Bonnie Doon Trial Report Summary- Impact of Turf wetting agents on Dark Green Colour Index (DGCI) and Volumetric Moisture Content (VMC)

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18/08/2019

Abstract

In conjunction with an ongoing ***Poa Anna*** management and organic supplement trial over the last 80 plus days we have been investigating the impact of wetting agents on a mixed ***Poa annua/Agrostis*** sward on a practice putting green at Bonnie Doon G.C. Results showed the following:

1. All the wetting agents trialled appeared to have some impact on soil moisture content vs control (Treatment B - no treatment).

2. Over the term of the trial the control generally exhibited the highest VMC and Biowet® the lowest. Both Matador® and Tricure AD® gave results falling between the control and Biowet® readings.

3. Biowet® appeared to draw water away from the surface rapidly to the extent that VMC levels fell dramatically following application. This suggests it may have an application to aid initial water penetration.

4. Turf Quality as measured by DGCI was highest after multiple applications of Matador® and Tricure AD® with Matador® regularly having significantly higher DGCI results than the control. **Over the overall trial Matador® gave the highest readings.**

5. Turf Quality as measured by DGCI was lowest with the Biowet® treatment and this can no doubt be directly correlated to the lower VMC readings found.

6. Quality readings appeared to be accumulative following three applications of any of the surfactants. There a short term response following application coupled with a cumulative effect.

Discussion

The increase in DGCI readings following treatment with Matador® is an indirect result of increased water availability due to the surfactant or alternatively the chemical is in itself improving plant health through a direct effect. The fact that those plots treated with Matador® never show the highest VMC strongly supports this view.

Background to Treatments

The overall trial looked at the following inputs focusing on soil wetting agents and their impact on Volumetric Soil Moisture Content (VMC) and Turf Quality as measured by Dark Green Colour Index (DGCI).

Volumetric soil moisture at the 0 to 3.8cm cm depth as measured with a TDR 350 ranged from 4.1 to 62.4% with a mean of 26.7%. Soil temperature at the 3.8 cm depth ranged from 10.6°C to 33°C with a mean of 24.5°C. Organic matter levels ranged from 8.2-20% at a depth of 0-10mm to 7.9-16% at a depth of 10-20mm.

Tricure (Treatment E)

According to the marketing literature TriCure AD® is an advanced soil surfactant designed to prevent and control hydrophobic soil conditions while maintaining optimum soil-water management. Unique soil treatment capabilities make TriCure AD the most effective multi-use soil surfactant available for treatment on the widest range of soil types and turf applications.

TriCure AD® 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.

A study was conducted at New Mexico State University during the summer months of 2003 and 2004 to investigate the effects of several wetting agents on sand-based rootzone hydrophobicity and putting green turf appearance. The efficacy of wetting agents varied over depth and was most pronounced at depths of 2.5 cm or less. All treated plots with the exception of Naiad and Respond 2 plots exhibited lower water repellency than the untreated plots at a depth of 0.5 cm. Plots treated with Aqueduct® and LescoFlo® showed consistently lower water repellency at rootzone depths of 0.5, 1.5, and 2.5 cm than the untreated plots. Naiad-treated rootzones exhibited greater hydrophobicity at depths of 0.5, 1.5, 2.5 and 3.5 cm compared to the untreated rootzones. In 2003 plots treated with Brilliance®, Cascade® Plus, HydroWet®, LescoFlo®, and Primer® Select had higher turfgrass quality than the untreated plots, while Naiad-treated plots showed lower quality and color ratings than other plots. There were no differences in colour or quality, among the treatments in 2004.

In a study by Leinauer et al (2005) data from a GCSAA-USGA wetting agent evaluation, showed the products that most consistently reduced hydrophobicity (soil water repellency) were Aqueduct®, Brilliance®, Cascade Plus®, HydroWet®, Primer Select® and TriCure®.

Products that consistently did the best job of reducing hydrophobicity also unfortunately had potential (though limited potential) to cause some reduction in turf quality. However, this decrease in quality was seen in a maximum of two out of nine locations. And in most cases, it is likely that the benefits of reduced water repellency outweighed the potential for turf damage.

Products that consistently peformed poorly in reducing hydrophobicity included Naiad®, Respond® 2 and Surfside® 37.

More regional specific studies have been conducted in recent years by the University of Minnesota-Twin Cities and the University of Wisconsin-Madison. These studies have been published in Hole Notes and The Grass Roots. One study included in the June 2011 issue of Hole Notes, “2010 Wetting Agent Study Update” (Johnson, A and Leeper K. 2011) evaluated the effects of six wetting agents that were currently being used by twelve golf courses in Minnesota.

Through GPS mapping of TDR data, these researchers were able to track changes in soil moisture levels and uniformity following a wetting agent application. 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. Gluco-ether block polymer wetting agents (Tournament Ready®, Dispatch®) reduced soil moisture by 2.7%, while decreasing uniformity by 3.9%. This study is a good demonstration of the differences between the water-holding and soil-penetrating chemistries of wetting agents (Johnsen and Horgan, 2011).

A follow up study was conducted in 2011 on the same golf courses with a modified treatment list. Wetting agent chemistry differences continued to be apparent based on soil moisture and uniformity. TriCure®, Revolution®, Immerse® GT, Magnus®, and Performa Gold® treatments increased soil moisture by an average of 4.4 percent. Dispatch® decreased soil moisture by 4.7%. TriCure®, Magnus®, and Revolution® increased uniformity by 6.5%, while Dispatch® and Tournament Ready® reduced uniformity by 4.5% (Johnsen et al., 2012). These results are fairly consistent with the data collected in 2010.

In a 2011 study (Baird et al, 2011) tested products on five separate experiments (3 putting greens; 2 fairways) on three golf courses in northern California and at the University of California, Riverside for their ability to alleviate drought stress and localized dry spots (LDS) on turf. None of the products tested caused turf injury following applications. Localized dry spot, as the name implies, often occurs randomly and non-uniformly in turf thus making it challenging to assess product effects in a replicated experiment and practically impossible in a non-replicated demonstration. As a result, most of the products tested were not significantly different from the untreated control at most locations, and all products tested were no different from the control when irrigation or soil water was not limiting.

However, under extreme water stress conditions, Revolution® (Aquatrols) performed the best of all products tested in alleviating turf drought symptoms and LDS incidence. TriCure AD® was next best and the following products deserved honourable mention (in alphabetical order): A16982A; Affinity® (BASF); NT-0949; and Neptune® (Numerator Technologies).

Hydro-Pak® Matador (Treatment K)

Hydro-Pak® Matador is a non-ionic wetting agent, based on innovative block polymer technology designed to establish and maintain a consistent moisture level in the root zone.It works by breaking down the hydrophobic coatings found in certain soil profiles reducing water repellency. Generally Wetting agents or soil surfactants have been used as the primary means for mitigating soil water repellency (SWR) which causes drought issues, such as localized dry spots (LDS), on sand-based turfgrass systems. However, residual effects are often short-lived and repeated application of wetting agents are typically required. Alternatively, certain groups of wetting agents were developed to remove the hydrophobicity causing organic compounds (HOCs), thus providing extended control of SWR.

Alternatively, certain groups of wetting agents may remove hydrophobic organic matter for extended control of SWR. A laboratory study (Song et al 2017) investigated the effects of selected wetting agent chemistries, including Matador® (alkyl block polymer (ABP)) , pHAcid® (nonionic surfactant + acidifiers (NIS)), and OARS® (80% polyoxyalkylene polymers and 10% potassium salt of alkyl substituted maleic acid (PoAP)), for removing organic matter and reducing SWR.

Sand treated by PoAP showed enhanced water-holding capacity, although the effect diminished after the second wash. In comparison, ABP resulted in 2.3-fold greater output of combined dissolved organic carbon (DOC) and particulate organic carbon (POC) in the leachates than PoAP, and made the hydrophobic sand completely wettable. Alternatively, NIS showed similar effects compared with the control. Although PoAP reduced SWR to a minimum level, it was sorbed strongly to the sand, which resulted in 27% greater solid phase organic carbon (SOC) in treated sand, compared with the untreated control.

The results showed that while pHAcid® treatment and the water control showed minimal influence on SOC, both treatments induced higher SWR with an increase of molarity of ethanol droplet test (MED) values from 2.2 M to >3 M.

Sand treated by OARS® showed enhanced water holding capacity, although the effect diminished after the second wash. In comparison, Matador® resulted in 100% and 300% more DOC and POC output in the leachate than OARS, and completely transformed the hydrophobic sand to wettable media. Collectively, it appeared that the amount of dissolved organic carbon found in leachates from Matador®- and OARS®-treated sand columns accounted for 91% and 51% of the dissolved organic carbon introduced by the two treatments, respectively. It was clear that at least half of the dissolved organic carbon introduced by OARS® was retained in the sand system despite three washes, suggesting a strong sorption between OARS® and the sand.

In terms of insoluble particulate organic carbon, the water-only treatment removed a minimal amount of particulate organic carbon, likely because the sand collection and handling process might have weakened the attachment between the organic coatings and sand. OARS® or pHAcid® removed the same amount of particulate organic carbon from sand columns as the water control.

Treatment with Matador®, however, removed 6.9 times the amount of particulate organic carbon as water alone. It has been reported that, **even when present at a low concentration, fine particulate organic carbon significantly increases soil water repellency.** Therefore, these results suggest that application of Matador® followed by three sequential washes removed a substantial amount of water-insoluble organic coatings from the sand columns, which likely contributed to an improvement in wettability of the sand.

Sands treated with pHAcid® showed a 16% reduction in solid phase organic carbon compared with the sands that were not treated. Compared with the untreated sands, those treated with Matador® resulted in the same amount of solid phase organic carbon, while application of OARS® produced 27% greater solid phase organic carbon.

This result suggests that application of OARS® introduced an additional source of organic compounds to the sand profile, and these organic compounds remained in the sand system in a solid form. This result again suggested a strong sorption of the OARS® molecules to the sand, corroborating the findings on the dissolved organic carbon as described above.

After application of treatments and three washes, sand treated with pHAcid showed no change in its hydrophobicity compared with the water-only treatment. In contrast, application of OARS significantly reduced the hydrophobicity of the sand to the category of low water repellency. Application of Matador® completely reversed the hydrophobicity of the sand and resulted in a wettable sand.

Collectively, results from this research indicate that both OARS® and Matador® are promising for reducing soil water repellency to a minimum (OARS®) or zero (Matador®), following one application and three sequential washes. The data suggest that OARS® molecules exhibit strong sorption to the hydrophobic sand surfaces, and a significant amount of the molecules likely remain in the sand system despite sequential washes. In comparison, applying Matador may wash out a greater amount of organic compounds from the system in both water-soluble and insoluble forms.

These results also suggest that deep irrigation following application of wetting agents such as Matador® likely increases removal of organic coatings from the sand profile which is the cause of hydrophobicity and localized dry spot. It was also found that carrying out deep irrigation after applying Matador® will likely help to remove the amount of organic coatings from the soil profile.

Hydro-Pak® Biowet

Hydro-Pak® BioWet is a multi-functional wetting agent derived from DFE (designed for environment) sulfonic and carboxylic acid penetrants, and corn- and coconut-based hydration agents. BioWet is a fully biodegradable wetting agent that works with the soil ecology.

Trial Overview

A randomised block trial was marked out after using Edgar II for its design and layout. This comprised 60 x 1m2 plots with a 50mm buffer between each. Three of these comprised the wetting agent Treatments namely Biowet®, Matador® and Tricure AD®. The profile comprised approximately 50mm of thatch overlying a sandy rootzone. Treatments were applied with 4 replicates of each including a control which was untreated. This trial ran from 26th July 2019 to 4th November 2019.

Product was applied as per label rate in 800L of water (soil applications) depending on the specific treatment being applied with a backpack carbon dioxide spray unit fitted with flat fan spray nozzles and calibrated to apply 800L/Ha.The water source used was rainwater. All treatments were monthly where possible.

Treatments were applied on the following dates: 26th July, 20th August and 23rd September.

Results

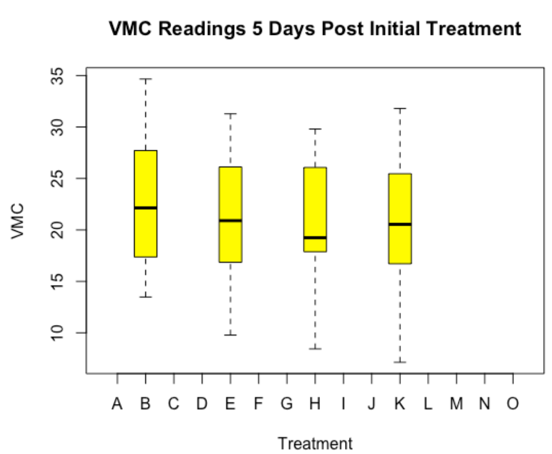
Weather data was recorded from the BOM site and localised data using the OmneTurf system equipped with a combined temperature/humidity sensor and an Apogee PAR sensor.

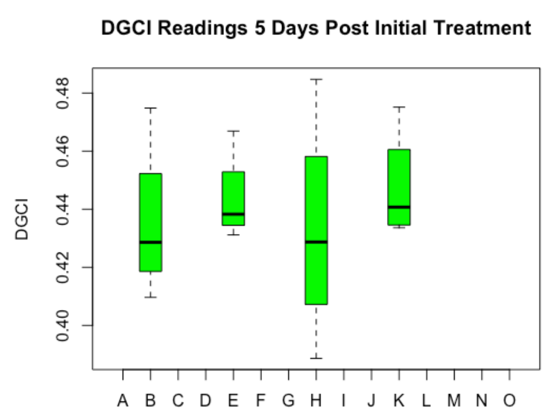
Plots were monitored using digital image analysis and a TDR 350 (Spectrum Technologies) was used to assess soil moisture levels throughout the trial, fitted with 3.8cm rods. 5 random readings were taken per plot.

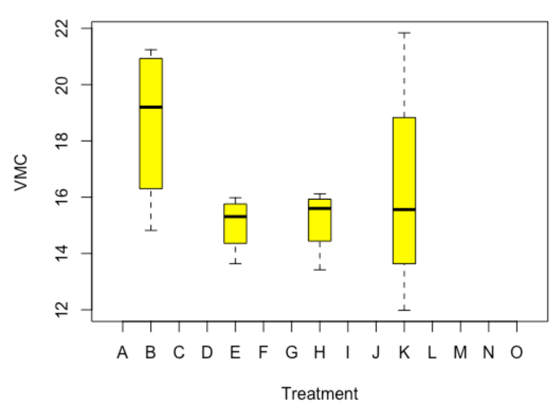
Images were taken monthly in both RAW and PNG format using a modified Canon PowerShot SX260 HS with NDVI filter and an Olympus Stylus respectively. Digital Image Analysis was carried out using Image J and the NCSU Turf Plug in. Statistical analysis was carried out using Programme R Agricola package.

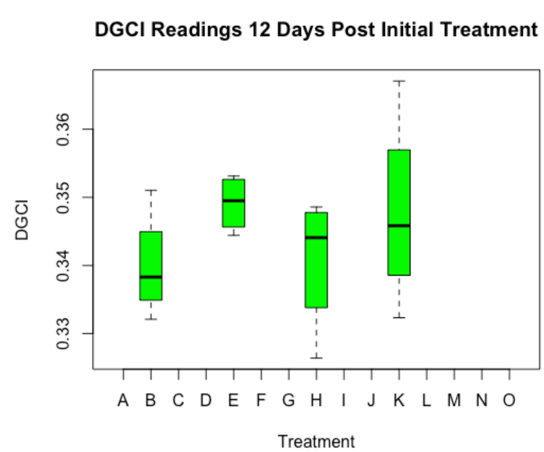
Post Treatment

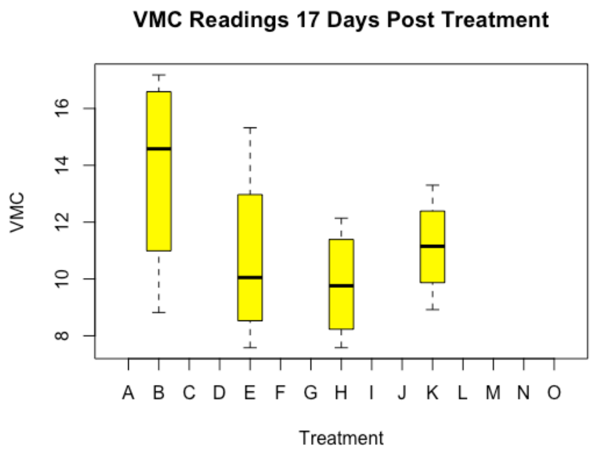
For all variables with the same letter, the difference between the means is not statistically significant. If two variables have different letters, they are significantly different.

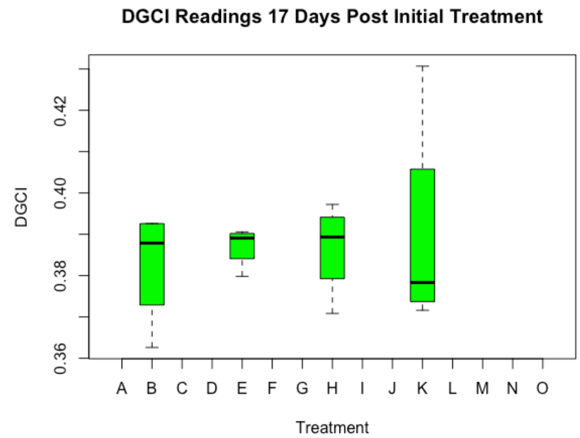


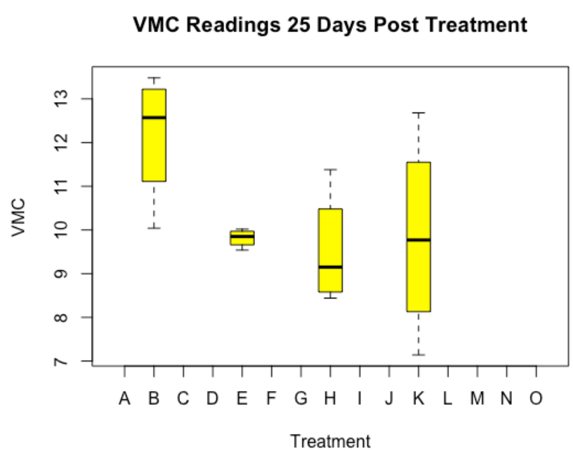


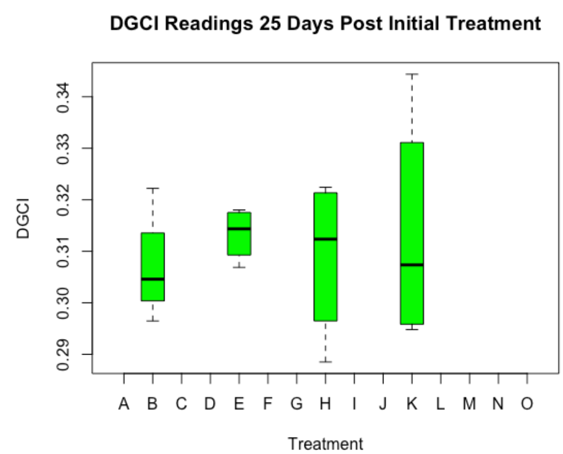




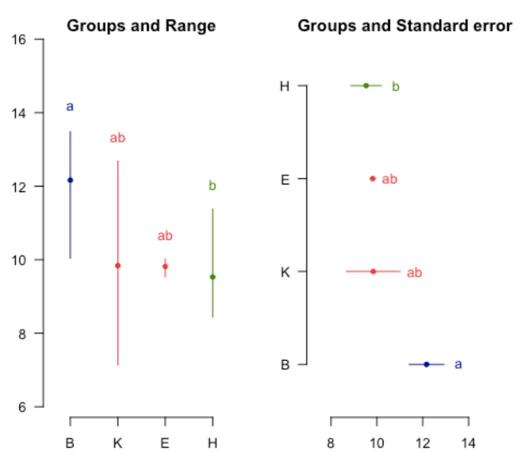


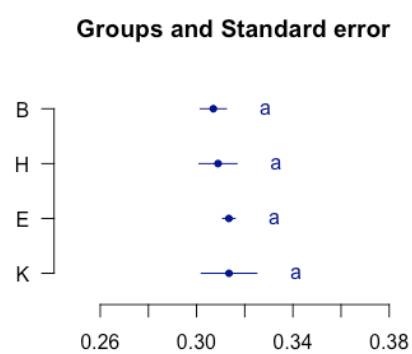




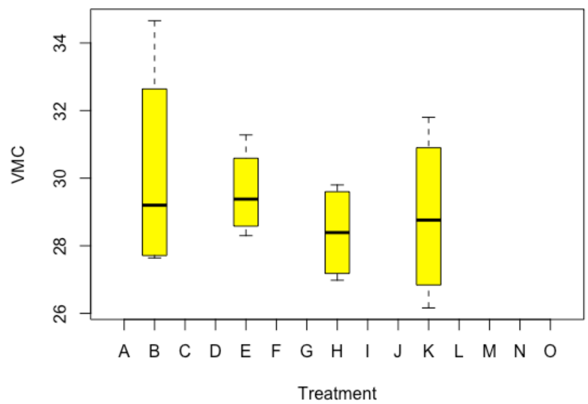


Duncan test for VMC 25 days post treatment showed results were significant at a 95% confidence level. No significant differences existed in DGCI 25 days post treatment.

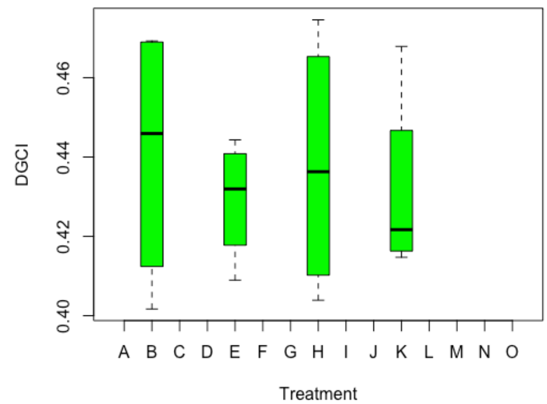




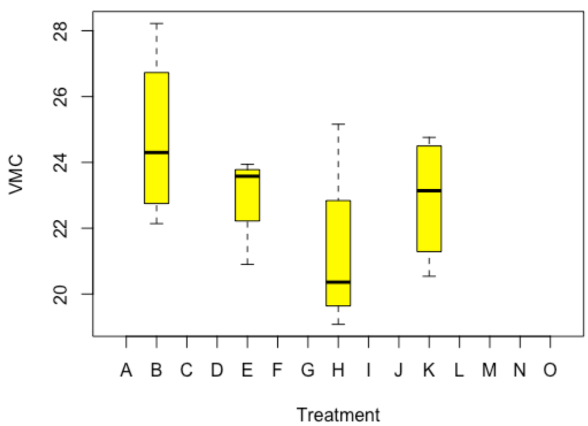
VMC Readings 36 Days Post Treatment



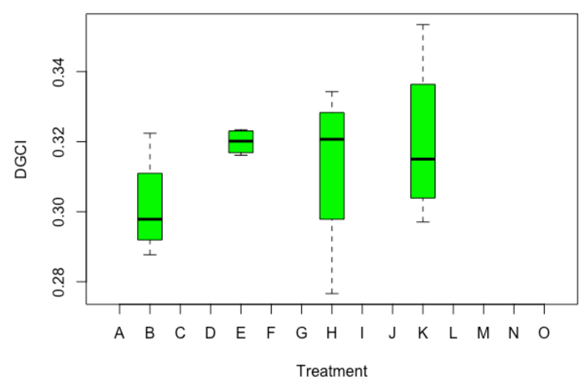
DGCI Readings 36 Days Post Initial Treatment



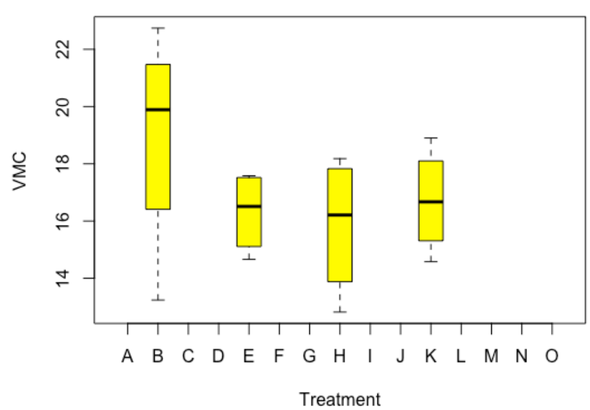
VMC Readings 41 Days Post Treatment



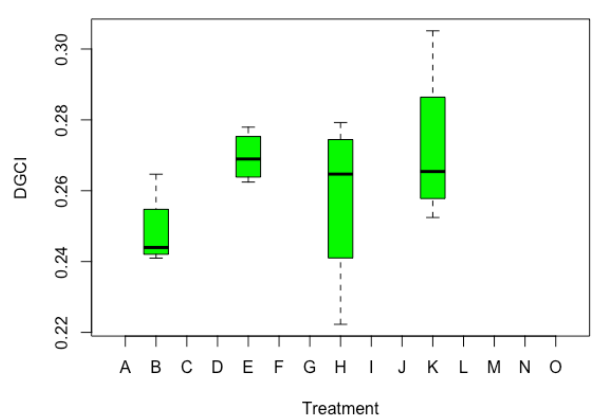
DGCI Readings 40 Days Post Initial Treatment

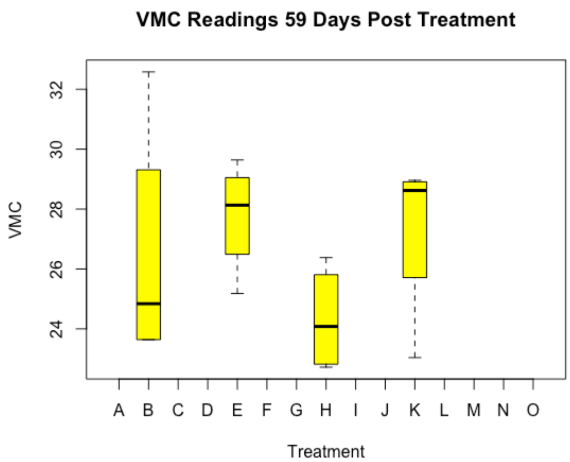


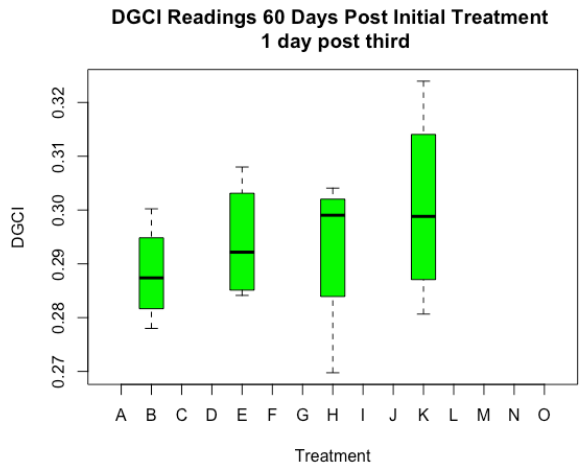
VMC Readings 47 Days Post Treatment

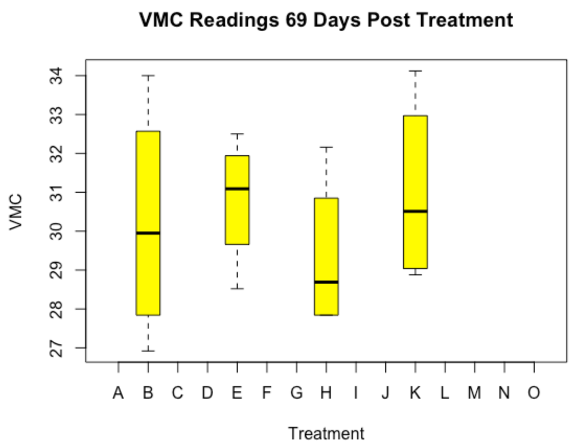


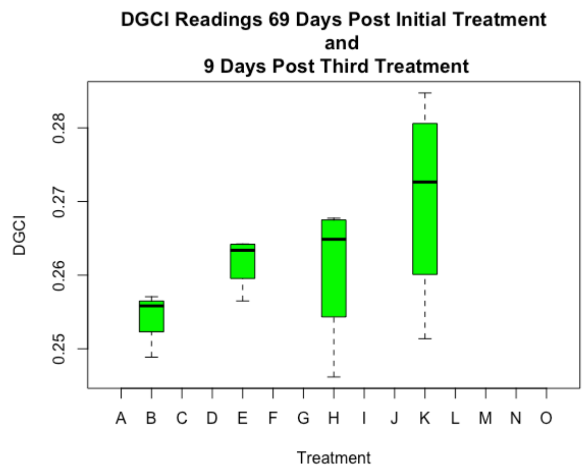
DGCI Readings 47 Days Post Initial Treatment



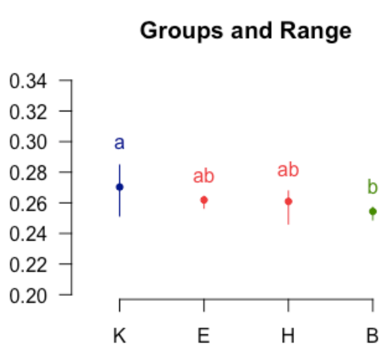


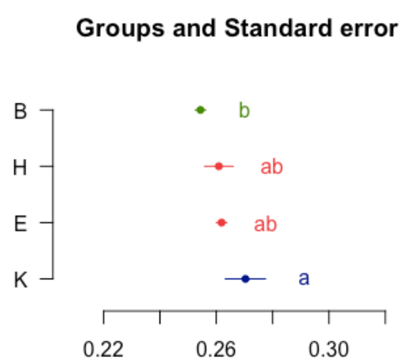


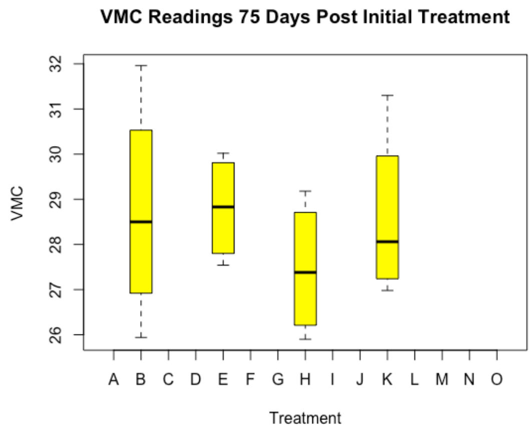


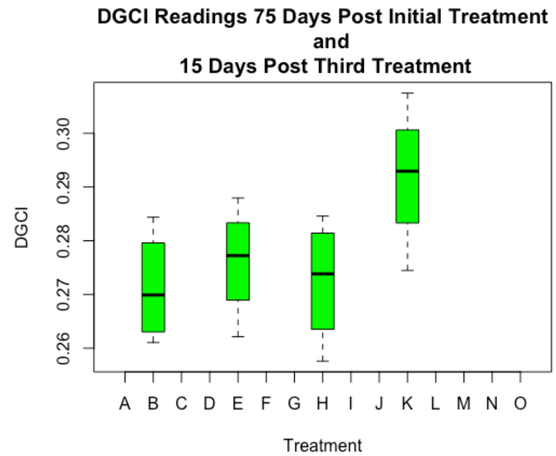


Duncan test for DGCI showed results were significant at a 95% confidence level 9 days post the third application.









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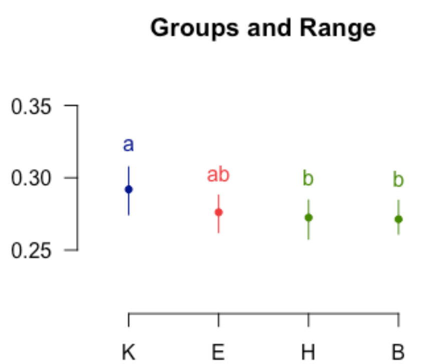

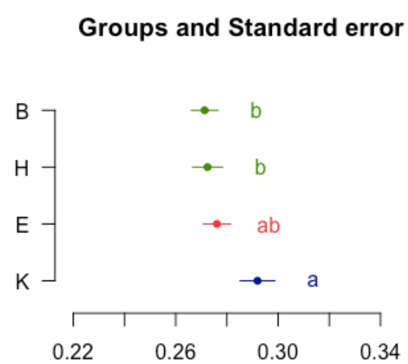

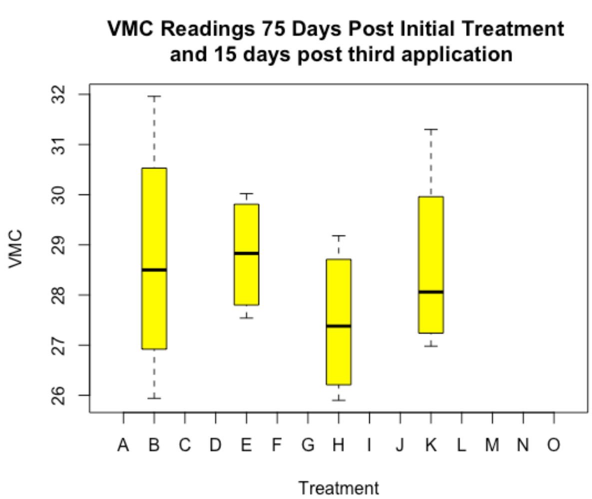

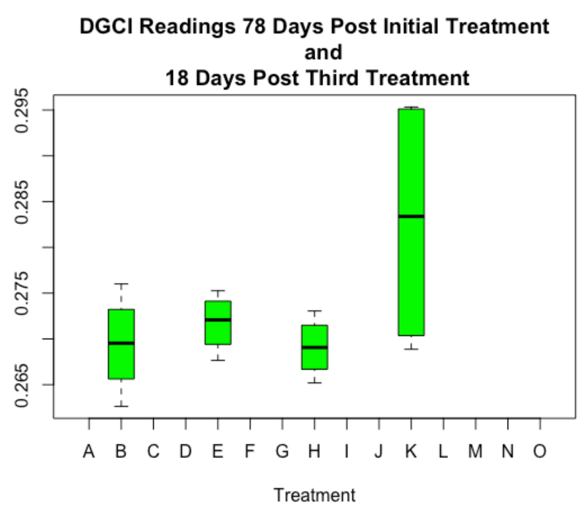

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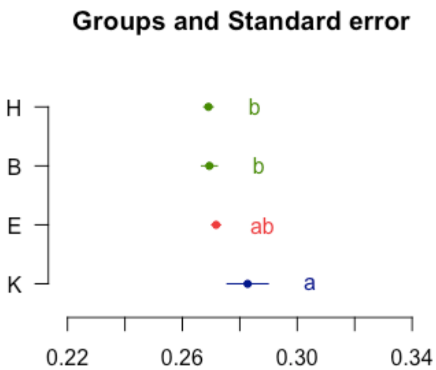
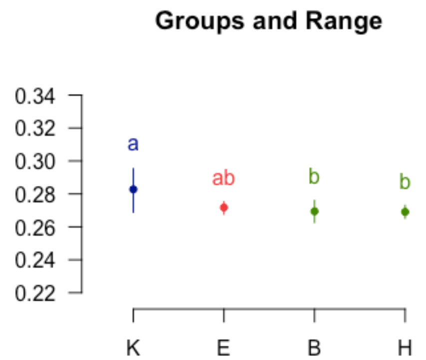
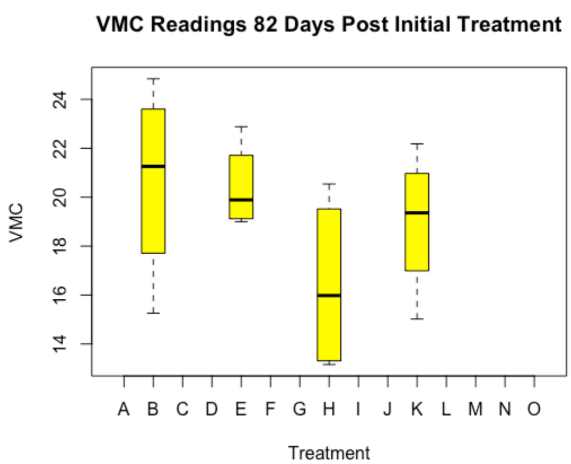
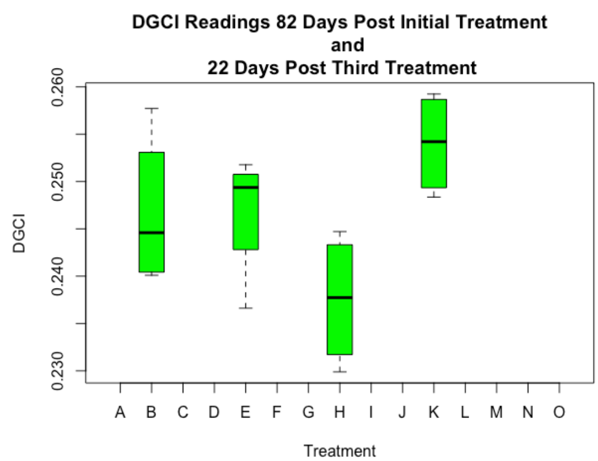
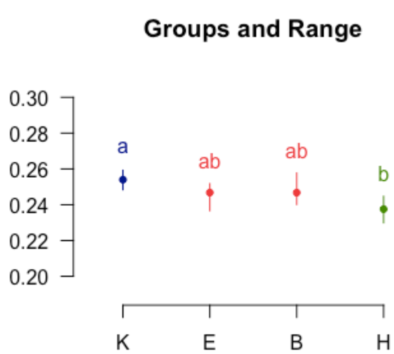


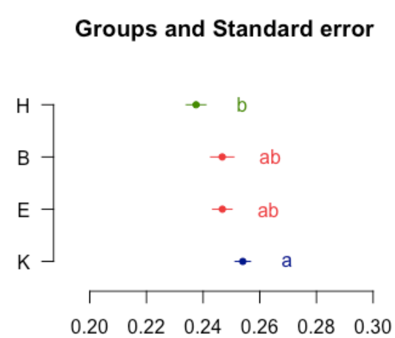




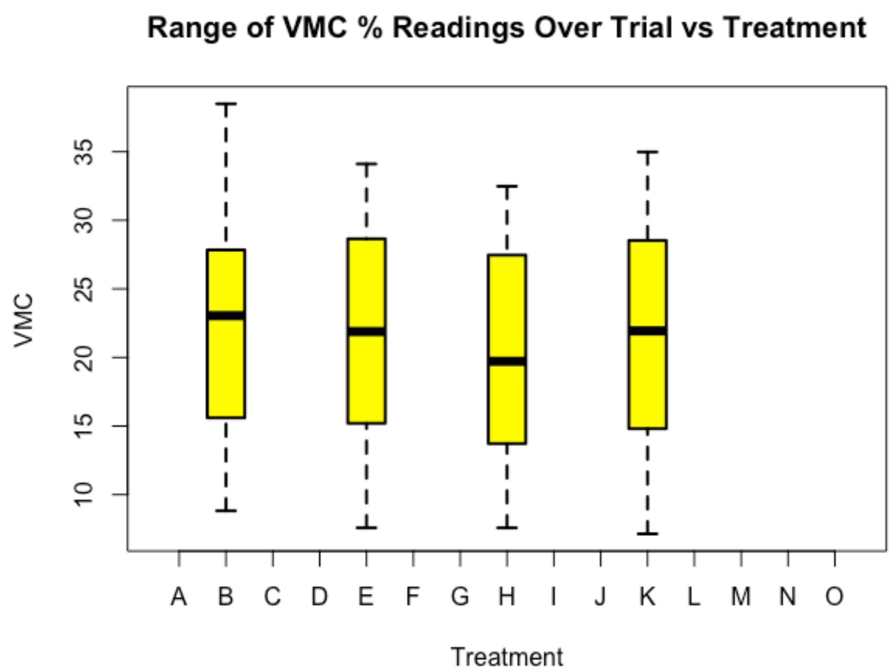


Duncan test for DGCI showed results were significant at a 95% confidence level 22 days post the third application.

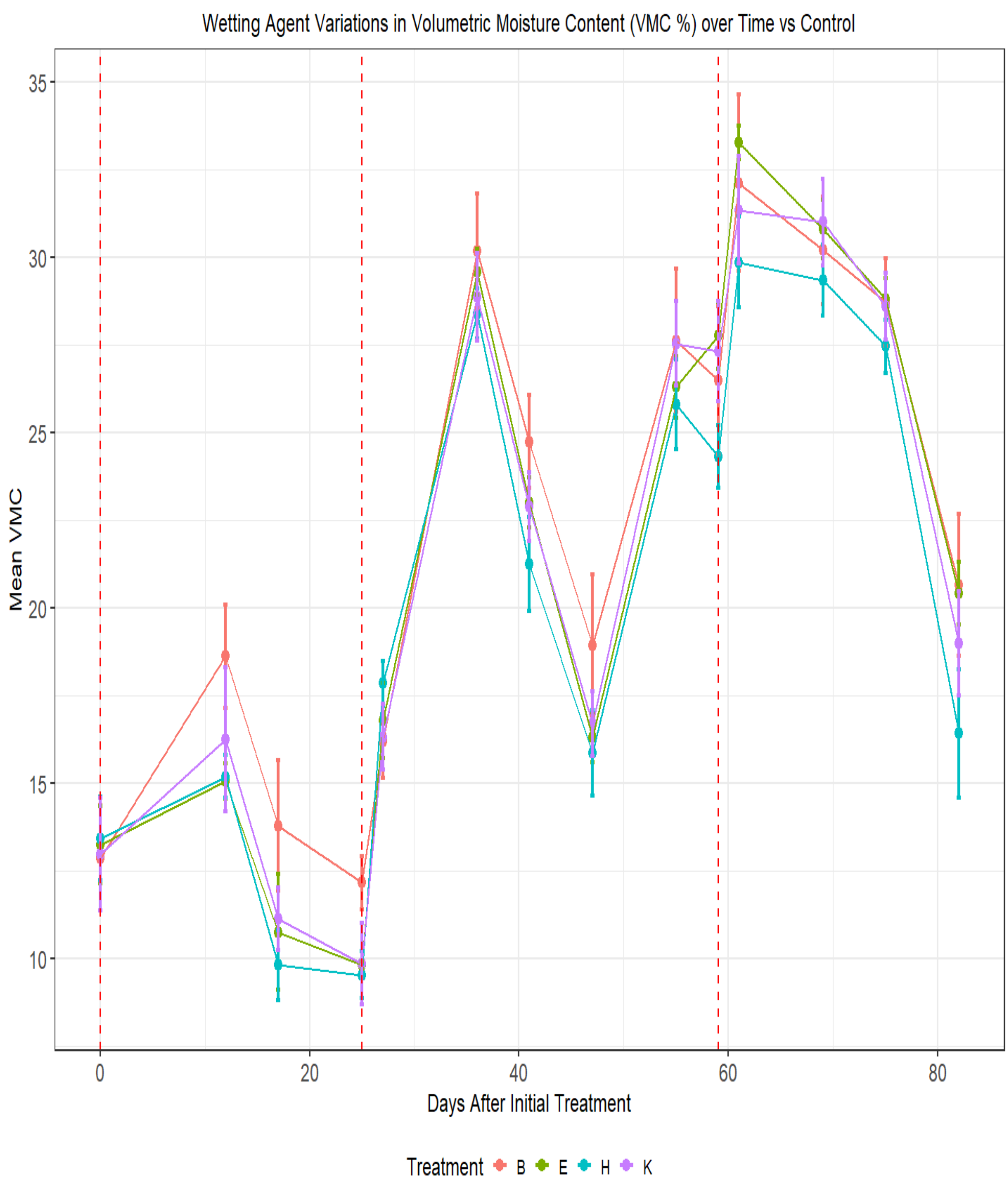




VMC % Variations over Time

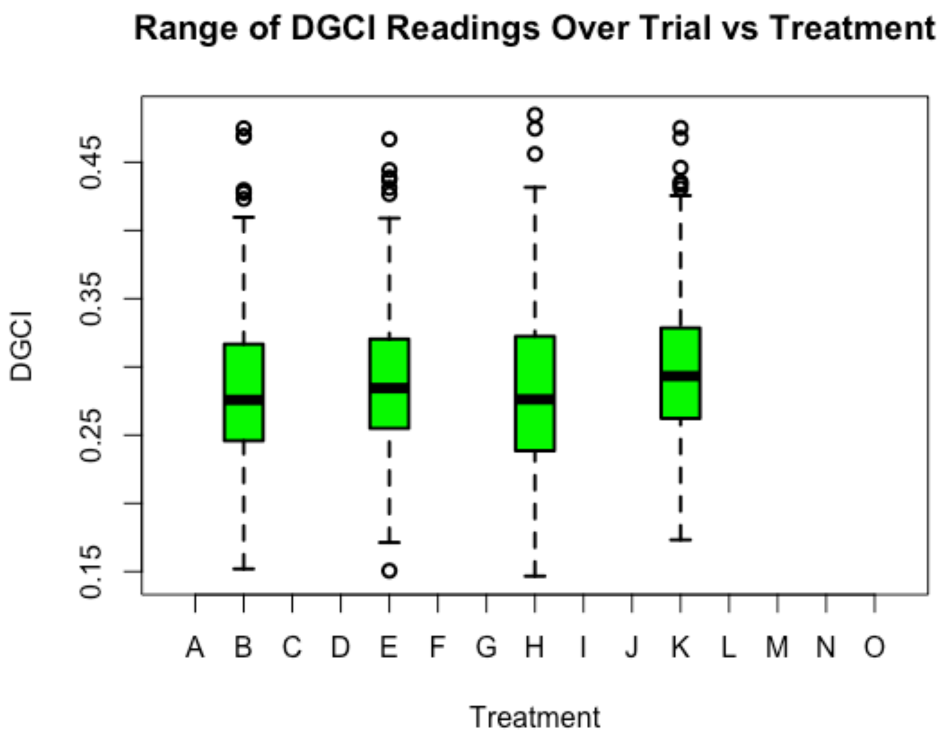


	VMC	groups
B	22	a
E	22	a
K	21	a
H	20	a

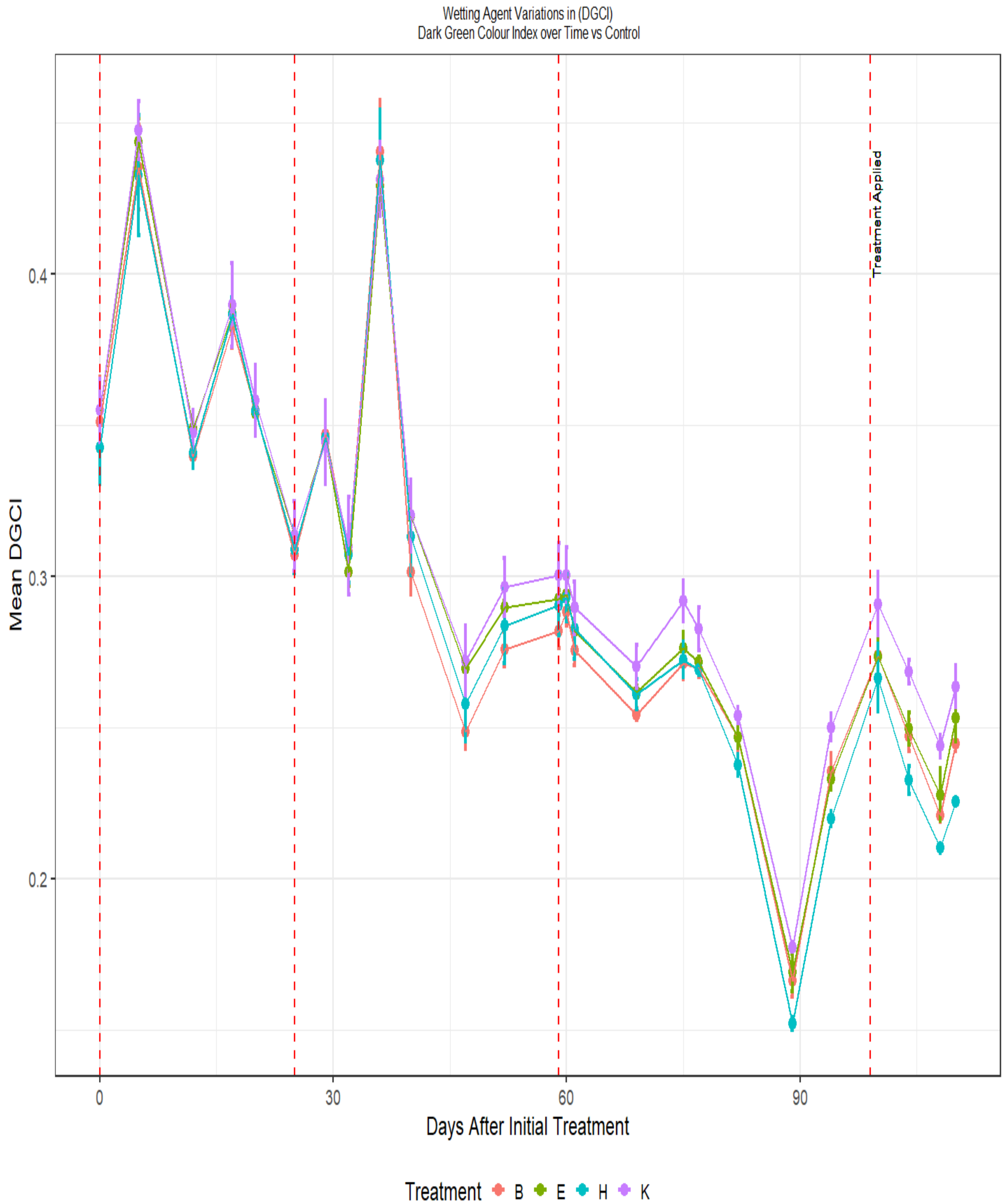


Wetting Agent Variations in Volumetric Moisture Content (VMC %) over Time vs Control
Mean VMC
35
30
25
20
15
10
0
20
40
60
80
Days After Initial Treatment
Treatment
B
E
H
K

DGCI Variations over Time



	DGCI	groups
K	0.3008568	a
E	0.2930840	ab
B	0.2874571	ab
H	0.2848743	b


Wetting Agent Variations in (DGCI)
Dark Green Colour Index over Time vs Control
Treatment Applied
Mean DGCI
0.4
0.3
0.2
0
30
60
90
Days After Initial Treatment
Treatment
B
E
H
K

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