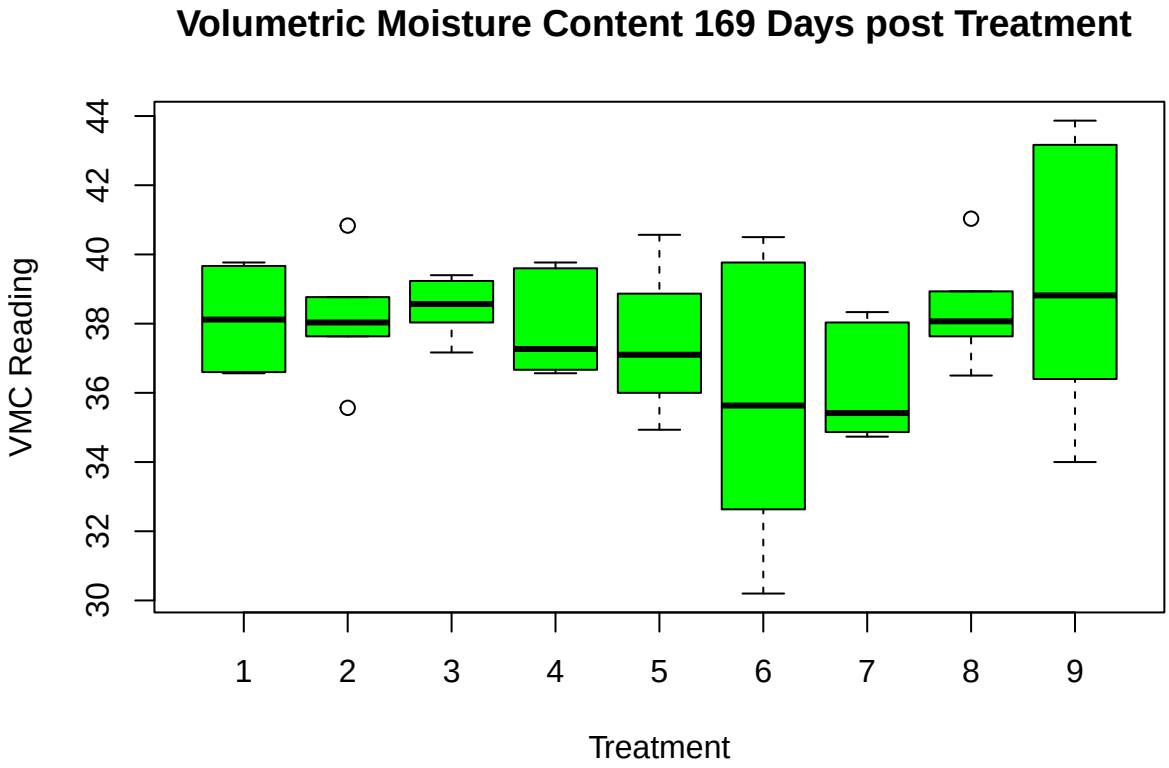


Table 97: Analysis of Variance Model 169 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	60.58	7.572	1.423	0.2134
Residuals	45	239.5	5.322	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.31 VMC Reading 173 Days Post Treatment (2022-04-28)

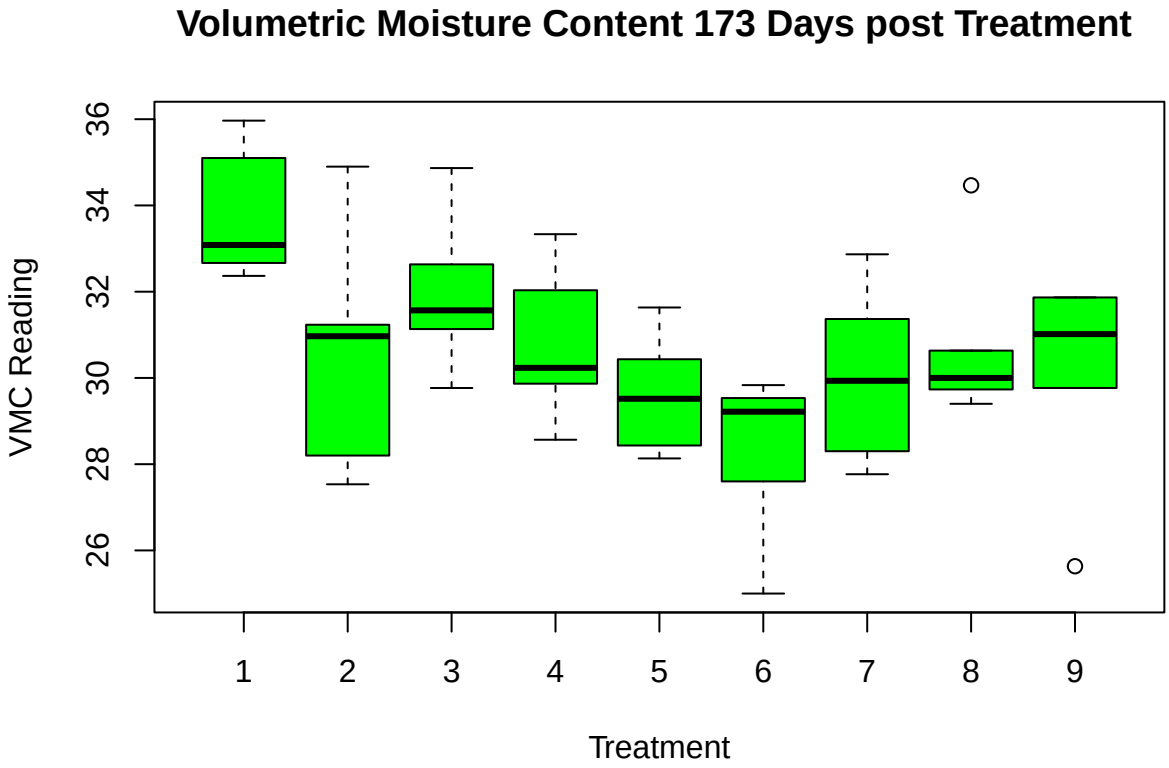
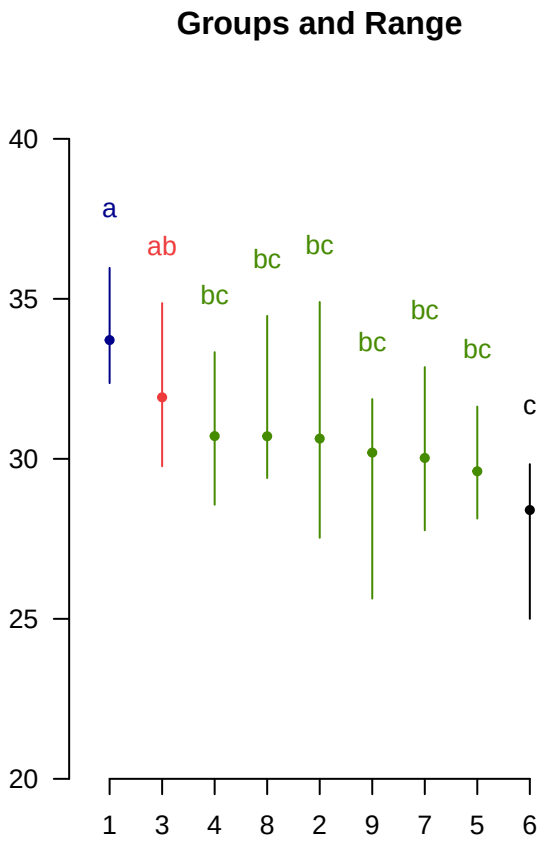


Table 98: Analysis of Variance Model 173 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	106.4	13.3	3.583	0.002706
Residuals	45	167	3.712	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.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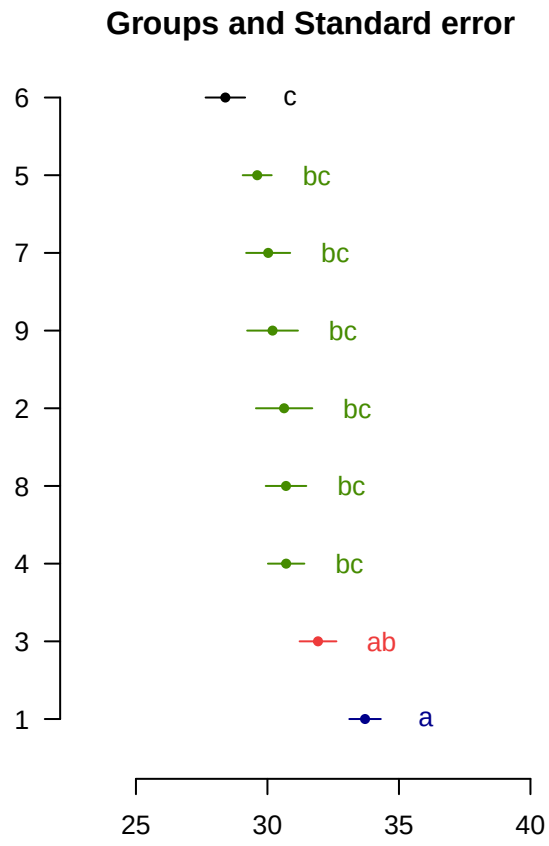
Groups and Standard error
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12.32 VMC Reading 180 Days Post Treatment (2022-05-05)

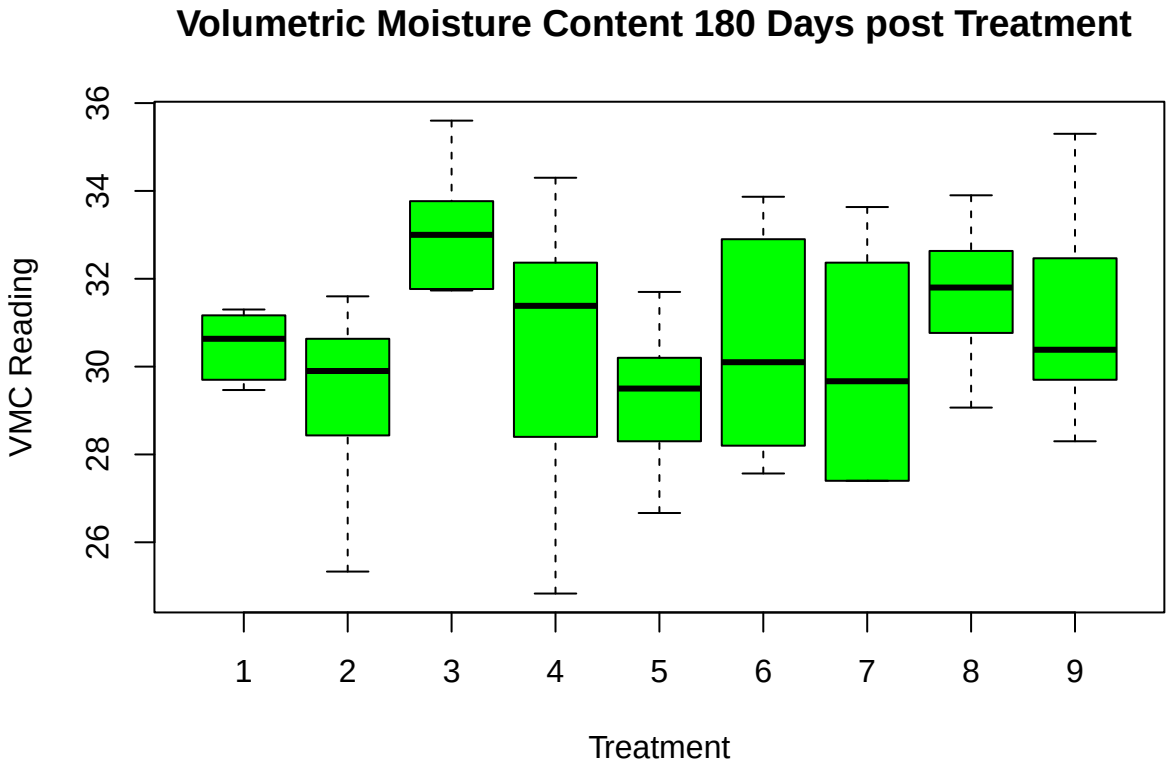


Table 99: Analysis of Variance Model 180 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	69.32	8.665	1.754	0.112
Residuals	45	222.3	4.94	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.33 VMC Reading 185 Days Post Treatment (2022-05-10)

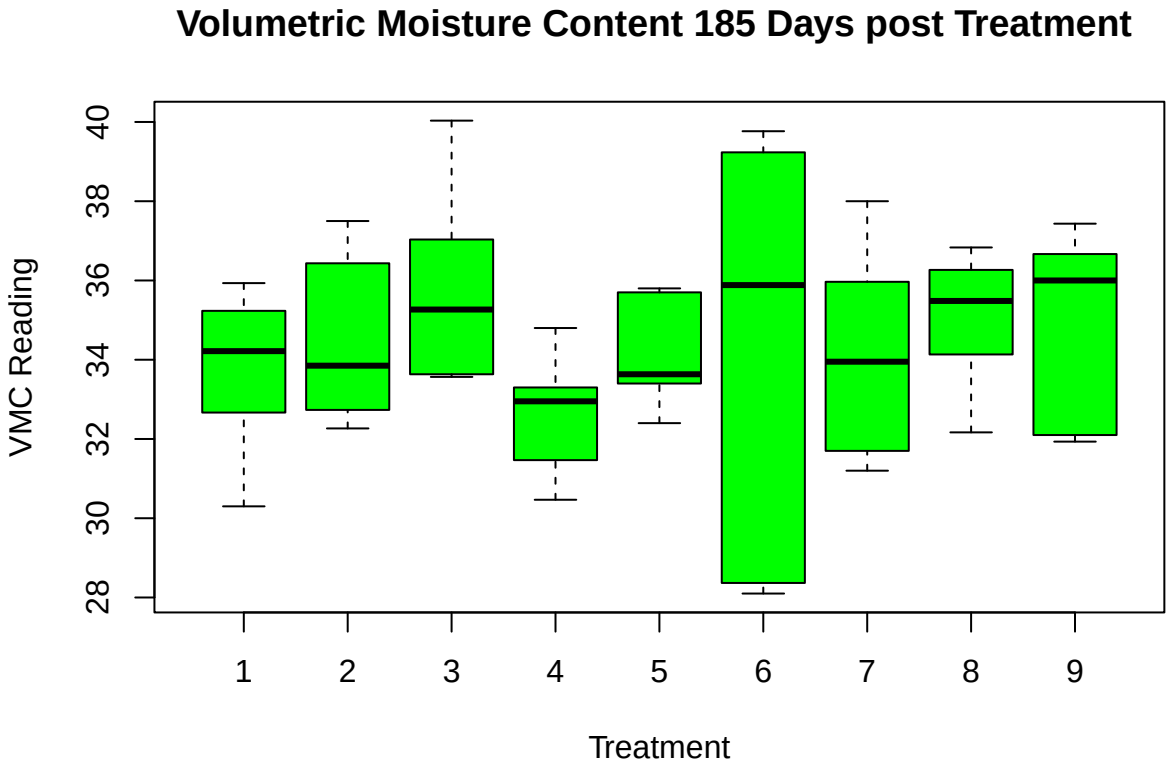


Table 100: Analysis of Variance Model 185 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	38.54	4.817	0.696	0.693
Residuals	45	311.4	6.921	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.34 VMC Reading 187 Days Post Treatment (2022-05-12)

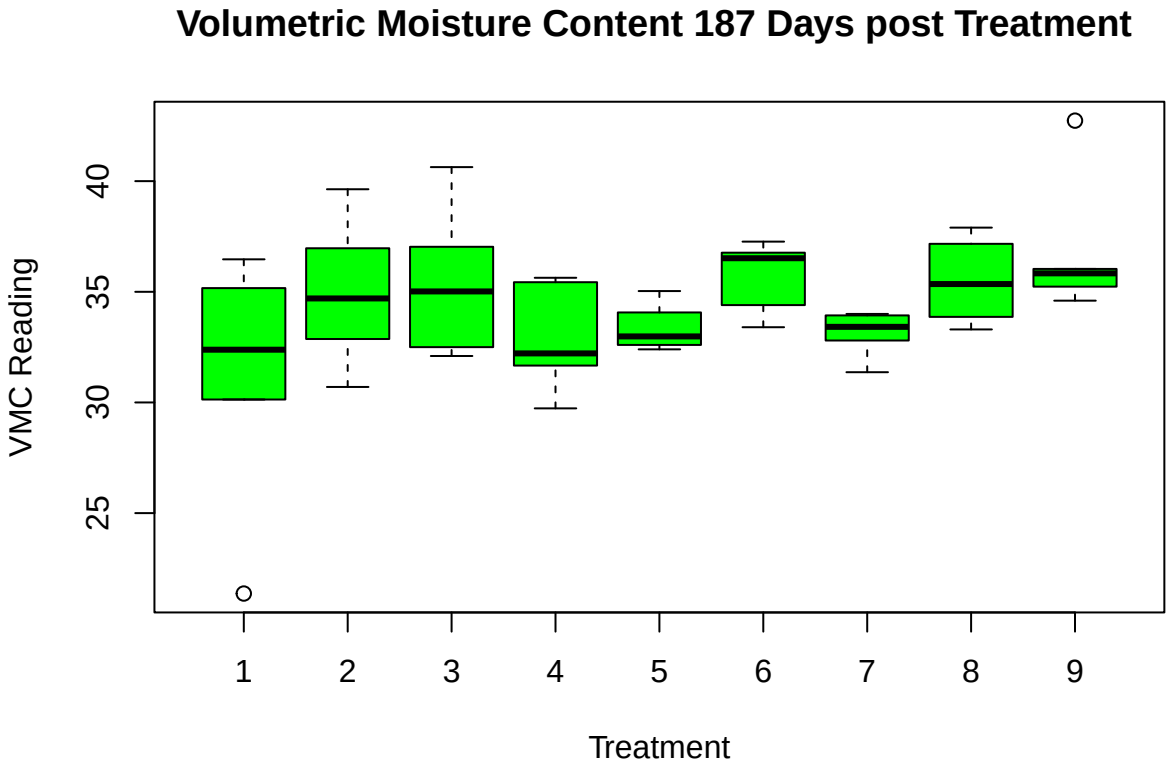
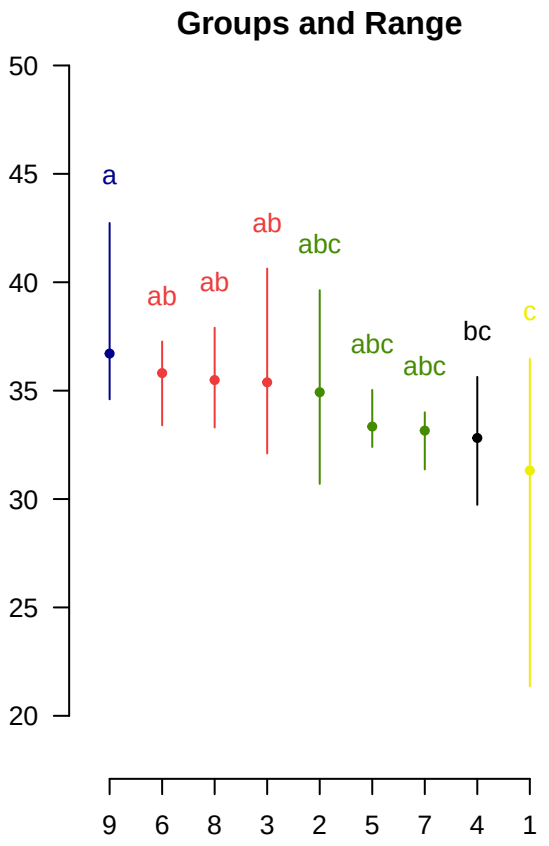


Table 101: Analysis of Variance Model 187 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	146.4	18.3	2.28	0.03845
Residuals	45	361.1	8.024	NA	NA

In the resulting ANOVA table above, the F-tests show that there is a significant difference in Treatment factor levels.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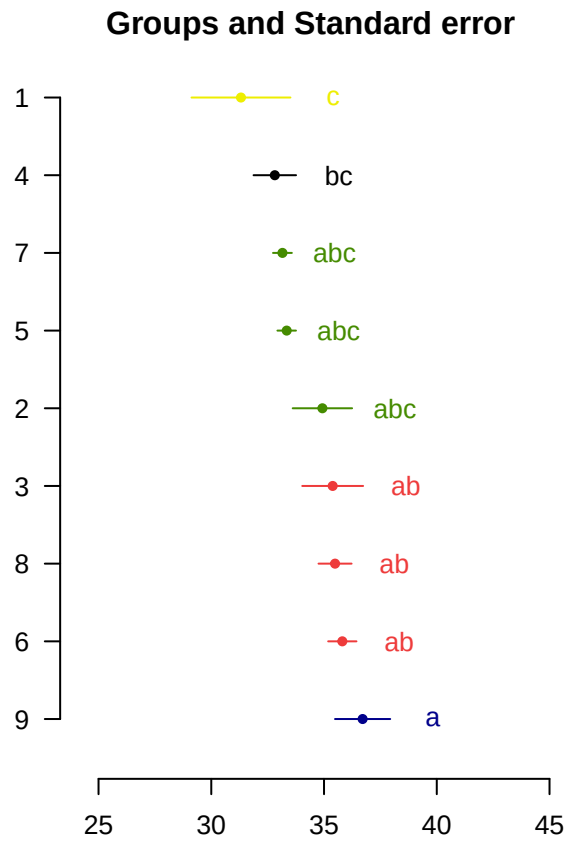
Groups and Standard error
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12.35 VMC Reading 191 Days Post Treatment (2022-05-16)

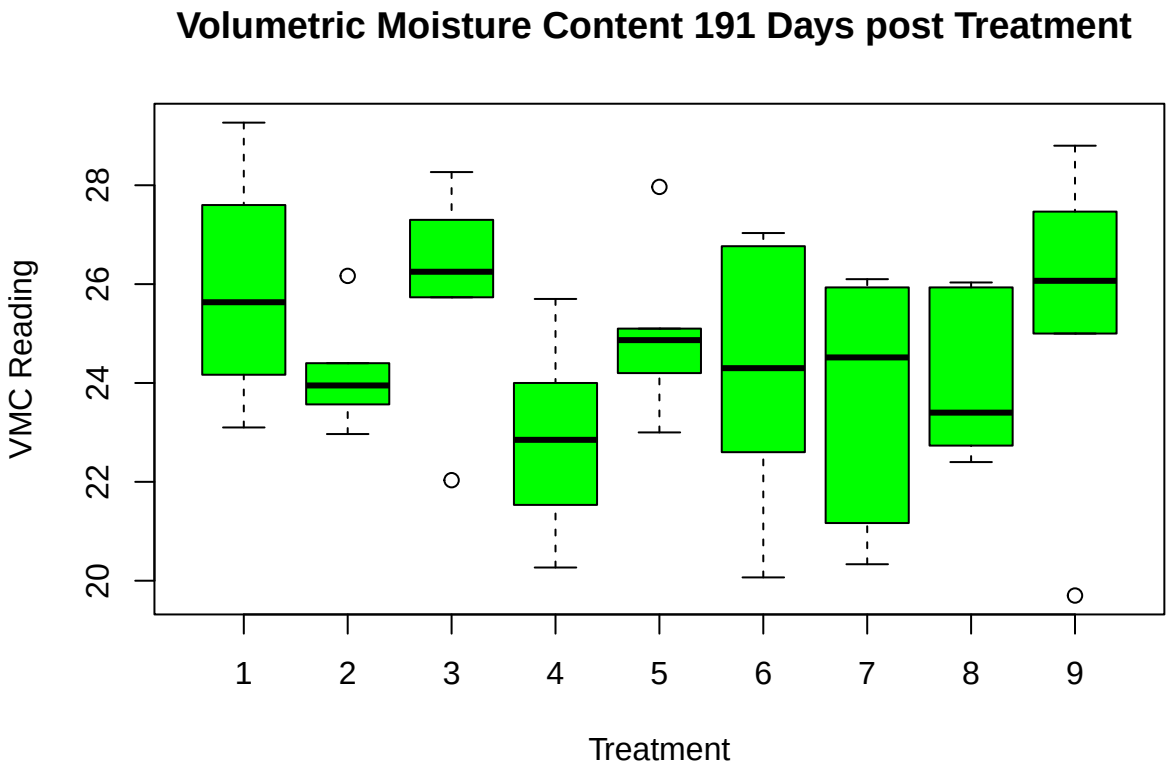


Table 102: Analysis of Variance Model 191 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	54.16	6.771	1.398	0.2234
Residuals	45	217.9	4.842	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.36 VMC Reading 194 Days Post Treatment (2022-05-19)

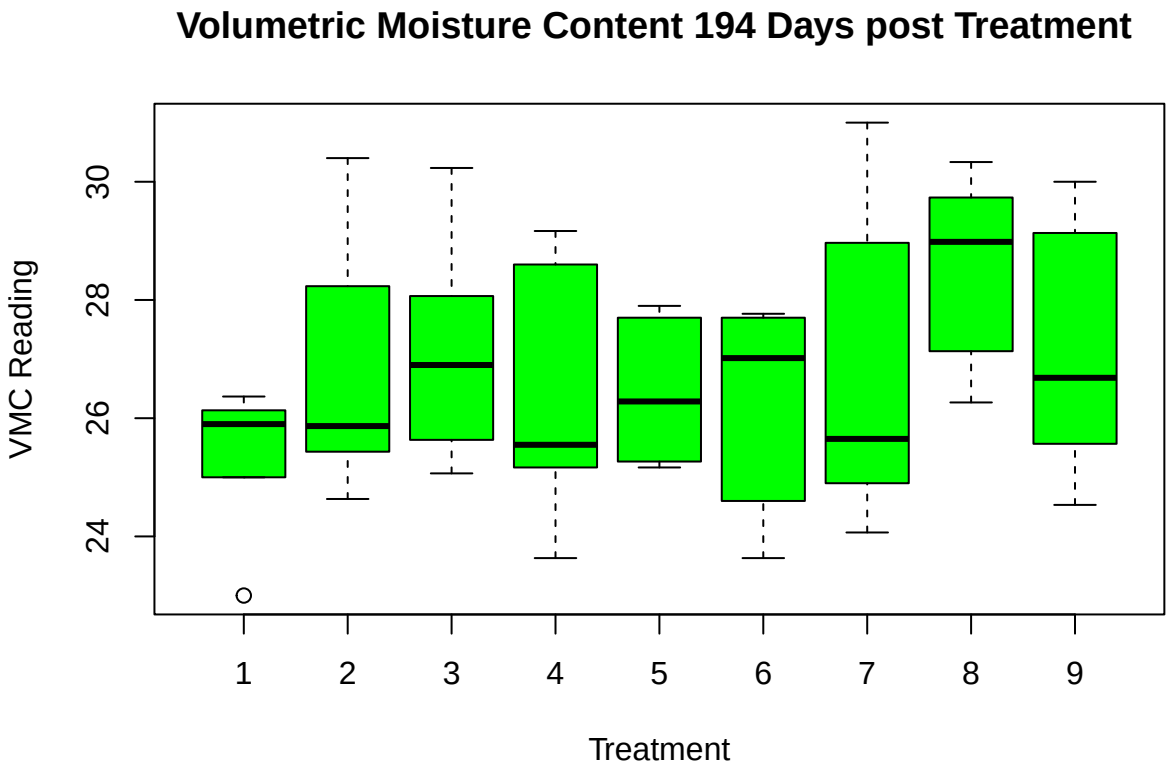


Table 103: Analysis of Variance Model 194 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	35.97	4.496	1.22	0.3094
Residuals	45	165.8	3.684	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.

12.37 VMC Reading 200 Days Post Treatment (2022-05-25)

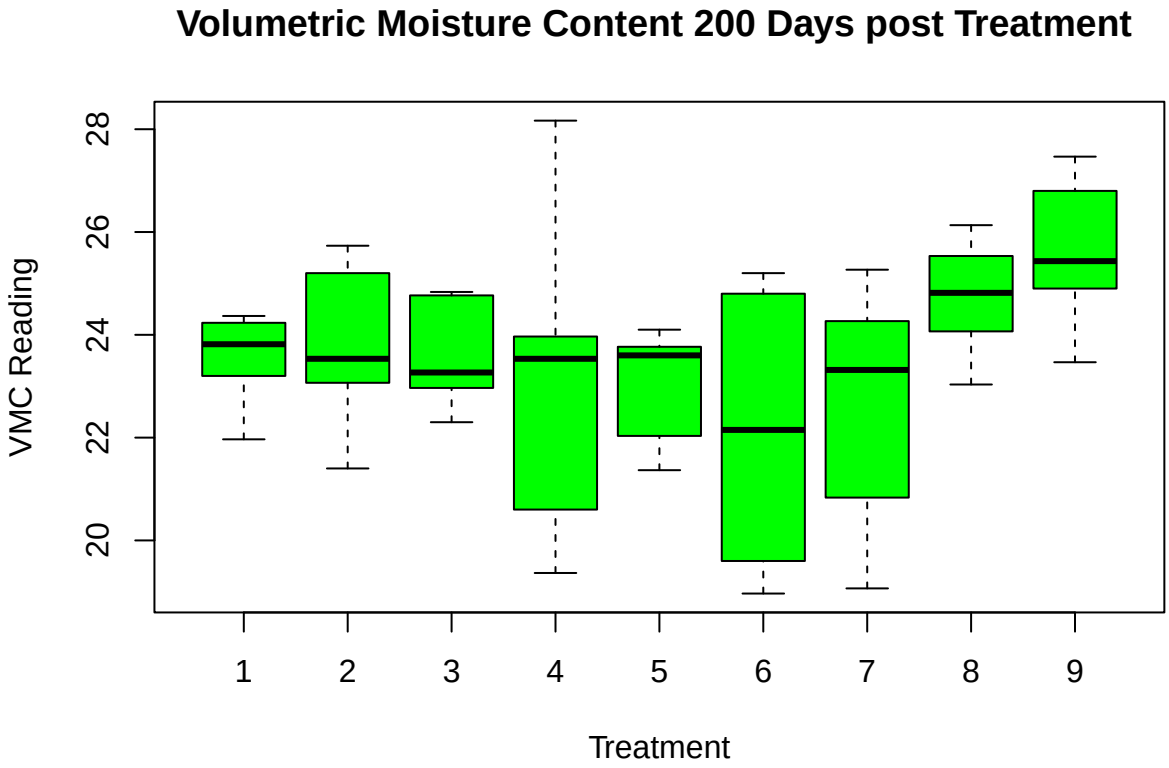
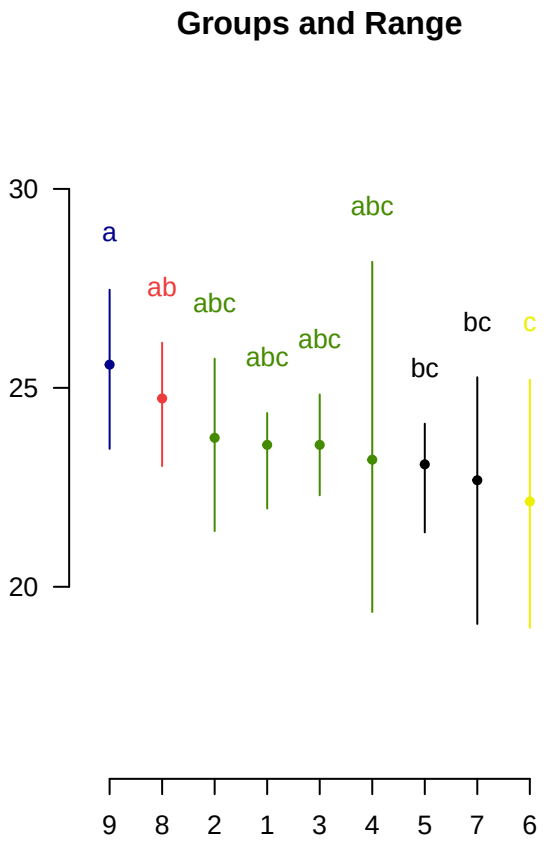


Table 104: Analysis of Variance Model 200 Days post Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	51.88	6.485	1.939	0.07716
Residuals	45	150.5	3.344	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference in Treatment factor levels.


Groups and Range
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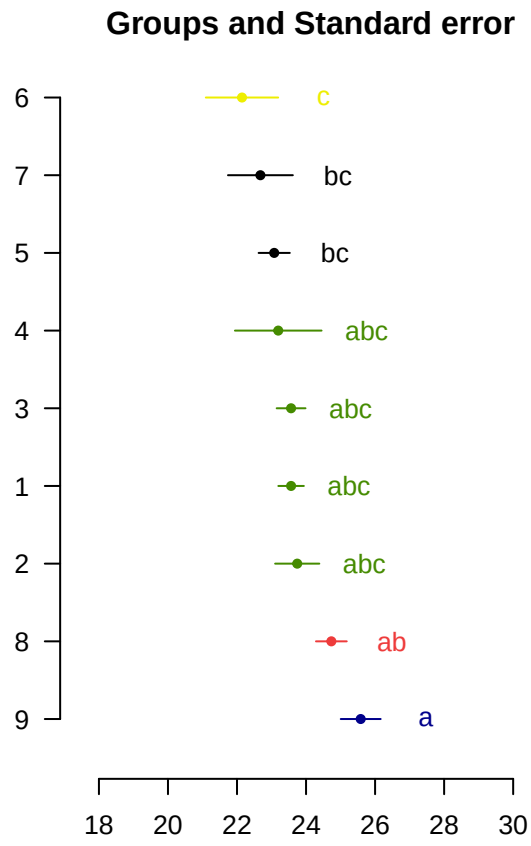
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13 Dollar Spot Infection Centres - DSIC

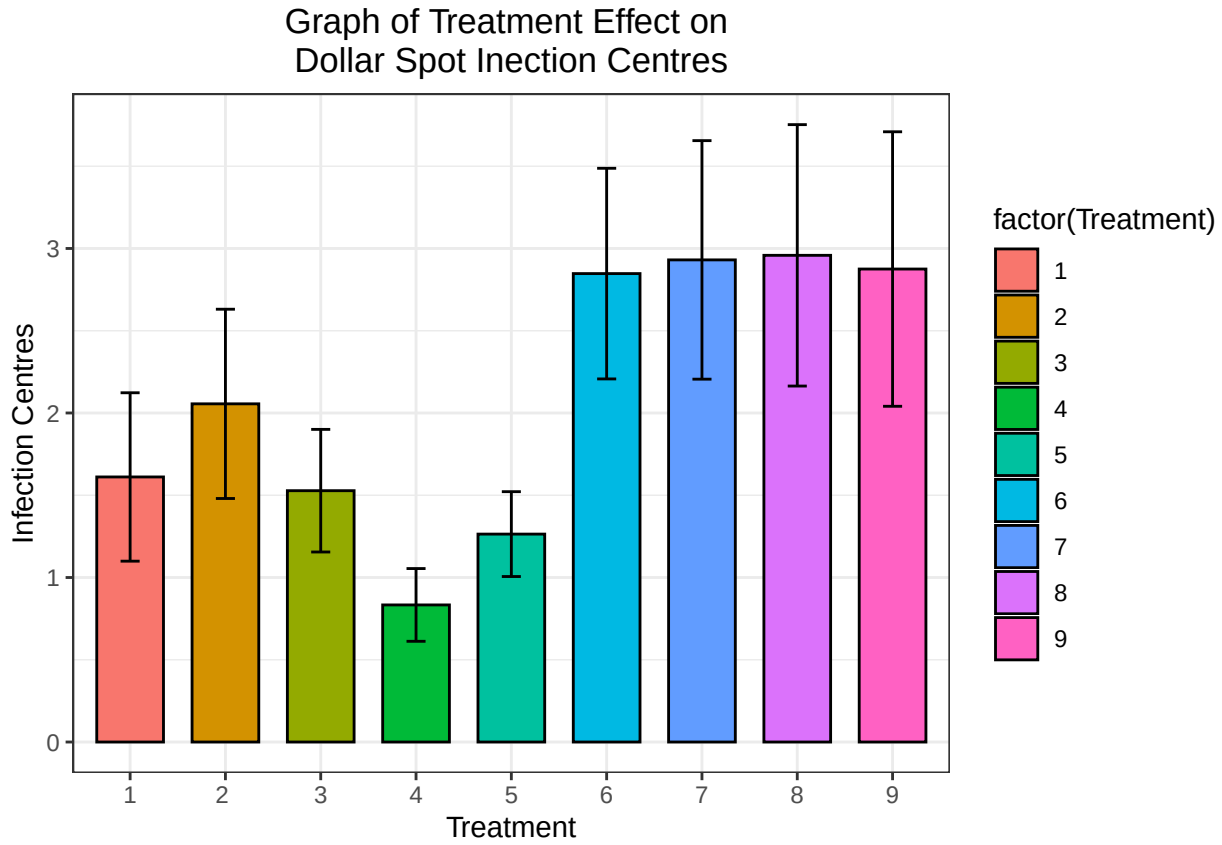
Table 105: Statistics by Treatment

Treatment	n	DSIC	sd	se	ci
1	72	1.611	4.343	0.5118	1.021
2	72	2.056	4.881	0.5753	1.147
3	72	1.528	3.162	0.3727	0.7431
4	72	0.8333	1.876	0.2211	0.4409
5	72	1.264	2.188	0.2579	0.5142
6	72	2.847	5.432	0.6402	1.277
7	72	2.931	6.151	0.725	1.446
8	72	2.958	6.742	0.7945	1.584
9	72	2.875	7.079	0.8343	1.663

The following table shows that dollar spot infection centres ranged from a mean low of 0.8333 (Treatment 4) to a high of 2.958 (Treatment 8).

Treatment	DSIC
1	1.611
2	2.056
3	1.528
4	0.8333
5	1.264
6	2.847
7	2.931
8	2.958
9	2.875

When this are shown graphically it can be seen that the Treatments can be divided into two distinct groups. Those that cause a reduction in dollar spot infection centres (Treatments 1,2,3,4 and 5) and those that don't cause any reduction compared to the untreated control.

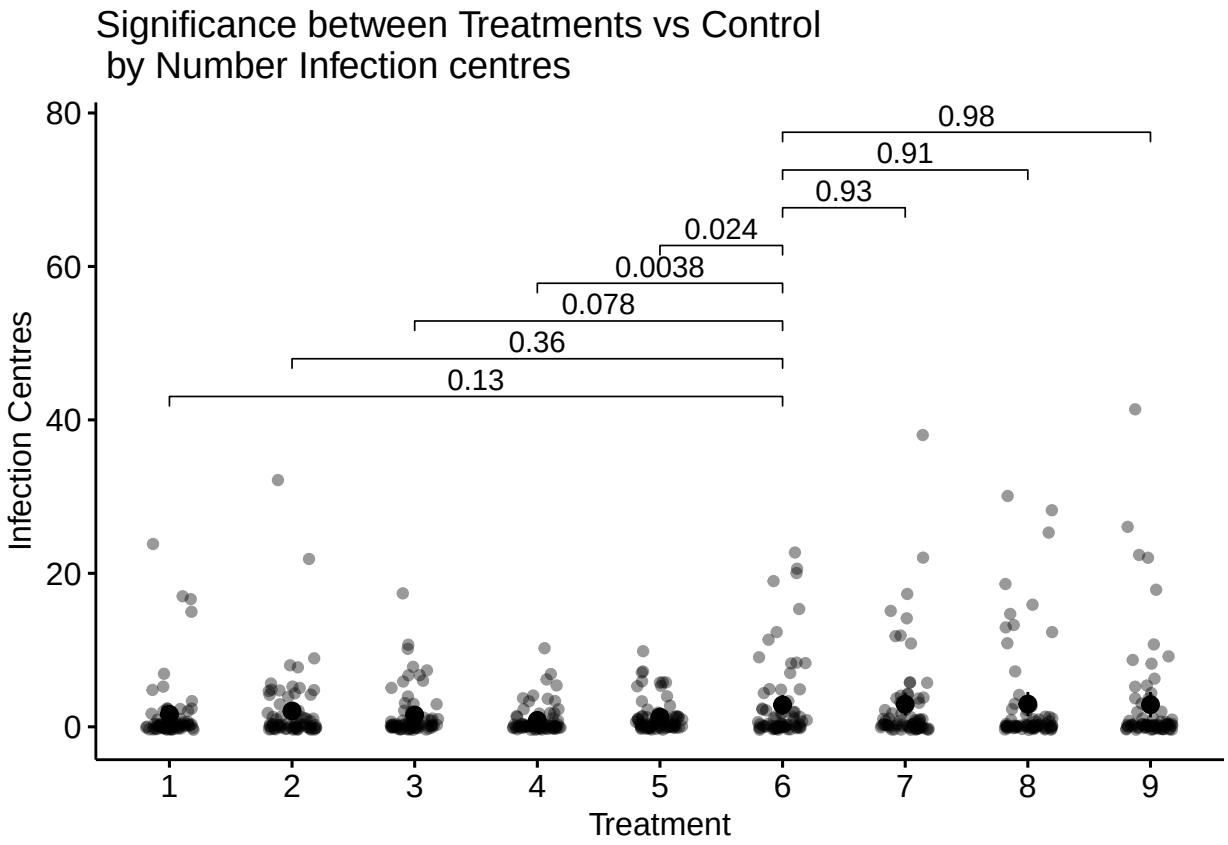


Statistically significant differences between the treatements and the control were apparent with Treatments 4,5 showing less dollar spot infection centres.

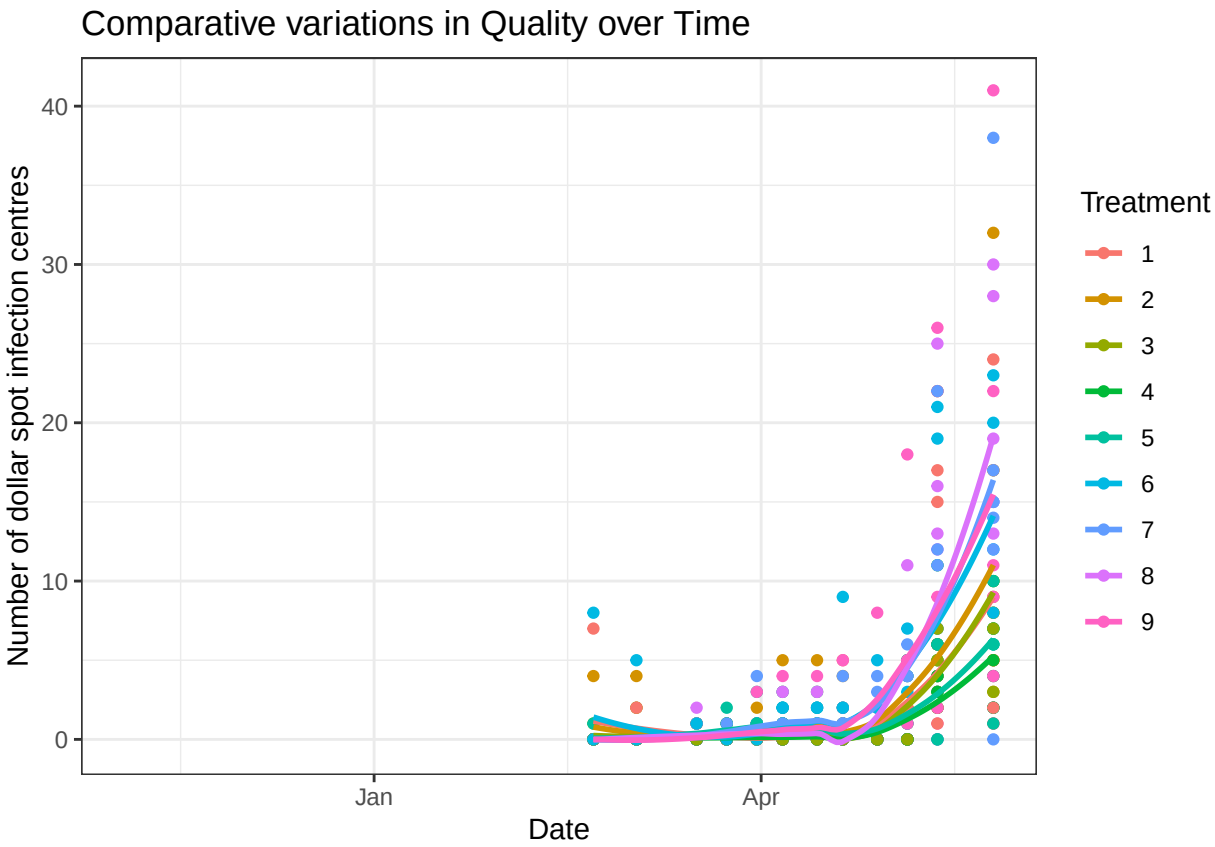
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1.159	0.7321	1.583	0.1139
Treatment2	0.4444	0.8301	0.5354	0.5926
Treatment3	-0.08333	0.8301	-0.1004	0.9201
Treatment4	-0.7778	0.8301	-0.9369	0.3492
Treatment5	-0.3472	0.8301	-0.4183	0.6759
Treatment6	1.236	0.8301	1.489	0.137
Treatment7	1.319	0.8301	1.589	0.1125
Treatment8	1.347	0.8301	1.623	0.1051
Treatment9	1.264	0.8301	1.522	0.1284
Block2	0.1944	0.6778	0.2869	0.7743
Block3	1.13	0.6778	1.667	0.09609
Block4	0.5556	0.6778	0.8196	0.4127
Block5	-0.2222	0.6778	-0.3279	0.7431
Block6	1.056	0.6778	1.557	0.1199

Table 108: Significance of Results by Treatment

Observations	Residual Std. Error	R^2	Adjusted R^2
648	4.981	0.03446	0.01466



When we look at the between treatment effects we can see significant differences existed between the treatments in regard to leaf area.



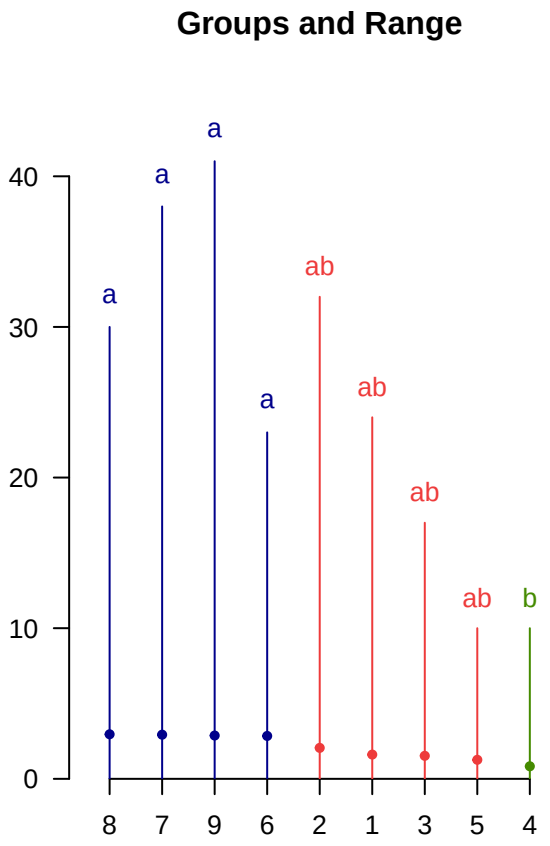
Not surprisingly as time increased the incidence of dollar spot did also.

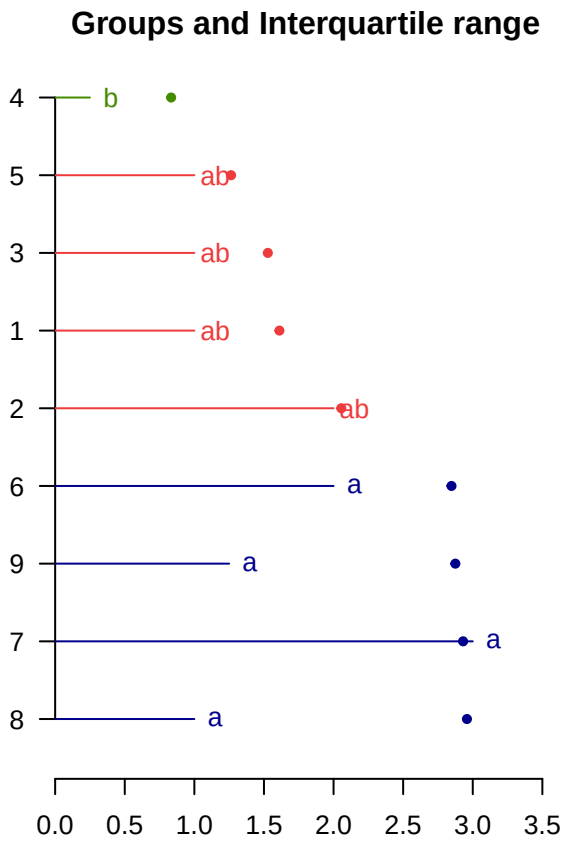
Table 109: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(Treatment)	8	392.9	49.12	1.974	0.04727
Residuals	639	15898	24.88	NA	NA

Table 110: Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	5	168.4	33.68	1.88	0.09579
Treatment	8	392.9	49.12	2.742	0.005587
Date	1	3863	3863	215.6	3.716e-42
Treatment:Date	8	668.7	83.58	4.665	1.469e-05
Residuals	625	11197	17.92	NA	NA


Groups and Range
40
30
20
10
0
a
a
a
a
ab
ab
ab
ab b
8 7 9 6 2 1 3 5 4


Groups and Interquartile range
4
5
3
1
2
6
9
7
8
b
ab
ab
ab
ab
a
a
a
a
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5

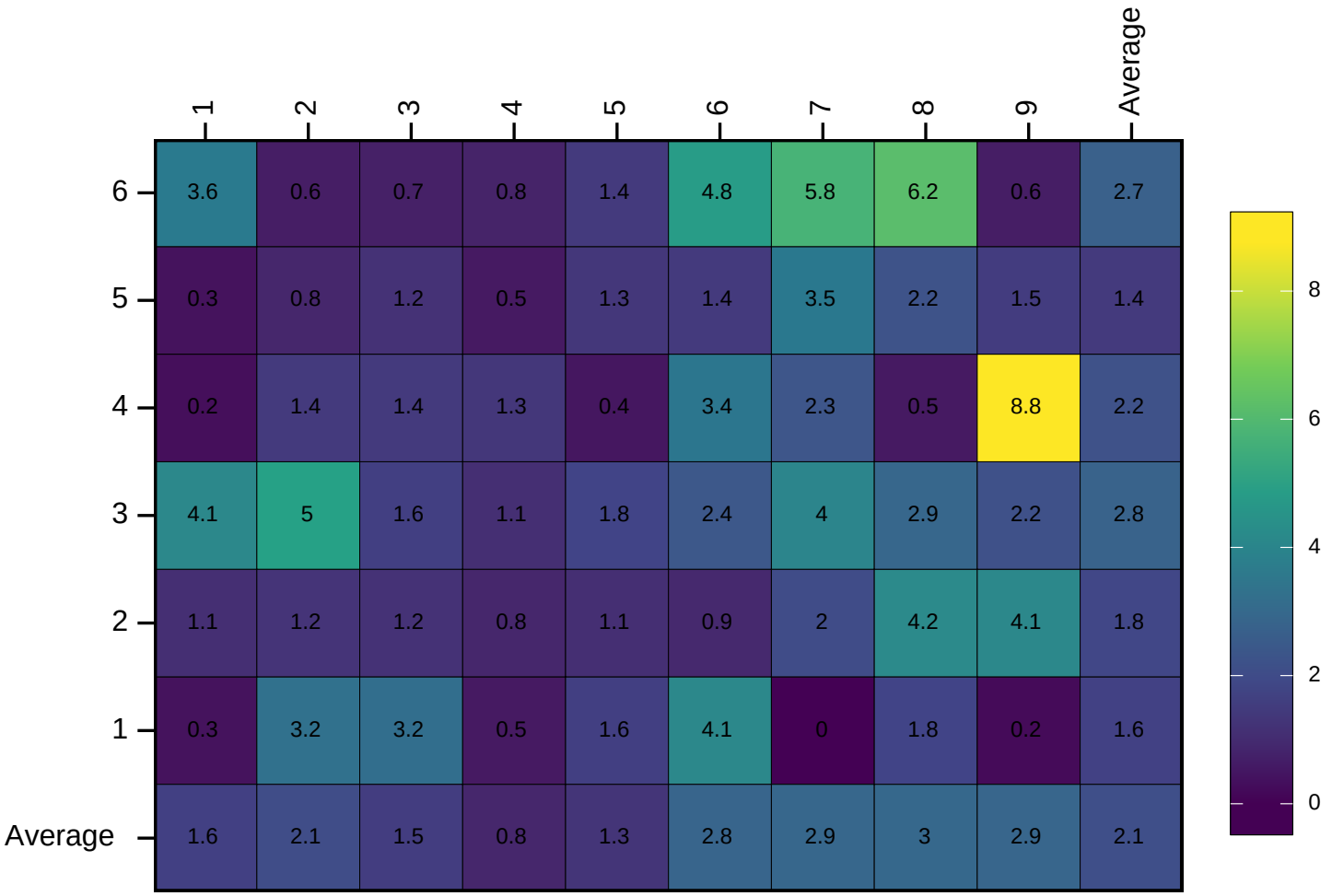
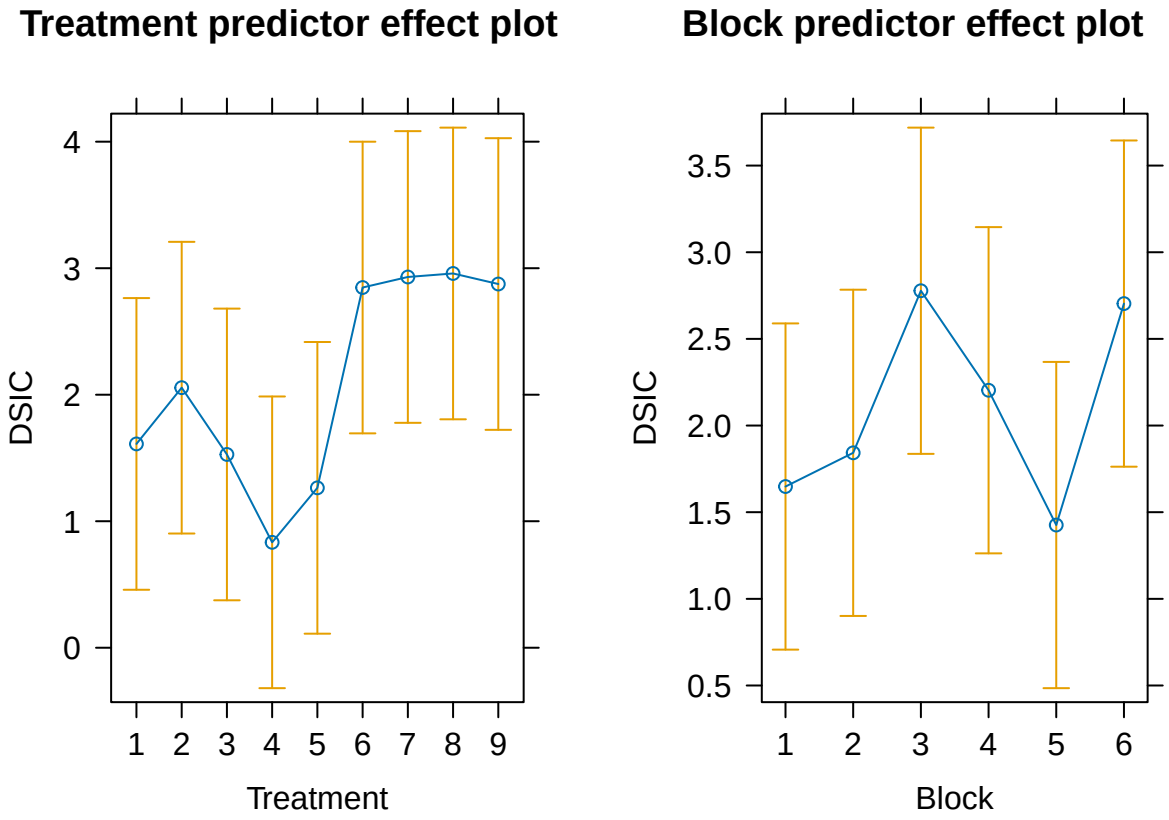
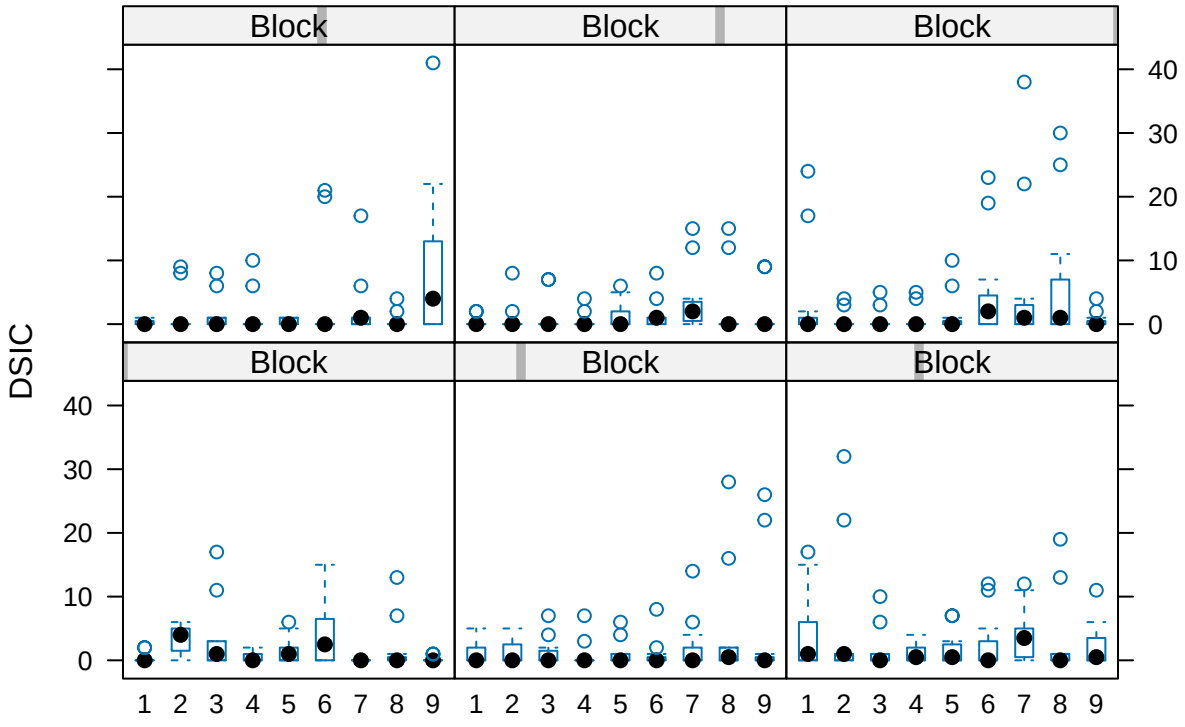


Figure 16: Dollar Spot Infection Centre plot means for Treatment and block

14 Block Effect with Treatment on Infection Centres





There appeared to be an interaction between both the Treatment and Block factors

Table 111: Significance of Results by Treatment, Block and Days after Initial Treatment

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Block	1	18.4	18.4	1.415	0.2347
Treatment	8	392.9	49.12	3.778	0.000252
DAT	11	7621	692.8	53.29	6.809e-79
Treatment:DAT	88	1250	14.2	1.092	0.2783
Residuals	539	7008	13	NA	NA

14.1 DSIC Reading 106 Days post first Treatment (2023-02-21)

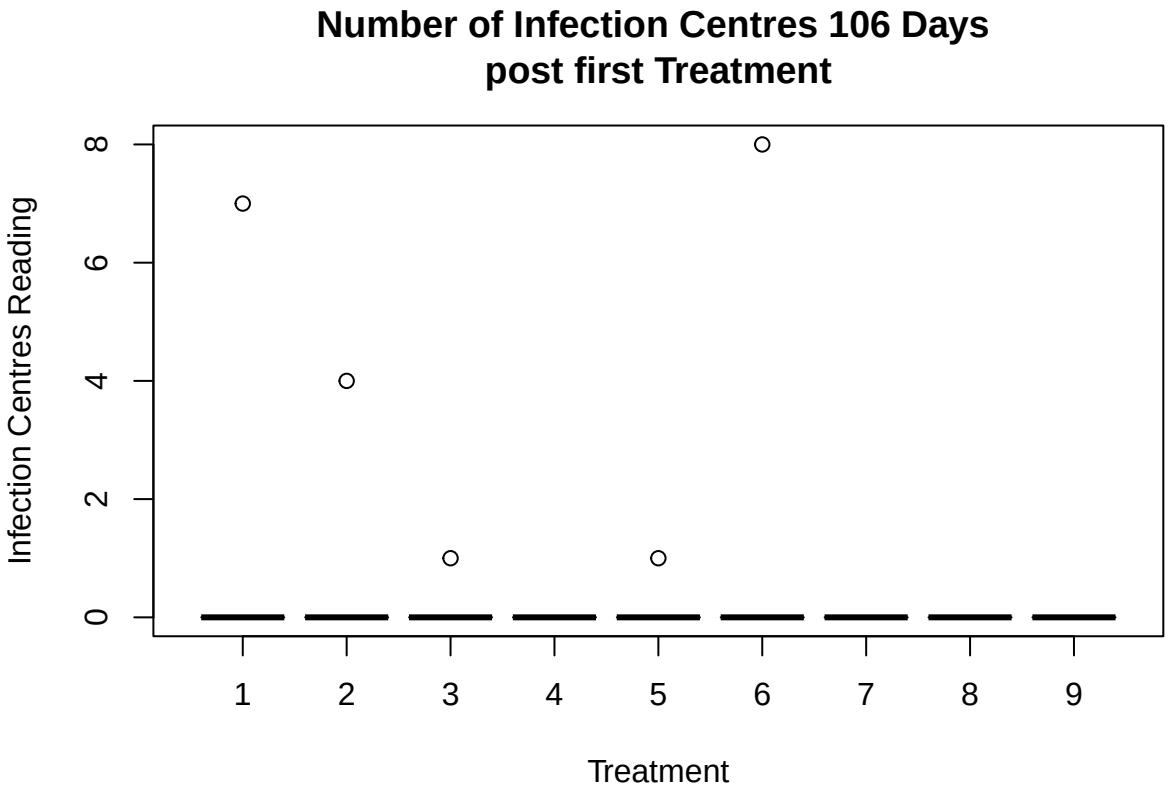


Table 112: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	13.67	1.708	0.7042	0.6861
Residuals	45	109.2	2.426	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.2 DSIC Reading 116 Days post first Treatment (2023-03-03)

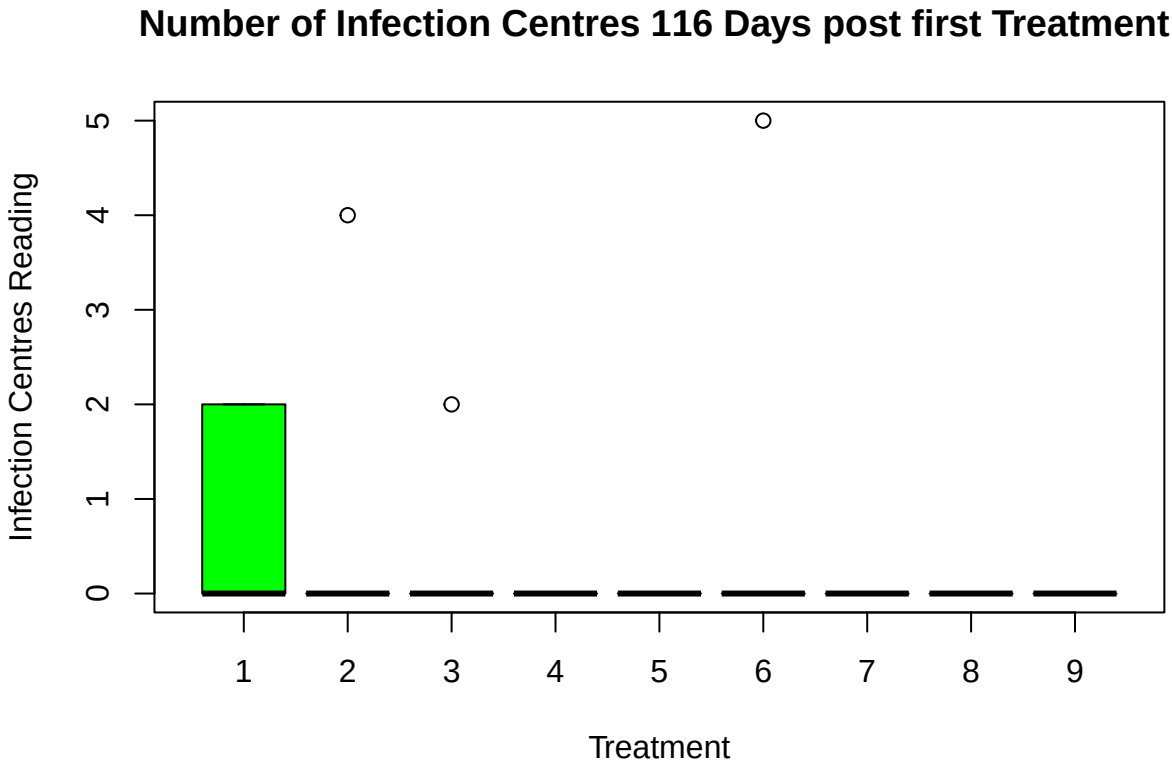


Table 113: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6	0.75	0.7879	0.6157
Residuals	45	42.83	0.9519	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.3 DSIC Reading 130 Days post first Treatment (2023-03-17)

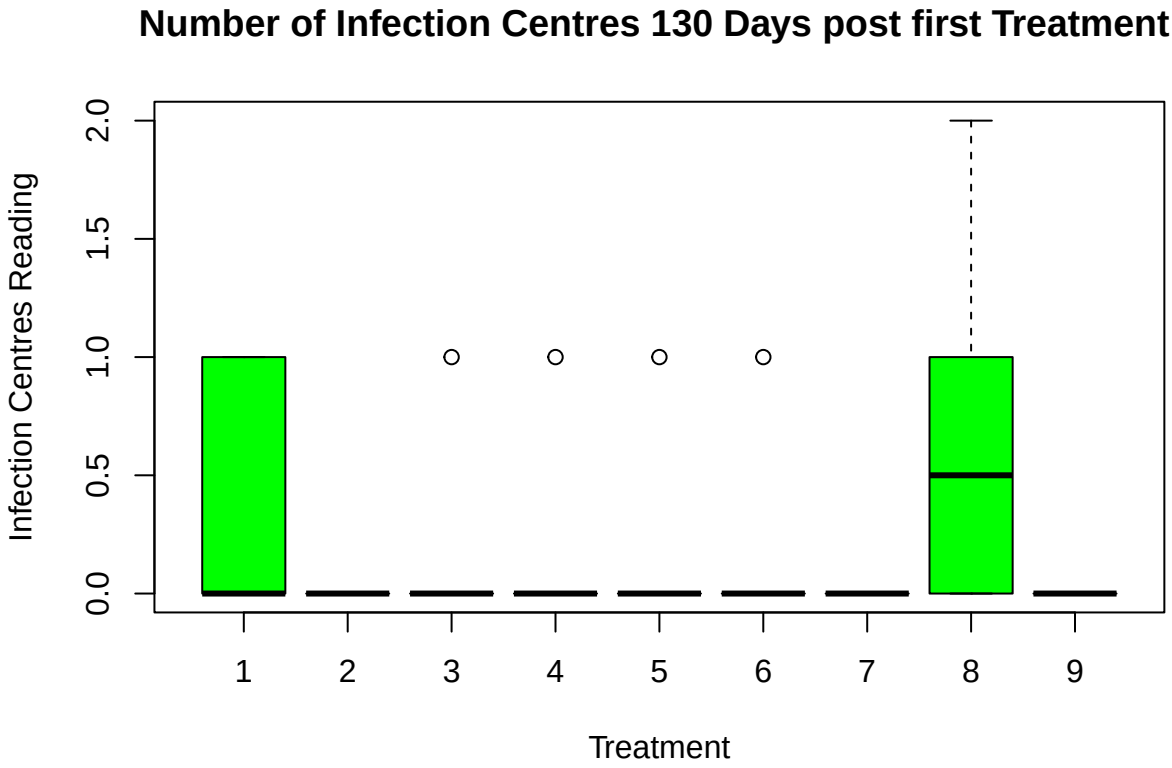


Table 114: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	2.148	0.2685	1.51	0.1806
Residuals	45	8	0.1778	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.4 DSIC Reading 137 Days post first Treatment (2023-03-24)

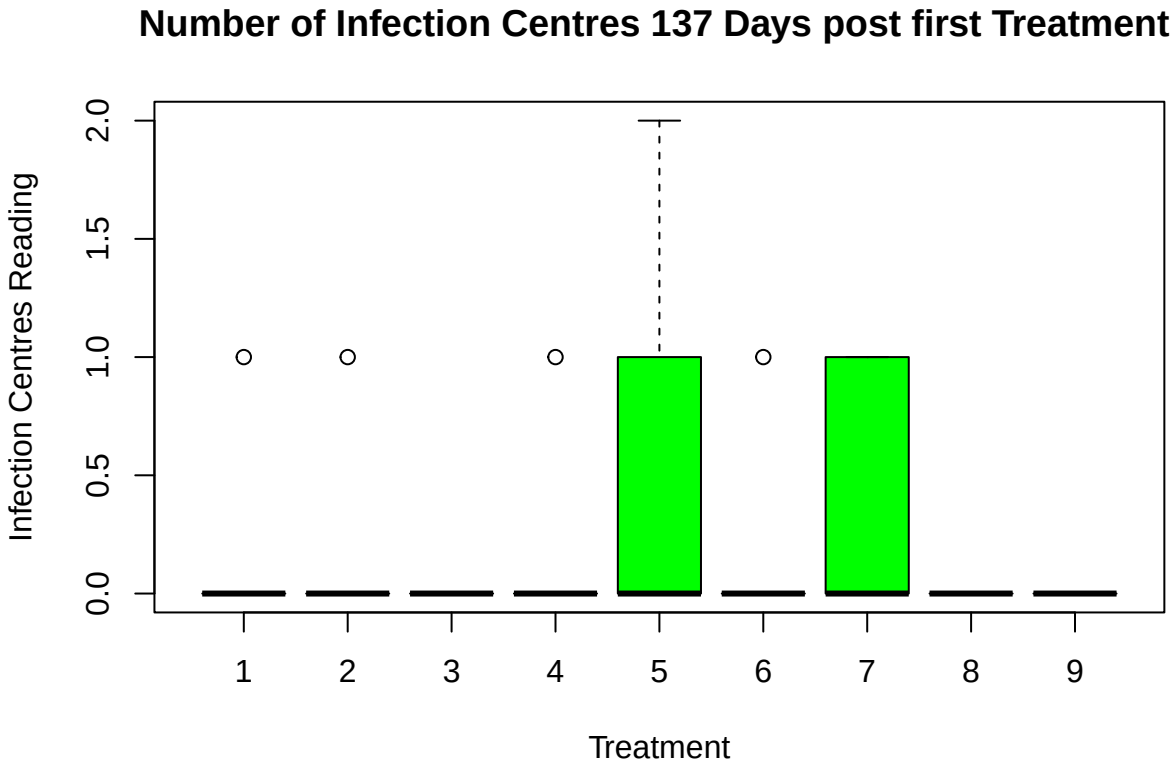


Table 115: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	1.333	0.1667	0.9184	0.5104
Residuals	45	8.167	0.1815	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.5 DSIC Reading 144 Days post first Treatment (2023-03-31)

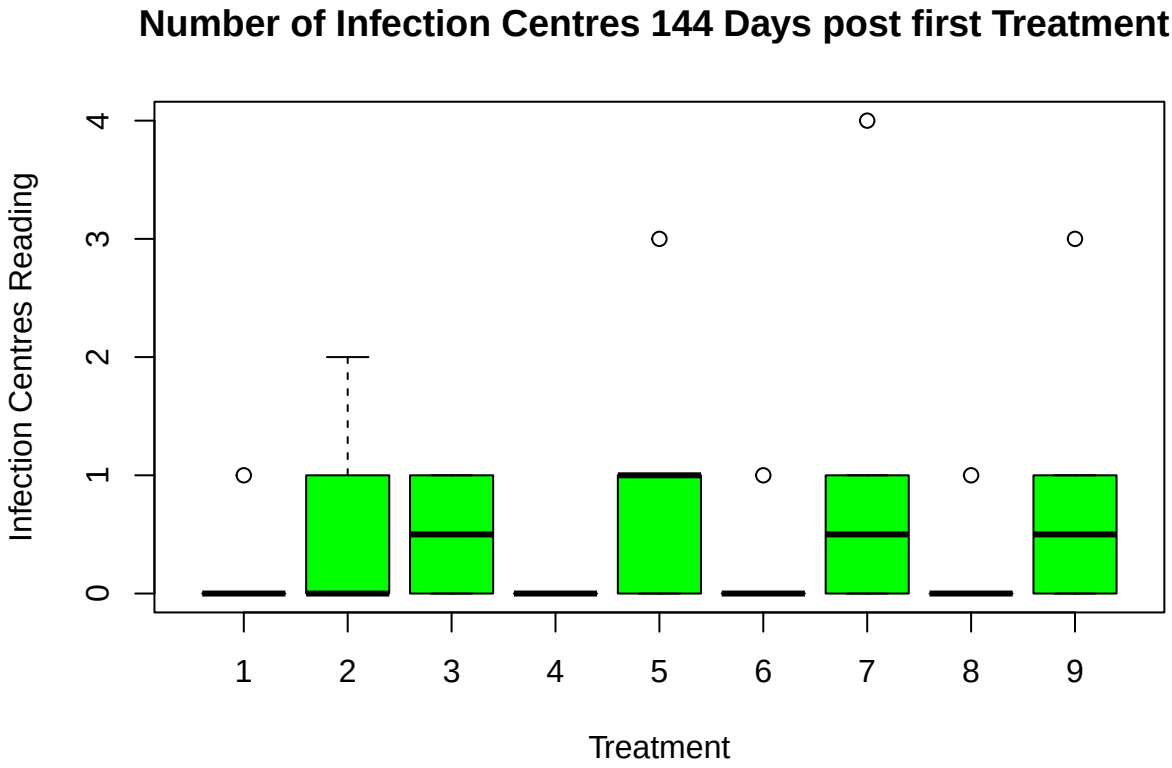


Table 116: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	7.148	0.8935	1.244	0.2968
Residuals	45	32.33	0.7185	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.6 DSIC Reading 151 Days post first Treatment (2023-04-06)

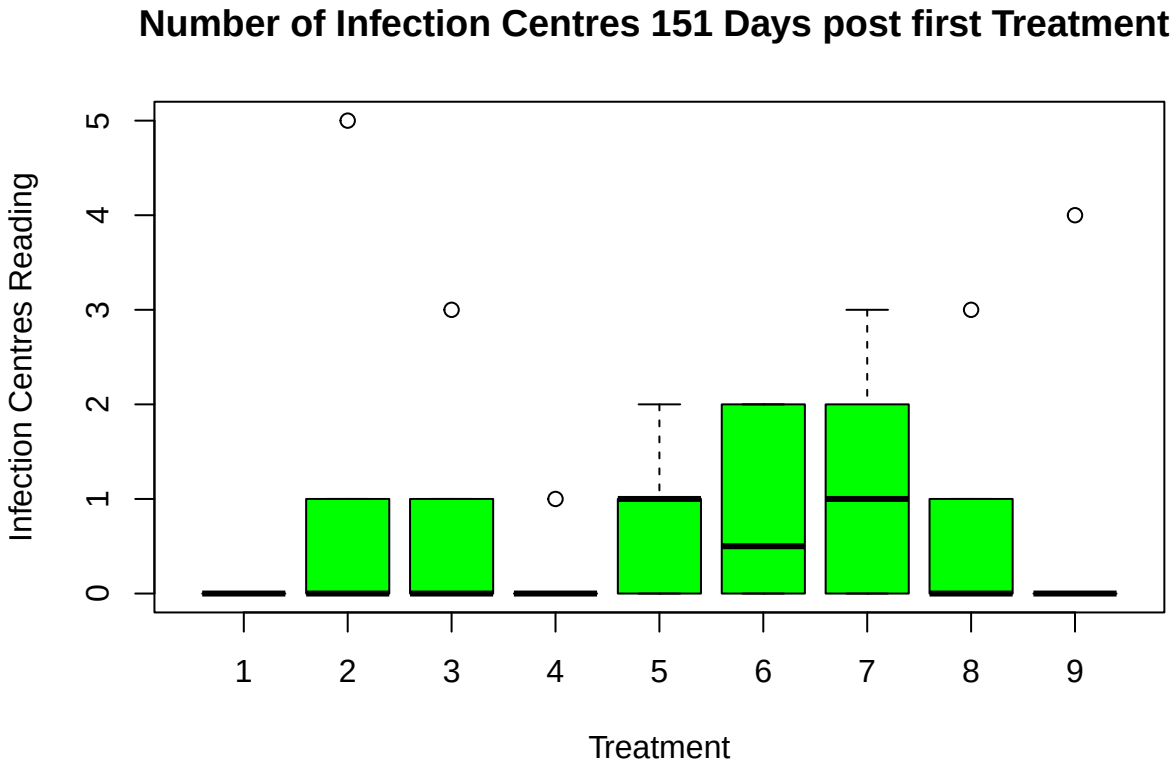


Table 117: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6.667	0.8333	0.5921	0.7791
Residuals	45	63.33	1.407	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.7 DSIC Reading 159 Days post first Treatment (2023-04-14)

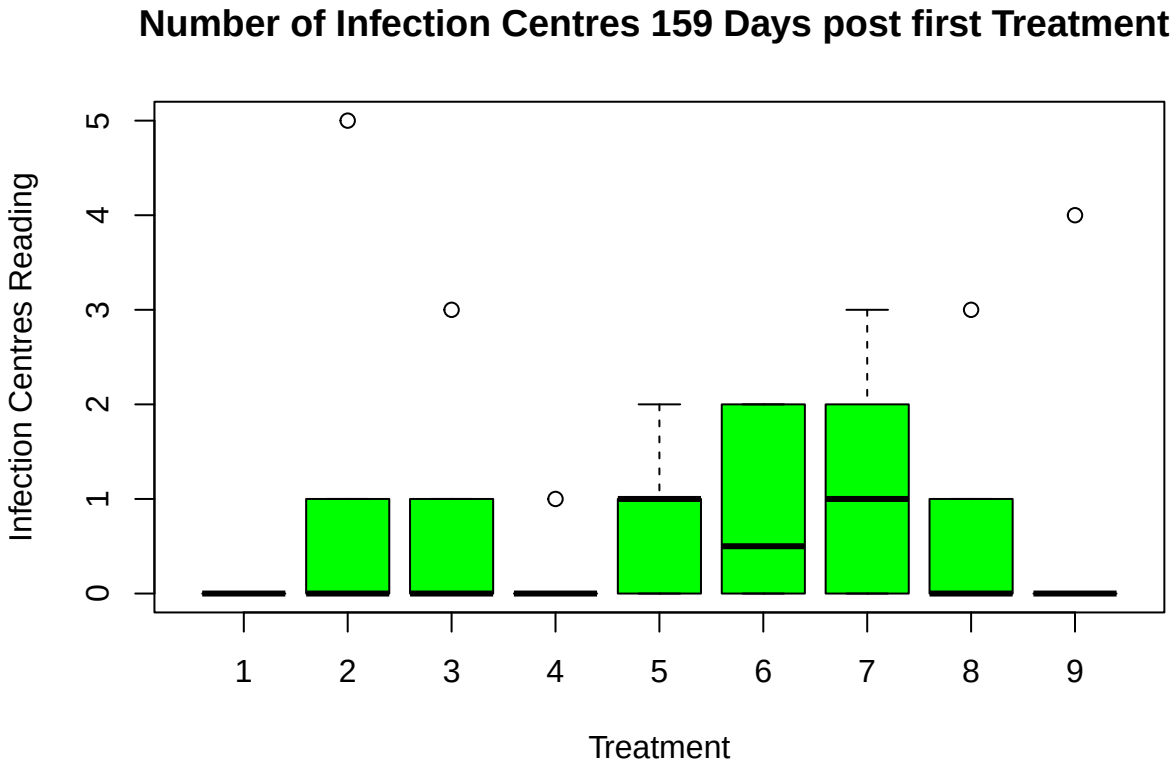


Table 118: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	6.667	0.8333	0.5921	0.7791
Residuals	45	63.33	1.407	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.8 DSIC Reading 165 Days post first Treatment (2023-04-20)

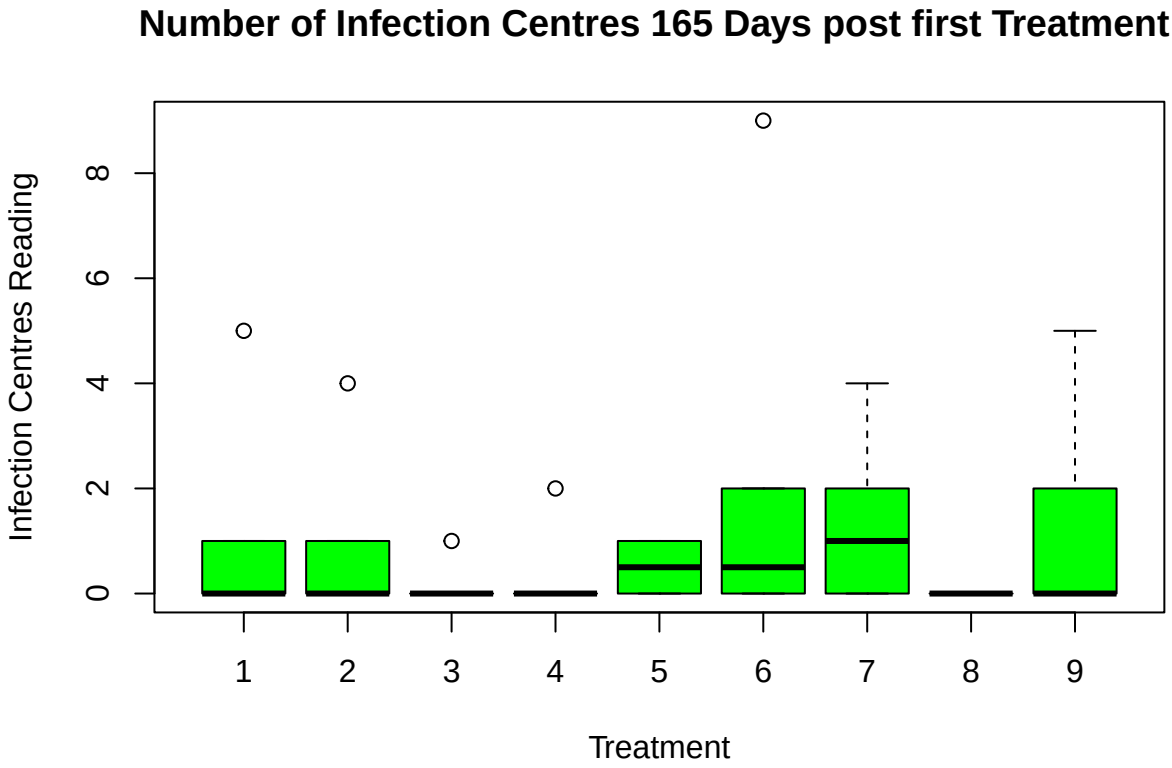


Table 119: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	19.48	2.435	0.826	0.5842
Residuals	45	132.7	2.948	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.9 DSIC Reading 173 Days post first Treatment (2023-04-28)

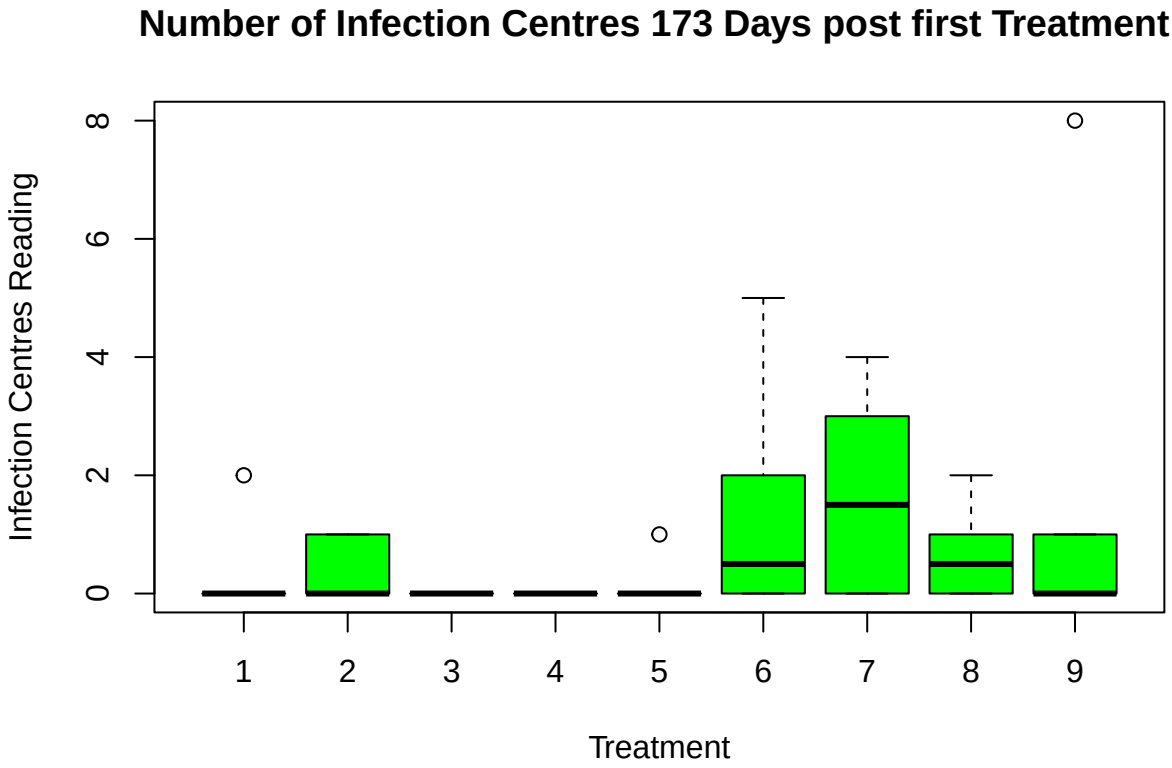


Table 120: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	21	2.625	1.27	0.2829
Residuals	45	93	2.067	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.10 DSIC Reading 180 Days post first Treatment (2023-05-05)

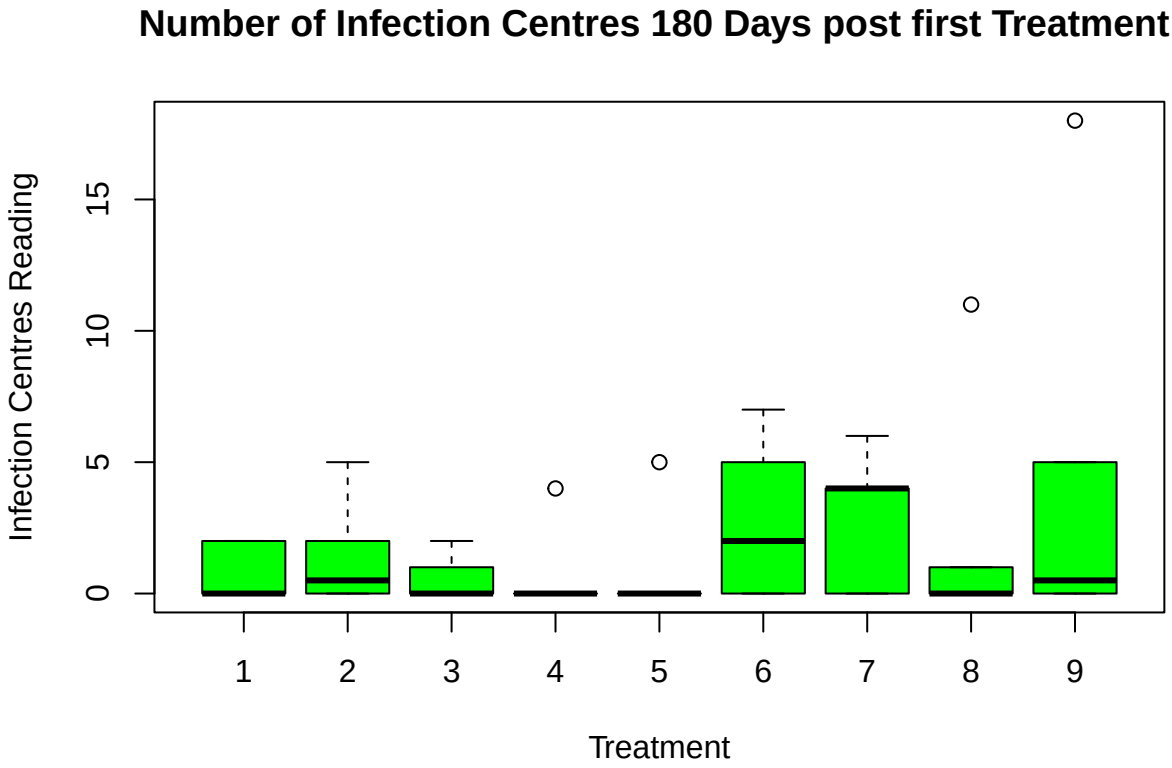


Table 121: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	74.7	9.338	0.8652	0.5524
Residuals	45	485.7	10.79	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.11 DSIC Reading 187 Days post first Treatment (2023-05-12)

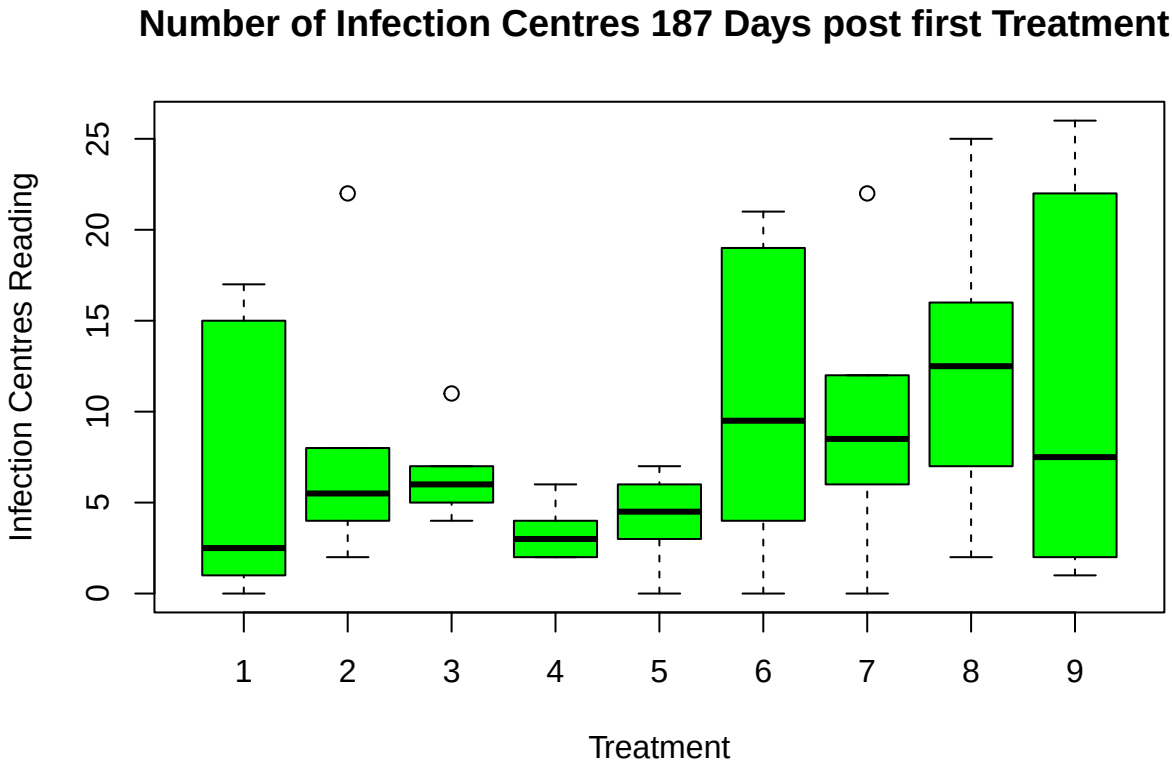


Table 122: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	475.6	59.45	1.27	0.2829
Residuals	45	2106	46.81	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

14.12 DSIC Reading 200 Days post first Treatment (2023-05-25)

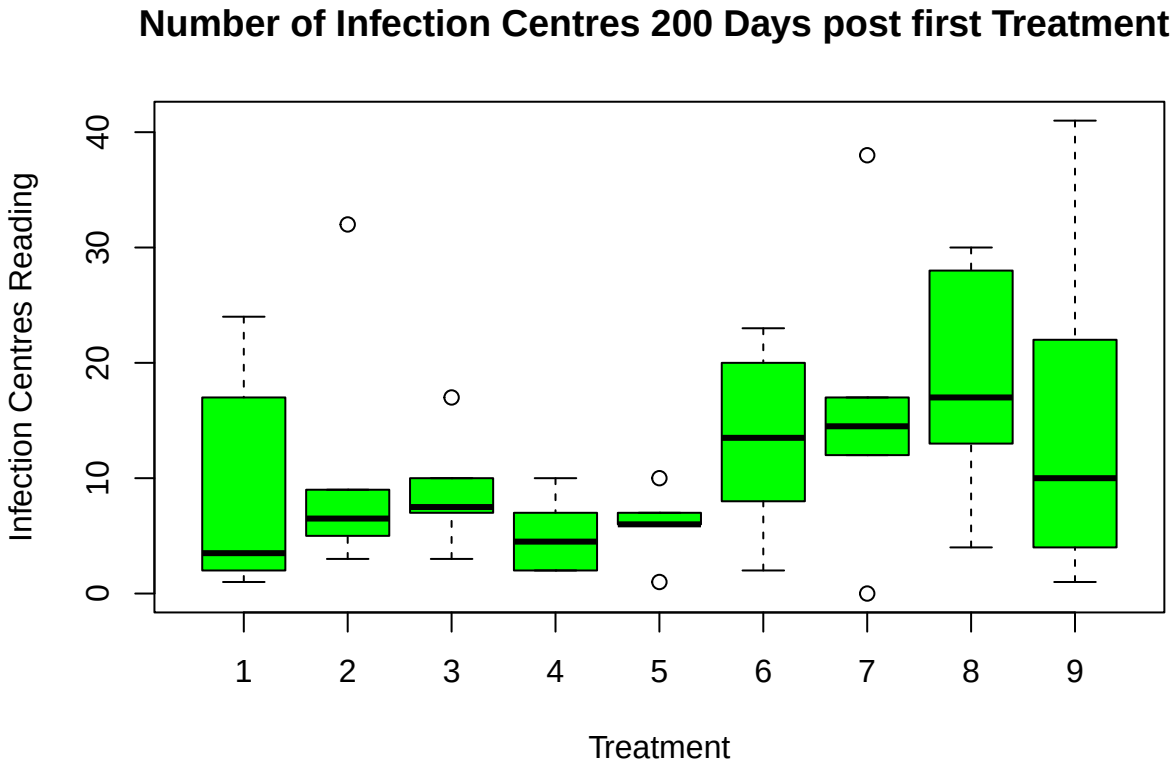


Table 123: Analysis of Variance Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	8	1008	126.1	1.461	0.1983
Residuals	45	3882	86.26	NA	NA

In the resulting ANOVA table above, the F-tests show that there is no significant difference between treatments before the trial starts.

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