
Technical Case Study – Ref 5.1.16

Influence of Agriwater water treatment on drip irrigation performance and uniformity at Dessie Fresh Farm, Vredendal, Western Cape – 2019 to 2020

Introduction

Drip irrigation is regarded as one of the most reliable, environmentally friendly and effective irrigation technologies to implement. It gained this status through the many possible advantages it holds, namely:

- enclosed pipelines minimizing water and fertilizer loss or environmental contamination,
- targeted water and fertilizer application,
- controllable discharge rates from emitters,
- increased water use efficiency,
- minimized salinity hazard to plants through water-soil management,
- decreased energy requirements, and
- high degree of irrigation uniformity.

The key to achieving and maintaining reliable, effective and economic drip irrigation is in careful and consistent operation, maintenance and management of the irrigation system. This is due to the high tendency of drip emitters to become partially or totally clogged, which has a direct effect on the irrigation system's operation, efficiency, economy and service life. The controlling of emitter and pipeline clogging is thus a crucial part of drip irrigation practices.

The degree of clogging risk for drip irrigation systems is directly related to water quality characteristics – the most direct and basic influencing factor causing clogging. It is also important to note that from a clogging hazard perspective any addition of fertilizers or other chemicals to the irrigation water also negatively effects these conventional water quality characteristics. Ultimately, any increased presence of chemical, physical or biological components adds to the clogging risk for irrigation systems since those components will have a high probability of reacting and/or combining with each other or the reactive components of added fertilizers. The reaction and/or combining of these different components in water easily forms sediments and precipitates that can attach and further grow in filters, on inner pipe walls or in drip emitters. This process is especially exacerbated by the wet and dry cycles associated with the use of drippers. These alternating conditions facilitate the build-up and growth of chemical and biological deposits as well as other sediment layers, which significantly influence emitter capacity and overall system operation efficiency, while increasing the roughness and adhesive force of that built-up layer (further promoting build-up and growth of clogging substances).

Agriwater water treatment efficiently targets the base mechanisms of all combinations of clogging factors. In short, Agriwater treatment ensures that all components present in water (including fertilizers) are transformed to and/or kept in their most basic, favourable and intended form through various oxidation, cleavage and shielding reactions and interactions. This firstly prevents flocculation, sedimentation or deposition of substances onto or into any inner surface throughout the irrigation system. Secondly it enables the breakdown and removal of any such built-up layers from the inner surfaces of the irrigation systems that any Agriwater treated water comes into contact with.

The aim of the case study was to monitor and verify the above-mentioned irrigation system cleaning effects of the RainBox on existing drip irrigation systems and compare with non-treated controls on the same farm, using the same water source.

Experimental Description

The following four vineyard irrigation blocks on Dessie Fresh Farm near Vredendal, Western Cape were chosen:

Block number	Installation year	Drip line type	Rated Discharge	Treatment
1	1999	Netafim AgriPlus non-pressure compensating (17 mm)	2.3 ℓ/h*	Control
7	2016	Stinger pressure compensating (20 mm)	3.5 ℓ/h	Control
15	1992	Netafim AgriPlus non-pressure compensating (17 mm)	4 ℓ/h*	Agriwater
17	1992	Netafim AgriPlus non-pressure compensating (17 mm)	4 ℓ/h*	Agriwater

* Irrigation system designs were set up according to different operating pressures to achieve different effective discharge rates accordingly, e.g. Block 15 was operated at a higher pressure than that required to obtain the rated delivery, whereas Block 17 is operated at a much lower pressure, yielding a lower effective discharge rate.

Comparisons in cleaning of Control and Treated drip irrigation systems of similar age and type (Netafim Agriplus) as well as with a new, more advanced type (Stinger PC) of untreated irrigation system were possible. All maintenance and monitoring practices on the farm were consistent for all irrigation systems and vineyard blocks.

A row, representative of the lines found in that block, at the centre of each block was chosen and 15 or 20 emitters at the beginning (15), middle (20) and end (15) of the row were marked and measured. This row was always measured at a set time of day, once a week for a period of five weeks (Week 4 could not be measured due to a canal break causing water supply problems during Week 4). From these measurements the average discharge rate of each of the tested emitters could be calculated. The measurement used was weight of water delivered (g) in the set time (min) converted to average flow rate (ℓ/h). Uniformity of water delivery throughout the represented row at the time of measurement was then compared.

All lines were flushed once a week as per standard vineyard practice. On top of that all lines were flushed prior to measuring collection. Extra readings were taken on Block 1 and 7 to compare discharge before and after flushing. It was noted that additional flushing and tapping had to be done on the control lines.

Discharge uniformity improved over 5 weeks of Agriwater water treatment. This was directly related to effective cleaning of dripper lines and emitters. In comparison, control line discharges stayed variable, were not as per delivery specifications and required additional flushing of lateral lines to alleviate clogging issues.

Calculated variable definitions

The variables calculated from the measured emitter delivery data are as follow:

- Distribution Uniformity (DU):
 - $DU = \frac{q_{25}}{\bar{q}} \times 100$
 - DU (%): measure of delivery uniformity performance of dripper lines. Designed to be at least 90% under optimized lab conditions. Irrigation system designs and installations are done to yield initial DU values of at least 80%.
 - q_{25} (ℓ/h): average discharge rate of the lowest 25% emitter discharges in measured row
 - $\bar{q}$ (ℓ/h): average discharge rate of all measured emitters in the row.

- Coefficient of Uniformity (CU):

- $CU = (1 - \frac{\sum_{i=1}^n |q_i - \bar{q}|}{n\bar{q}}) \times 100$
- CU (%): measure of achieved discharge uniformity of the measured emitters (design uniformity standard > 90%; pressure compensating emitters should have values close to 100%)

Results and discussion

Variation in emitter discharge rates in the beginning (15 emitters), middle (20 emitters) and end (15 emitters) of the measured rows in each block are shown in the line graphs (Fig. 1 – 4) below. These graphs represent the improvements measured in dripper line emitter performance 1 to 5 weeks after the installation of the Agriwater water treatment unit on Block 15 and 17 (Fig. 1 & 2). Fig. 3 shows how the control dripper lines of Block 1 of a similar type and age performed with before and after flushing – using their standard irrigation cleaning procedures. Note that measurements taken in Control Block 1 were almost identical in week 1 and 3 so were not included in this study.

Finally, Fig. 4 shows the poor performance of the much more advanced dripper line (pressure compensation and larger pipe diameter) and newer (3 years compared to 20 – 27 years) drippers in Control Block 7. Given its age and superiority it was expected to deliver an excellent performance. As with Control Block 1, measurements in Control Block 7 did not vary between week 1 and 5 so the repetitive data was not included in this study.

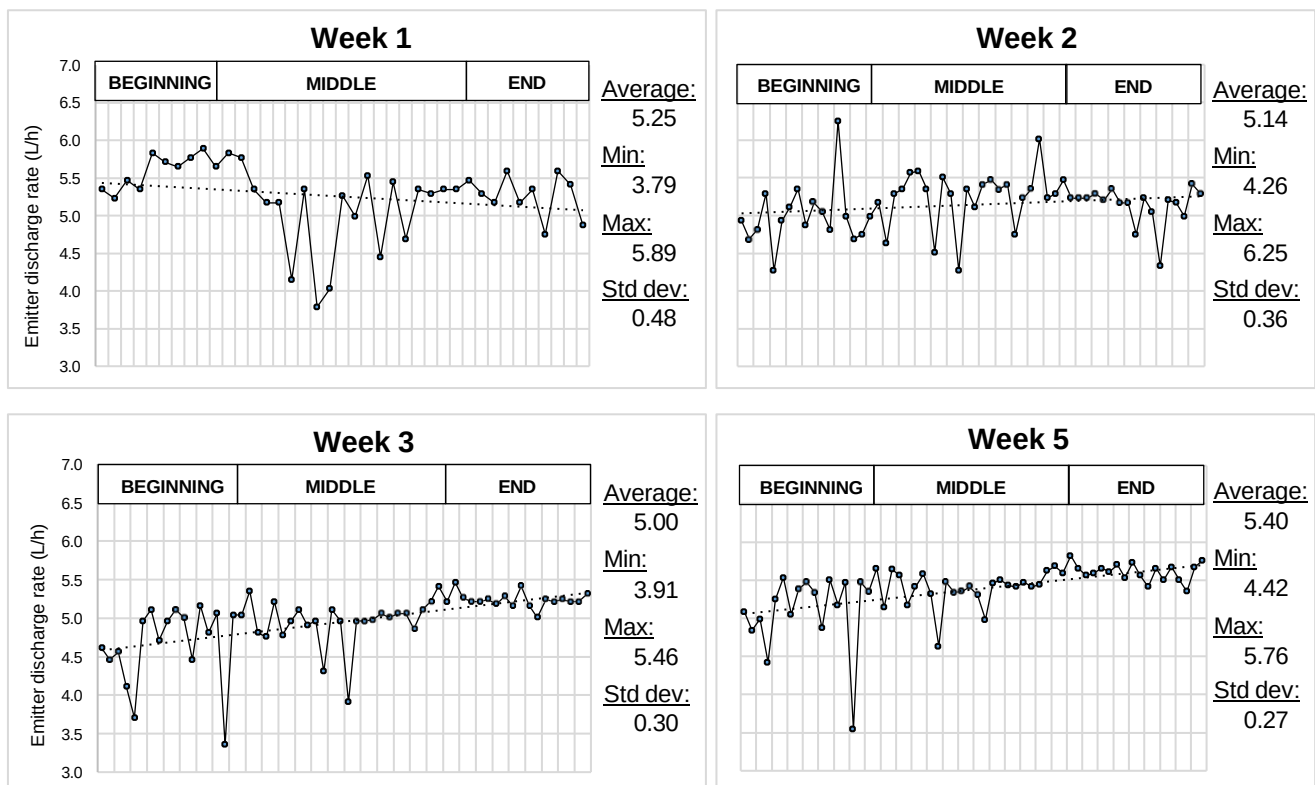


Figure 1: Measured discharge rates of 4 L/h rated drippers in Agriwater treated Block 15 from 1 – 5 weeks after Agriwater installation.

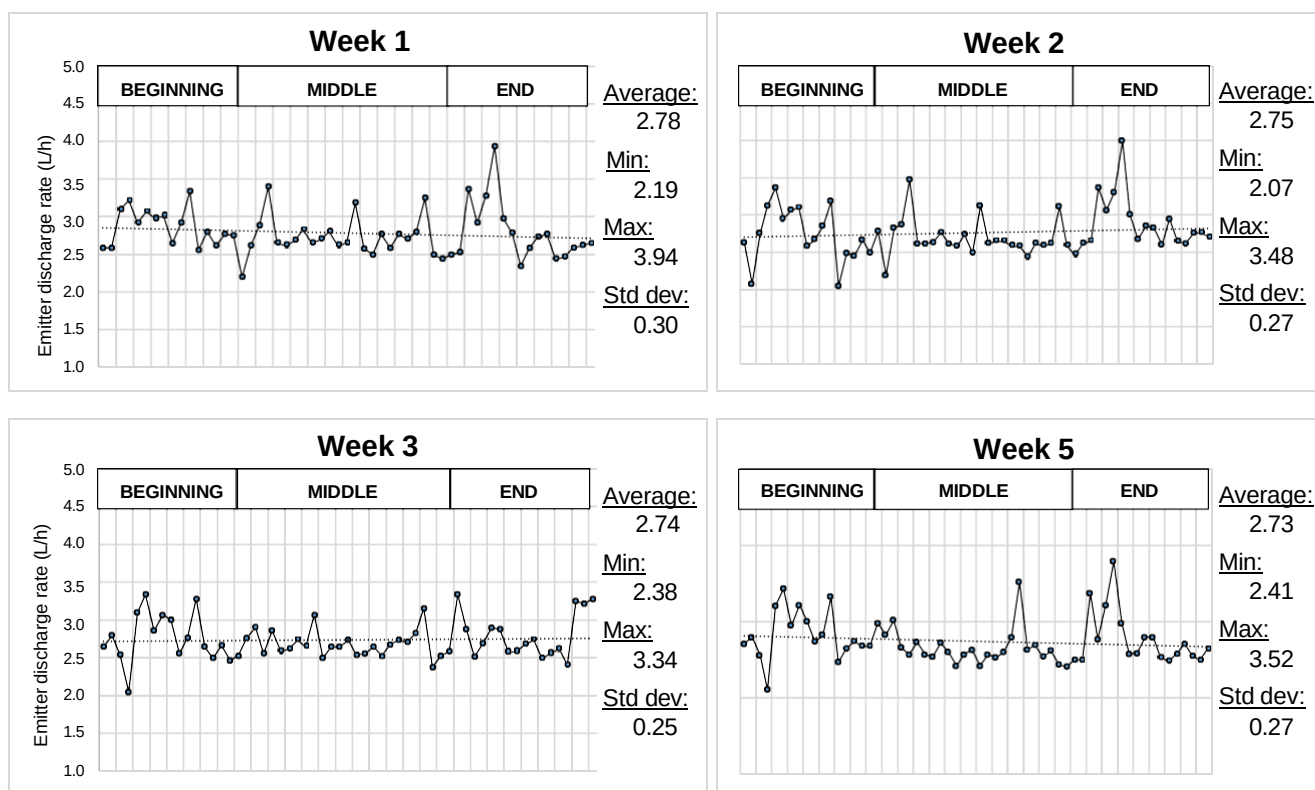


Figure 2: Measured discharge rates of 4 l/h rated drippers in Agriwater treated Block 17 from 1 – 5 weeks after Agriwater installation.

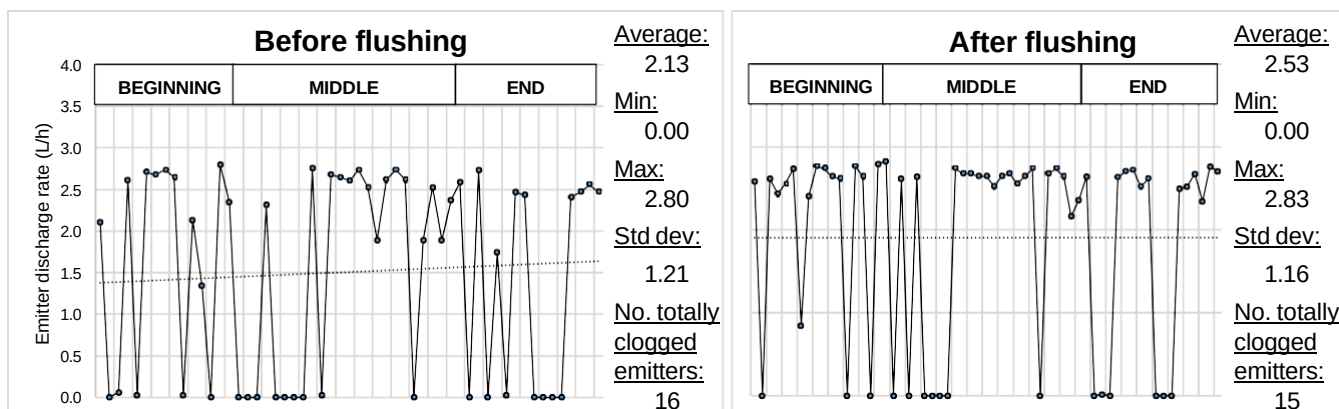


Figure 3: Measured discharge rates of 2.3 l/h rated drip emitters from Control Block 1 before and after standard flushing and tapping practices.

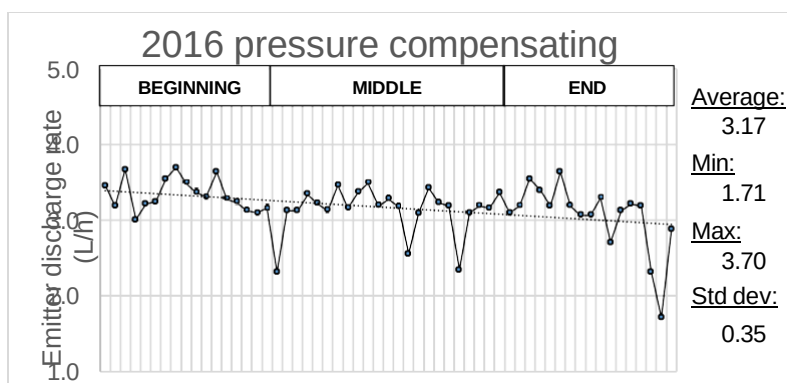


Figure 4: Measured discharge rates of 3.5 l/h rated dripper in Control Block 7 after standard flushing and tapping practices.

From these graphs it was clear that drip irrigation lines of similar age (amount of use) and type were quickly and more effectively cleaned by the Agriwater treatment (Fig. 1 & 2) than rigorous flushing procedures (Fig. 3). After only one week of Agriwater water treatment to Blocks 15 and 17 (having the oldest irrigation lines), the emitter discharge rates and uniformity could be compared to the much newer and more advanced pressure compensating drip lines (Fig. 4).

The normal decreasing trend of water delivery per emitter from the start towards the end of a row was reduced with Agriwater treated irrigation water. This was observed in the trend lines of Fig. 1 – 4. These emitter discharge trend lines normally indicate pressure loss effects throughout the irrigation lateral line, but it should be noted that when damaged emitters (generally caused by attempts to manually clean drip emitters) are present in lines without significant pressure losses across them, an increase in average discharge along that line can be seen – as is the case in Fig. 1.

In Fig. 3 an averaging out of the line trend across the drip line was seen after rigorous flushing of the lines had been done. Thus, build-up from the lateral line was removed by thorough flushing but, as can be seen from the lack of improvement in number of totally or severely clogged emitters - clogging substances trapped inside emitters cannot be alleviated by flushing operations.

Block-and-whisker charts illustrate the variation in emitter discharges across the test lines as shown in Fig. 5.

These charts show that Agriwater treated water in Blocks 15 and 17 improved uniformity of emitter discharge rates significantly above that which was achievable with similar age and type drippers (Control Block 1), and that they were even comparable to the much newer and more technologically advanced pressure compensating emitters found in Control Block 7.

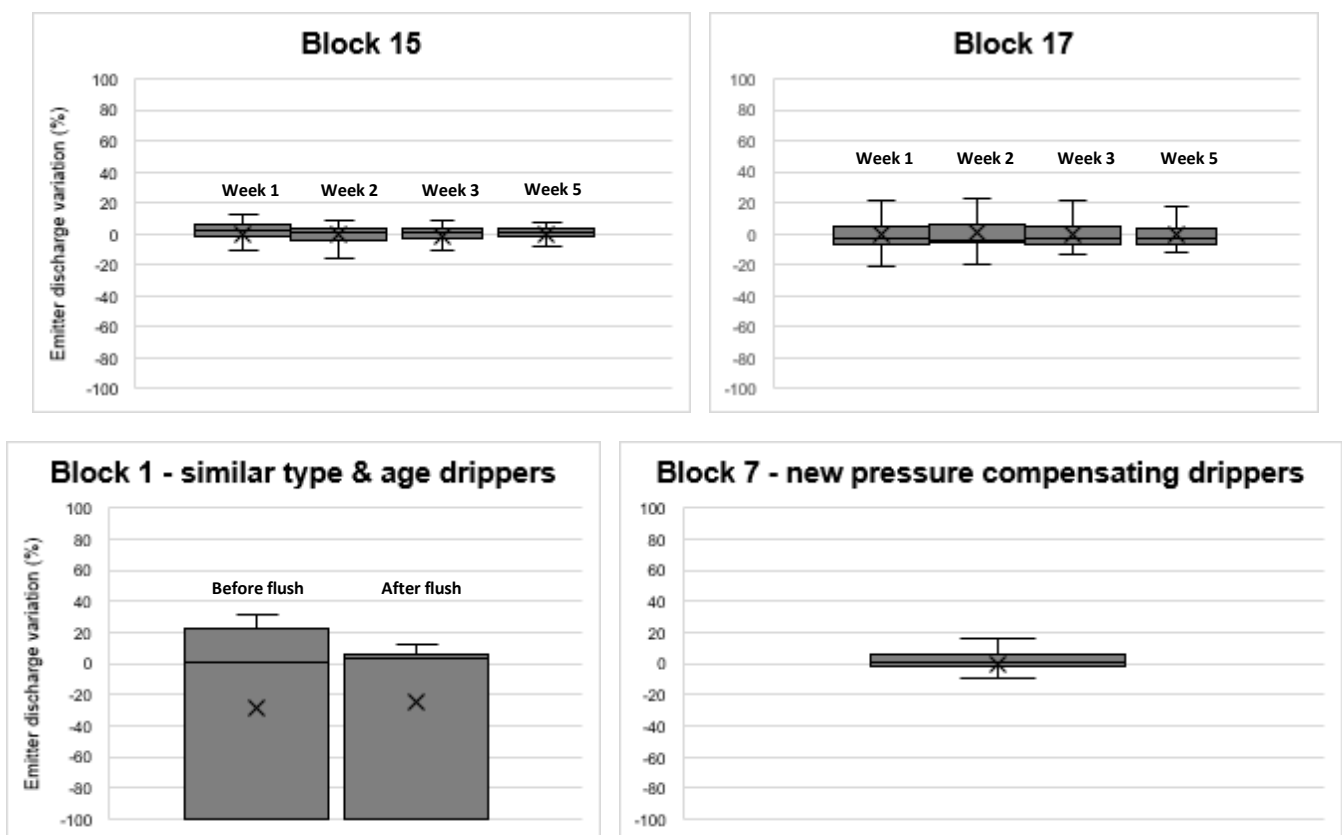


Figure 5: Box-and-whisker diagrams showing the variations in measured emitter discharge rates throughout representative rows of all treated blocks from Week 1 to 5.

The combination of all the treated and untreated dripper delivery data and use of frequency distribution and pie charts to illustrate the change, show a dramatic improvement in the Agriwater treated dripper water delivery (Fig. 6 & 7). Overall it's very clear that Agriwater treated drippers delivered closer to the ideal range of 90-100% of the dripper specification. 29% of the untreated drippers delivered <90% of the required water with 22% delivering <5%. In comparison only 4% of Agriwater treated drippers delivered <90% of the required water. Similarly over-delivery went from 60% delivering 100% - 135% of the expected delivery in untreated drippers to 50% of the drippers in treated lines delivering between 100% and 125% of the expected rates, with most of this being in the 100-105% range i.e., only a 5% over delivery. Finally, the biggest improvement was observed in the percentage of drippers giving the correct delivery in untreated and treated dripper lines. This percentage went from only 11% in lines without Agriwater treatment to 46% in lines that received Agriwater treated irrigation water for 5 weeks. The cleaning action of Agriwater treated water is very clear over this five week period.

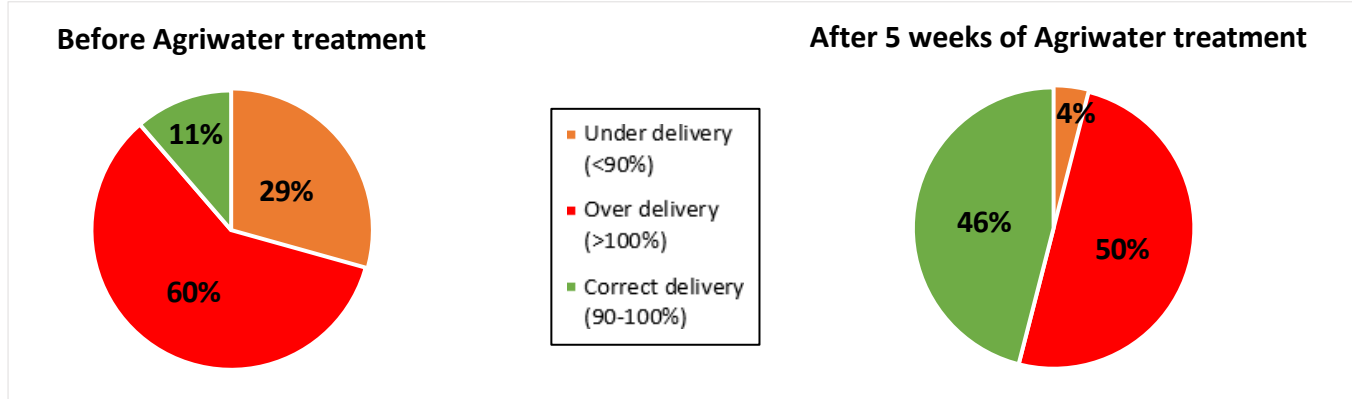


Figure 6: Dripper delivery pie charts showing fractions of over, under and correct delivering drippers in all untreated and Agriwater treated lines (after 5 weeks of treatment).

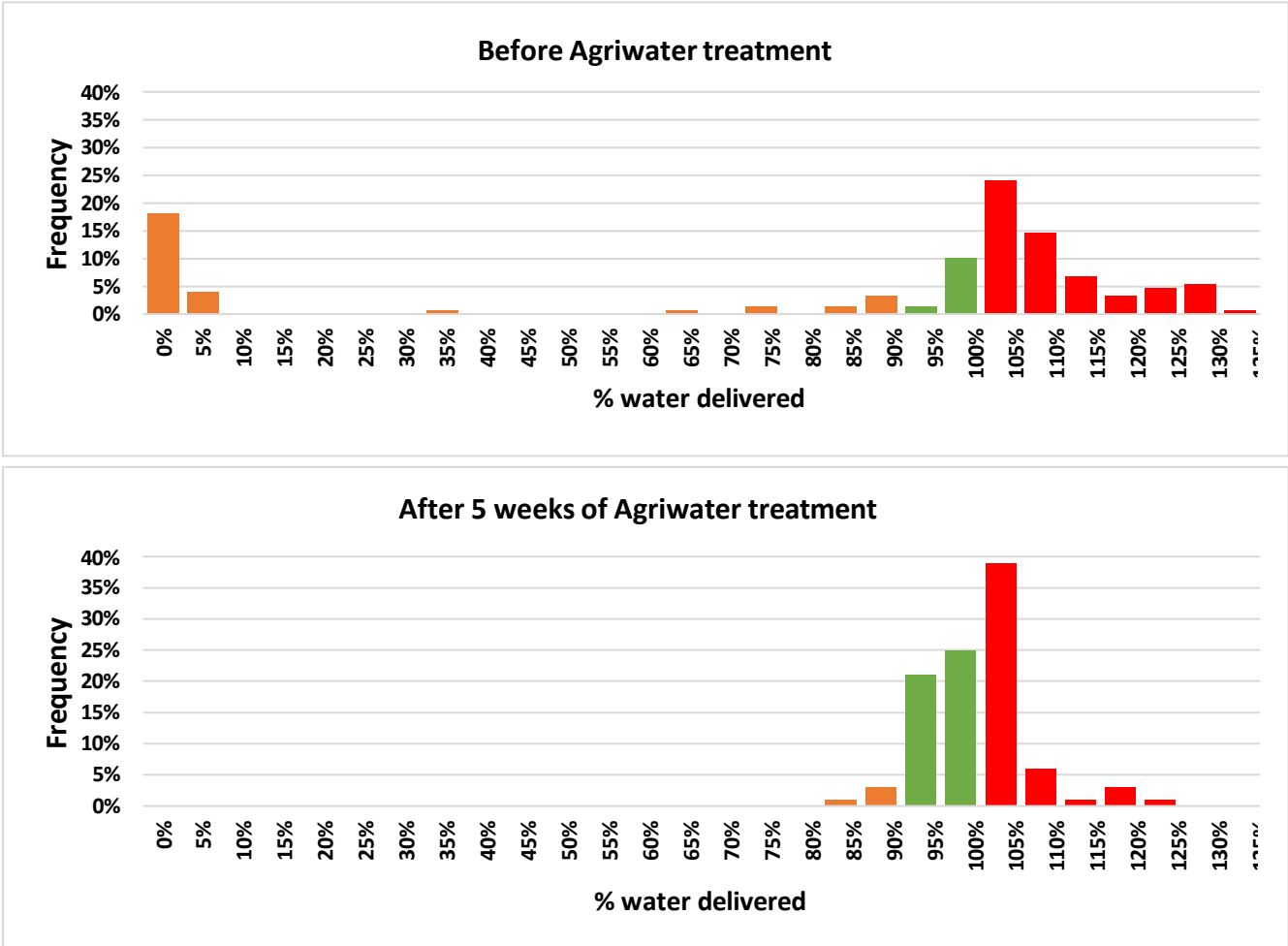


Figure 7: Frequency distributions of dripper delivery without and with Agriwater treatment, respectively.

The collected emitter data provides a useful and visual picture of the overall effects of the Agriwater water treatment on dripper delivery. Furthermore we have added other standard industry measurements to evaluate the significance of the variations. Distribution uniformity (DU) and coefficients of uniformity (CU) values were calculated from this data. These results were summarized in Table 1 below.

Table 1: DU and CU values

	Time of measurements	Distribution uniformity (%)	Coefficient of uniformity (%)
Agriwater treated Block 15	1 week*	86.46	93.48
	2 week*	97.97	94.74
	3 week*	91.43	95.64
	5 week*	92.86	96.36
Agriwater treated Block 17	1 week*	89.26	91.79
	2 week*	89.75	92.26
	3 week*	91.37	92.83
	5 week*	90.89	92.59
Control Block 1	Before flushing**	36.85***	49.81
	After flushing**	81.38***	66.34
Control Block 7	After flushing**	86.51	92.86

* Time after installation of the Agriwater water treatment unit in the irrigation system.

** Additional rigorous flushing of lateral lines was done to attempt to clean clogged irrigation lines.

*** Completely clogged emitters were excluded from calculation because more than 25% of emitters had zero discharge.

The DU values in Table 1 clearly show the improvement in emitter uniformity and performance with Agriwater treated irrigation water in Block 15 and 17. After only one week of Agriwater treatment, DU values went up from a maximum estimated pre-Agriwater value of 81.38%, to 86.46% and 89.26% respectively. Note that the average DU value obtained for Block 1 (same type and age drippers) was 59.12% and would be a more realistic estimation of what the initial DU value was. Similarly CU values went up from a maximum estimated pre-Agriwater value of 66.3% to 93.48% and 91.79% for Blocks 15 and 17, respectively. Note that the average CU value obtained for same type and age drippers of Block 1 was 58.08% and would be a more realistic estimation of what the initial CU value was. Over 5 weeks these values (already close to that of newly manufactured non-pressure compensating emitters) further improved to DU and CU values of 92.86% and 96.36% for Block 15 and 90.89% and 92.59% for Block 17, respectively. *These final calculated values for the Agriwater treated blocks were comparable to standards of newly manufactured pressure compensating drip emitter lines.*

In comparison the two control blocks both showed low and reduced DU and CU values. Block 1 had DU of 81.38% and CU of 66.34% respectively, which were far below the Agriwater treated Blocks 15 and 17 (similar age and type). The Control drippers were simply ineffective conduits of irrigation water. Similarly Block 7, which was fitted with much newer and more advanced dripper lines, also show reduced DU and CU values that indicated already compromised emitter performance and uniformity.

Conclusion

All the results clearly show that Agriwater water treatment in drip irrigation systems effectively and efficiently cleans, improves and resolves clogging issues in emitters. This is critical in enabling properly functioning drip irrigation systems and correct water delivery. On the other hand, when irrigation line and emitter clogging issues are not explicitly managed and solved - the performance, uniformity and service life of the irrigation system can be significantly compromised, and irrigation scheduling will be out of sync with actual soil requirements.

This case study has verified that even persistent and thorough flushing, as well as manual attempts to clean out emitters throughout the years were simply not very effective. These standard methods used do not solve clogging issues in drip irrigation systems and irrigation efficiency and uniformity will eventually be sacrificed – especially when irrigation water quality is poor or deteriorating. In direct contrast - *the Agriwater treated blocks were comparable to standards of newly manufactured pressure compensating drip emitter lines.*

Customised Agriwater water treatment is designed to handle a wide range of water quality challenges and is effective in cleaning irrigation lines and emitters. This enables the irrigation system to function as per its original design thus uniformly syncing scheduling with soil requirements and will ensure minimal energy, pressure and water losses as well as uniform water and fertilizer delivery and crop uniformity. Agriwater water treatment thus gives you an automated solution to keep your irrigation lines clean and simultaneously provide the farmer with the ability to be more efficient, productive and economic in their irrigation practices.

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