



BOOKLET THREE

Spreadmark Code of Practice:

Technical Specifications for the Testing and Certification of Conventional Boom Sprayers Applying Liquid Nutrient

www.fertqual.co.nz



Introduction

This booklet is one of four booklets containing information that supports the Spreadmark Code of Practice for the Application of Nutrients in New Zealand.

The Spreadmark Code of Practice can be found [here](#).

This booklet forms part of the Code and all information related to copyright, document control, acknowledgments and glossary contained in the main Code apply equally to the information in this booklet.

Other booklets containing support information for the Spreadmark Code of Practice are:

- **Booklet 1:** Spreadmark Procedures, Protocols, Policies and Codes.

- **Booklet 2:** Technical Specifications for the Testing and Certification of Solid Nutrient Application Units.
- **Booklet 4:** Spread Pattern Testing and Certification for Fixed Wing Aerial Application of Solid Nutrients.

These booklets are supported by two technical documents listed below and found here:

<https://fertqual.co.nz/spreadmark/>

- Nutrient Application Specifications; and
- Nutrient Physical Properties - General Information.

Index

	Page
1 Principles	3
2 Background	5
3 General	7
4 Facilities	8
5 Test products	9
6 Test conditions	10
7 Measurement techniques	11
8 Measurement standards	12
9 Schedule of tests	13
10 Field report	16
11 Certified bout widths	17
12 Reporting	18



1. PRINCIPLES

Scope

In order to ensure that products are spread according to the requirements of the Spreadmark programme the following principles shall be followed with regard to the testing of nutrient applicator units. Operational matters are covered in the Code of Practice for Fertiliser Nutrient Management. <https://www.fertiliser.org.nz/Site/code-of-practice/>

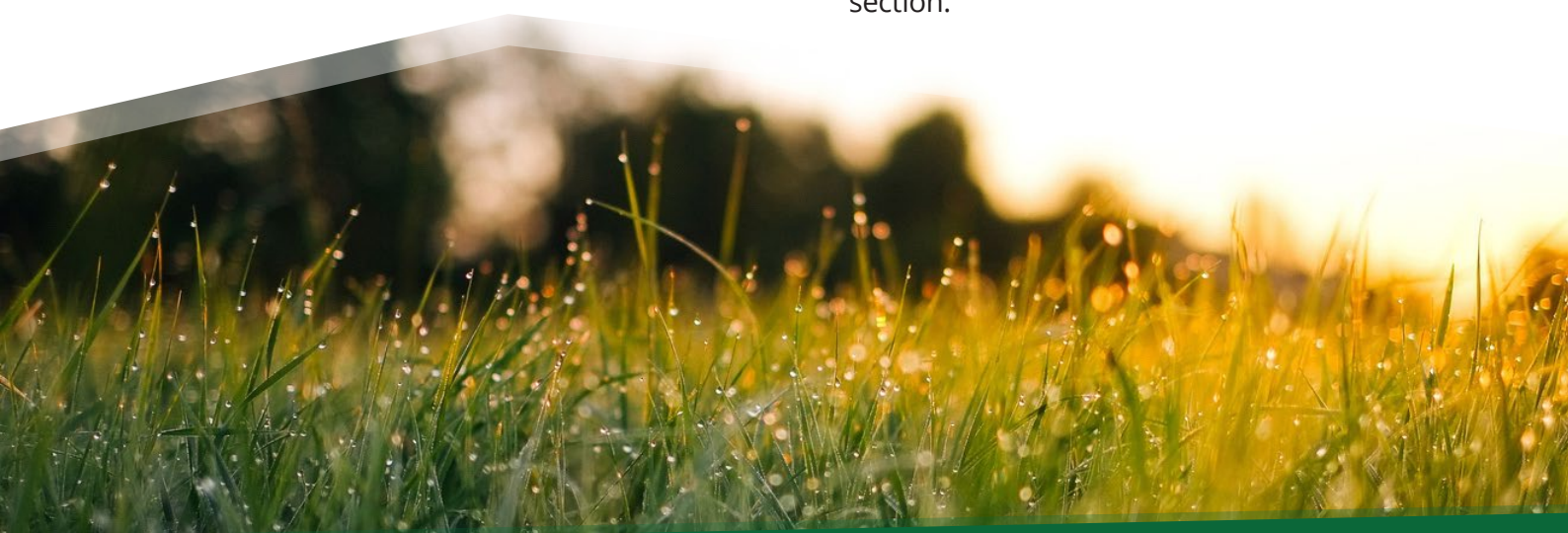
1.1 Principles

- a. The spreader test procedure allows each spreader to be characterised so it can be set to accommodate variable product characteristics. The test procedure has been linked to international methods and practice, adapted to New Zealand conditions.
- b. Both indoor and outdoor testing is permitted for ground spreading units. For outdoor testing, requirements for wind speed and direction, angle of slope and nature of surface shall be set. Outdoor testing shall be carried out in a way that does not cause environmental contamination by overloading the test site. For indoor testing the test facility shall be of such a size as to not interfere with the test result.
- c. The evenness of product spreading shall be expressed as a Coefficient of Variation. The evenness of spread both across and along the direction of spreader travel is important. Application rate at the time of test and application rate calibration settings shall be recorded.
- d. To be Spreadmark Registered, application units must satisfy the performance standard for transverse CV% of 15% for nitrogenous nutrients and 25% for all other products.
- e. The spreadability of product depends on its physical characteristics, usually described by their bulk density (BD); uniformity index (UI); and size guide number (SGN). Spreading units shall be tested on a sufficiently wide range of products to provide a guide to the maximum safe bout width for the range of products the spreader distributes.

- f. Spreader certification testing shall be done at frequencies described in Section 3.4 (c) – (e) of the Spreadmark System Standard by Approved Spreading Unit Testers, who shall test spreaders in accordance with Spreadmark Technical Specifications for testing spreaders (refer Booklets 2-4). Testers shall prepare Spreader Performance Certificates and forward them to the company and to the Auditor.
- g. Spreader operators should use simple field tools (sieve box and bulk density measure) to estimate these parameters in the field and adjust the spreading units accordingly.
- h. Every certified spreader shall have, a unique identification number. For Groundspread vehicles spreader certification lapses if the bin changes to another vehicle.
- i. When spreaders are sold from a Spreadmark registered company to another Spreadmark registered company, the current Spreadmark Test Certificates can be transferred to the new owner. When spreaders are sold from a Spreadmark registered company to a non-Spreadmark registered company then the certificates lapse.

1.2 Testing

- a. There are two primary factors that determine whether nutrient is applied evenly and at the correct rate: the performance of the spreading unit; and the nutrient flow rate to that spreading unit.
- b. The performance of the spreading unit is determined by measuring the evenness of transverse and longitudinal distribution.
- c. The nutrient flow rate has two components; the average flow, which determines the application rate, and the momentary flow, which determines the longitudinal variation. The average flow rate is measured either directly when calibrating the spreader computer or can be determined by experience – the amount of product spread per unit area. Variations in momentary flow can be measured directly or indirectly by measuring the evenness of the longitudinal distribution.
- d. The interaction of these factors is complex and momentary changes in flow may affect transverse as well as longitudinal distribution.
- e. These two primary factors also interact with the operational conditions under which they are measured. It is necessary therefore to define the conditions under which they are measured. These are defined in the facilities section.





2. BACKGROUND

- a. Conventional boom sprayers apply liquids through manufactured hydraulic nozzles usually at 0.5m spacing. Bout width is predetermined by this spacing and the number of nozzles. So for example, 24 nozzles at 0.5m spacing will cover a 12m width. For boom sprayers attached to vehicles the distance between the nozzles and the target (soil) is significantly less with a conventional boom at 0.4 to 0.8m as compared booms attached to aircraft and UAVs, and to spinning discs applying granule nutrient where the distance will be much greater especially when applied by helicopters or UAVs. As a result, conventional boom applications of liquid nutrient from vehicles achieve relatively discrete and accurate application rates.
- b. There are two primary factors that determine whether liquid nutrient is applied evenly and at the correct rate; the flow rate of the liquid nutrient and the quality and performance of the nozzles.

2.1 Flow rate

- a. For conventional boom sprayers the liquid nutrient flow rate determines the application rate which is a function of the

spray pressure. The average flow rate is measured either directly when calibrating the sprayer controller or can be determined by experience¹ based on the amount of product applied per unit area. For computer controlled liquid nutrient applications, system pressure is increased or decreased in relation to forward speed to maintain target application rate. For these tests it is assumed the flow and speed inputs to the sprayer controller are accurate and the operator is continually comparing volumes applied with area covered. Flow and speed measurement devices may have also been checked by a 3rd party sprayer calibrator.

2.2 Nozzles

- a. At least two types of nozzle may be used. Specialist nozzles for liquid nutrient application or standard (flat fan type) spray nozzles designed for application of herbicides, insecticides and fungicides.

2.3 Nutrient Nozzles (Groundspread Only)

- a. Specialist nozzles apply liquid nutrient as a stream. These are preferred to standard nozzles which can cause leaf burn. Specialist nutrient nozzles produce streams of liquid

[1] This certification procedure assumes a controller is always used to automatically adjust flow in relation to forward speed.

at intervals of 0.1m or less along the width of a conventional spray boom. Common liquid nutrient nozzle options are shown in Figure 1.

b. This certification procedure assumes a controller is always used to automatically adjust flow in relation to forward speed.



Stream type nozzle



Dribble bar type nozzle

Figure 1 Common Liquid nutrient nozzle types

c. Reports of evenness of spread for nutrient nozzles are less common than for standard nozzles. One report shows a CV of 3.4% for a Lechlar FD 04 nozzle (Figure 2).

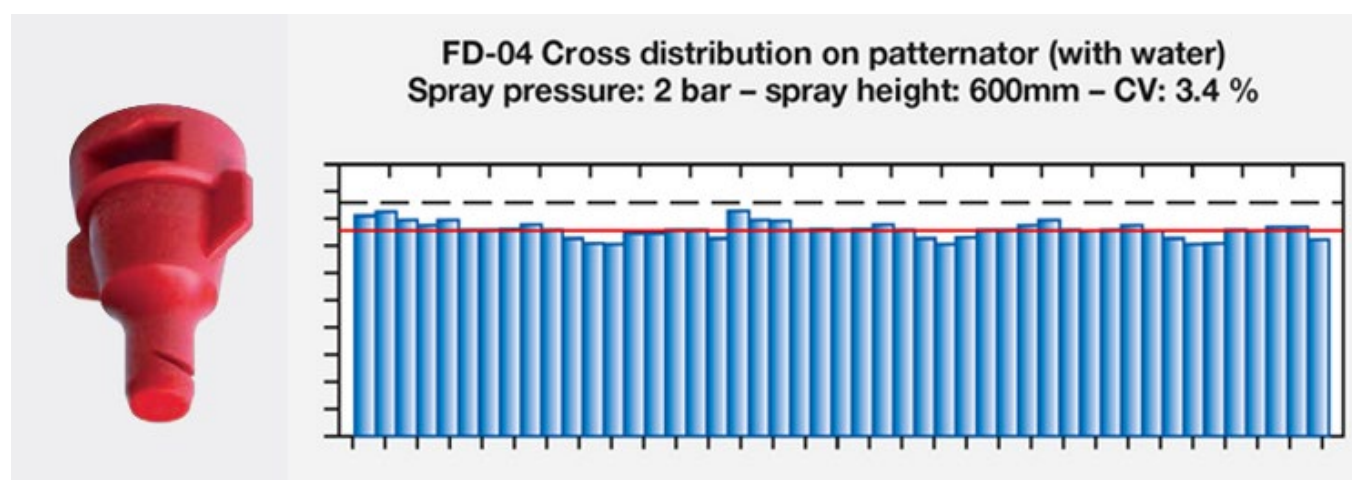


Figure 2 Evenness of spread for a Liquid nutrient nozzle

2.4 Standard Spray nozzles (flat fans)

a. Standard nozzles used for applying agrichemicals may also be used to apply nutrient in some situations. These precisely manufactured hydraulic nozzles are usually at 0.5m spacing along the spray boom and are manufactured in ISO certified facilities. For groundspread they are designed to achieve a coefficient of variation (CV) of

about 6% for evenness of application transverse to the forward movement of the vehicle. This low level of CV requires that all nozzles on the boom are of the same size, produce the same pattern, are arranged correctly on the boom and the boom is operating at an appropriate height above the target.



3. GENERAL

3.1 Manufacturers specifications list pressure and flow expectations by nozzle. For example a typical nozzle might be a Teejet StreamJet SJ7-06—VP. Flow charts show expected flow is 2.01 litres/minute at 2.0 bar. Convention / good practice would be to replace nozzles when flow is 10% higher than design specifications due to wear which affects the flow and pattern emitted.

3.2 Given that nutrient and standard nozzles are fitted at relatively close intervals, are precisely manufactured and meter product at a relatively close distance to the target, pattern testing or testing of individual nozzle flows is unlikely to add significant

value to any testing aimed at certifying evenness of spread.² Certification testing should focus on boom section pressures and comparison of test flow with expected performance.

3.3 Note that longitudinal distribution will be determined by the consistency of the liquid nutrient used and homogeneity of mixing processes.³ Measurement conditions are defined below.

[2] Determining if nozzle flow is within 10% of specifications requires flow tests on individual nozzles. C of V for nutrient nozzles operating in NZ should be carried out during the development of this specification unless this data is available from manufacturers.

[3] Longitudinal distribution is discussed in the existing Spreadmark COP for dry nutrient but no testing procedure or standards are apparent.



4. FACILITIES

For ground spreaders certification tests may be conducted either indoors or outdoors providing all the following specifications are met:

	INDOOR	OUTDOOR
Size	Width sufficient to unfold the spray boom	Width sufficient to unfold the spray boom
Slope	Flat	< 5°
Wind	Nil	< 15km/hr
Surface	Flat and hard	Firm and smooth
Anti-bounce	Water for boom section and nozzle flow tests	Water for boom section and nozzle flow tests
Site usage	Not to exceed local drainage capacity	Not to exceed local drainage capacity



5. TEST PRODUCTS

- a. It is proposed that water is used as the test product in lieu of actual product. Suggested tests are for a stationary sprayer. Safe disposal of liquid nutrients from a stationary sprayer could pose an environmental risk for stationary tests so water is preferred.
- b. Likely application products include nitrogen as the dominant nutrient subject to liquid nutrient application. By default, any nutrients applied as a liquid are dissolved,⁴ dissolved Urea⁵ being the most common.

	%N ⁶	PRODUCT EXAMPLE
1	18	Flow Fert N
2	19	Nrich Liquid Urea
3	?	Dissolved Urea
4	?	Other?

[4] There may be a need to define a liquid as compared with a slurry of fine (ground) particles in water as compared with a sludge. For the former the nutrient dissolves in water whereas for the latter the product remains solid but is in suspension. The concentration or specific gravity of the material in a tank may also indicate liquid versus slurry although some agrichemicals are suspended concentrates but are termed liquid rather than slurry. Viscosity describes the sheer resistance of a fluid.

[5] Common dissolved Urea products contain up to 19% N along with other macro-nutrients such as sulphur and micro-nutrients such as copper.

[6] The proportion of nitrogen on a weight-to-weight basis.



6. TEST CONDITIONS

Two stationary tests are proposed, boom section pressures and combined nozzle flow test. The following conditions must be met for measuring transverse distribution.

Conventional spray boom	Application units shall be clean and in sound working condition. The spray systems must have a display of pressure that can be observed by the operator while applying liquid nutrient. Operators should also be confident their flow meter is accurate and in sound working condition so that target application rates are being achieved. This should be continually tracked by keeping a running tally of volume used and hectares covered. Evidence of the use of an auditable GPS tracking device is mandatory for sprayers that are to have Spreadmark Test Certificates. It is expected that the positioning accuracy of the GPS is to within one metre. The tracking system must be able to verify that the placement of nutrient (mapping) is within the target area and in accordance with the Spreadmark test protocols so that nutrient is not spread into environmentally sensitive areas.
Tank fill	Sufficient to carry out boom sections tests and combined nozzle flow test with water (usually half full).
Application rate	Application rates used during test shall be the typical rates for that product used by the operator ⁷
Wheel speed sensor (groundspread only)	At least 50m distance, preferably 100m distance, average of two runs
Airspeed sensor	Airspeed indicator and means of displaying ground speed

[7] Otherwise, the default nominated test rates shall be:

- 150 L/ha
- 25 kgN/ha



7. MEASUREMENT Techniques

Two tests are proposed to be performed on a stationary conventional boom sprayer.

7.1 Boom section test

Aim: Ensure each boom section is operating at the same pressure.

- a. Application units shall have at least three boom sections and may have up to seven. Unfold the boom and with the nutrient nozzles turned on, run the stationary sprayer at required operating pressure for the selected forward speed and target volume application rate (e.g. 15 km/hr, 150 l/ha).
- b. Once the operator is happy that the system is running at target rate, fit a pressure gauge to each boom section in sequence (suggest work left to right looking forward). Figure 3 shows potential methods for measurement of spray boom pressure. The cap and nozzle are removed, a gauge is fitted and the nozzle is fitted to the base of the gauge.
- c. Record the pressure for each boom section. Boom pressures should be within 10% of each other e.g. range of 0.2 bar for an average pressure of 2 bar.

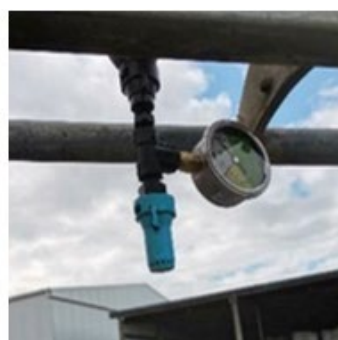
Figure 3 Possible methods set up for boom pressure measurement



Commercially available option (Spot On®, electronic)



AAMS Salvarini (courtesy of M. Keane)



Bottom entry 1/4" Isometric 63 mm Gauge fitted on a 1/4" Tee with Quick TeeJet cap*



Bottom entry standard mechanical 100mm pressure gauge (Silvan NZ)



- d. The test pressure gauge should be calibrated to ensure it is reading true pressure in the target range which is likely to be between 1 and 4 bar. A range on the gauge of 0 to 6 bar would be suitable. Check the test gauge after testing six boom sprayers or more often if necessary and at least annually.
- e. Pressure gauge calibration – Several methods can be used to check the test gauge.
 - On a test rig fit a calibration⁶ gauge and your test gauge with a tee junction. They should read the same pressure at 250 kPa (2.5 bar) within +/- 10 kPa
 - Purchase 5 gauges, compare them on a test rig, choose the most consistent two, one as test gauge and one as a calibration gauge. These two gauges should read within 10 kPa of each other.
 - WIKA brand pressure gauges can be sent to WIKA Instruments Ltd in Auckland for bench testing. A calibration report can be provided. Custom Pressure Systems NZ Ltd also provide a testing service with offices in Auckland, New Plymouth and Christchurch.
 - Other fittings may be needed for systems supplied by other manufacturers eg HARDI, ARAG, BFS.

7.2 Combined nozzle flow test

Aim: Ensure the nozzles are operating within 10% of their specification.

- a. Even application across the width of the boom will be achieved as long as each nozzle is performing as designed and nozzles are at least 0.5 m above the target. The flow meter used by the sprayer controller can be used for combined nozzle flow test for the boom.

7.3 For Stream type and standard nozzles

- a. Check that all nozzles are the same along the length of the boom. Identify the specified flow rate for 2 bar pressure from the manufacturers flow chart e.g. 2.01 litres/minute. Calculate the expected total boom flow per minute (flow per nozzle x number of nozzles) e.g. 48 nozzles x 2.01 litres/minute = 96.48 litres/minute.
- b. With the boom unfolded, fit a pressure gauge to boom section as for 1 (boom section test). Run the sprayer and adjust pressure and flow so that boom pressure is 2 bar. Turn the boom sections off, set the total flow on the controller to zero or record the total flow to date or maybe current tank volume (depends on the controller set up). This is the start volume.

[6] The calibration gauge is likely to be physically larger than a gauge found on a sprayer and should be compared with another calibration gauge annually or biannually. Note 1 bar = 100kPa = 14.5 psi

- c. Turn on the whole boom for exactly 2 minutes. Record the volume sprayed from the controller. Compare this with expected flow per minute x 2. Where the flow is more than 5% different than expected e.g. actual total flow less than 183 litres or more than 202 litres, the flow from some individual nozzles is likely more than 10% different from expected. At this point individual nozzle flow should be checked to identify and replace (or clean) any such nozzles.
- b. Unfold the boom and check that all dribble bars have the same orifice setting. Run the stationary sprayer at required operating pressure for the selected forward speed and target volume application rate (e.g. 15 km/hr, 150 l/ha).
- c. Once the operator is happy that the system is running at target rate, collect the flow from every second dribble bar for with Spreadmark trays or bucket for one minute.⁷ The volume of water collected can be measured with a 5 litre calibrated measuring jug or weighed and used to calculate a CV for evenness of spread across the boom.

7.4 For Dribble bar type nozzles

- a. Dribble or Stream bar type nozzles have manually adjustable flow systems to change orifice size. These systems are not manufactured with the same precision as stream type or standard nozzles so it is not practical to compare actual with expected flows. Also they can be subject to variation in positioning with manual adjustment.

[7] Suggest use a 5-litre jug and collect for sufficient time to fill jug with more than 2.5 litres of water.



8. MEASUREMENT Standards

The following measurements shall be made and recorded for each certification test.

FACTOR	MEASUREMENT	STANDARD
Boom section pressure	Bar or kPa	Test gauge +/-10kPa of calibration gauge
Distribution of boom pressure	Coefficient of Variation	<5%
Combined nozzle flow (stream or standard nozzles type)	Litres/minute at 2 bar nozzle pressure	+/- 5% of manufacturers specification ⁸
Individual nozzle flow (dribble type)	Litres/minute at nominated boom pressure	Measuring jug, 5 litre, calibrated OR scales ⁹ accurate to +/- 10 gm
Distribution of nozzle flow (dribble type)	Coefficient of Variation	< 15%

[8] Manufacturers flow chart per nozzle multiplied by the number of nozzles.

[9] 1 millilitre (ml) of water = 1 gram.



9. SCHEDULE of Tests

The following tests shall be conducted:

For conventional spray boom with standard nozzles:

- Boom section test
- Combined nozzle flow test

For conventional spray boom with dribble bar type nozzles:

- Individual nozzle flow test

All tests to be carried out with water with stationary sprayer.

10. FIELD REPORT

The following records shall be kept for each test:

Identification	Date:				
	Operator:				
	Spreading Unit Unique Identifier:				
	Technician:				
	Location:				
Sprayer detail	Spray Controller:				
	Number of nozzles and spacing:				
	Number of boom sections:				
	Application Volume rate (L/ha)				
	Forward Speed (km/hr)				
	Operating pressure (bar)				
Test Nozzles	Nozzle	Expected flow at 2 bar			
Test Conditions	Spreader condition:				
	Tank size				
	Flow meter calibration value:(pulse per litre)				
	Wheel or air speed sensor calibration value: (pulse per metre, if fitted)				
Certification	Nozzle	Bout width	Application Volume (litres/ha)	Speed (km/hr)	Pressure (bar)



11. CERTIFIED Bout Widths

11.1 The tester will generate a CV for boom section pressures. The Certified Bout Width of a sprayer will be set by the number of nozzles and nozzle spacing where the test result for boom section pressures is 5% or less.

11.2 The tester shall also generate a comparison of measured combined nozzle flow with expected combined nozzle flow for Stream type and standard nozzles at 2 bar boom pressure. The Certified

Bout Width of a sprayer will be set by the number of nozzles and nozzle spacing where the combined nozzle flow test shows the nozzles are within 5% of flow expected by manufacturers.

11.3 The tester shall generate a CV for dribble bars. The Certified Bout Width of a sprayer will be set by the number of nozzles and nozzle spacing where the test result is 15% or less for water.



12. REPORTING

12.1 Approved Spreading (Spraying) Unit Testers will, at the conclusion of the test, produce a Spreadmark Sprayer Performance Certificate. The Spreadmark Sprayer Performance Certificate must show, at least:

- a. The spraying company name, a vehicle or spreading unit unique identification number, sprayer and tank size.
- b. The boom section pressures.
- c. Comparison of combined nozzle flow with manufacturers expected combined flow.

d. The Certified Bout Width for each nozzle tested.

e. The date of the test and the expiry date of the certificate. The expiry date shall be two years after the date of the test.

f. The certified application rate for each nozzle.

12.2 On completion the Sprayer Performance Certificate will be sent to the company with a copy to the Auditor.



www.fertqual.co.nz