Teagasc
Agriculture and Food Development Authority

Precise Application of Fertiliser

The Fertilizer Association of Ireland in association with Teagasc

Technical Bulletin Series – No. 3

May 2017

Steps to precise application of fertilisers

1. Select a fertiliser spreader capable of even spreading at the desired bout width with the fertiliser types to be used. Check spread pattern and CV values from independent or manufacturers tests.

2. Select fertiliser that has good spreading characteristics with at least 80% of the granules in the 2 - 4 mm size range and preferably smooth round shapes.

3. To ensure an even spread across the bout width, use the spreader manufacturer's resources such as instruction manuals, internet material or phone apps, to set the spreader accurately for the fertiliser being used. To apply the correct rate of fertiliser, the spreader should be calibrated, using the manufacturer's resources as a starting point.

4. Clean after every working day and protect from corrosion. Check - all the spreading components for wear frequently.

Table of Contents

1. Introduction

The role of the fertiliser spreader is often under estimated in the delivery of fertilisers (N, P & K) as evenly and as accurately as possible. Fertilisers are a significant cost in grassland and tillage farming systems, representing between 20 to 30% of total production costs for either a cereal or grass silage crop. There are many steps involved in determining the actual rate of fertiliser from soil sampling to preparing a fertiliser plan. To profit from fertiliser planning it is essential that fertilisers are applied precisely and accurately. There are a number of factors to consider before spreading fertiliser such as:

1. Selecting the correct machine for the bout width and fertiliser to be used
2. Using good quality fertiliser
3. Correct setting of the machine

Technical bulletin No. 3 produced by the Fertilizer Association of Ireland in conjunction with Teagasc identifies the steps to consider for the precise application of fertilisers to optimise farm profitability and sustainability.

Authors: Dermot Forristal and Mark Plunkett, Teagasc.
Supporting material provided by Stuart Goodwin, Kildalton College and Trevor Richardson, Atkins Farm Machinery.

2. The Fertiliser Spreader - Machine Design

Fertiliser spreader developments in recent years have mainly been focused on twin-disc spreading units. The widely used spout type spreading mechanism (wagtail) has practical limitations to spread width and is usually limited to 9 to 12m working widths. Single disc spreaders tend to have a one-sided spread pattern. The more complex pneumatic spreader, while useful in windy conditions, has all but disappeared from the market because of its cost.

Spreaders have also increased in capacity with larger tractors able to carry up to 3 tonne mounted machines, and trailed spreaders with many times that capacity for contractors and larger farmers providing efficient transport.

While most spreaders sold today are twin disc machines, there are huge variations in their design which impact on how wide and evenly they can spread fertiliser. The design of the discs, spreading vanes and fertiliser drop-point determine how the fertiliser is thrown and consequently the shape of the spread pattern. There are substantial differences in spreading performance between machines from different manufacturers and even between models within manufacturer's ranges.

Manufacturers have pursued wider bout widths, with 24m, 30m and even 40m wide spreading capability claimed. While the greater widths can be achieved in test halls with perfect conditions, they present a challenge in real fields.

Choosing a fertiliser spreader

The most important aspect to consider when choosing a fertiliser spreader is its ability to spread the types of fertiliser to be used at the desired bout widths, evenly. This is determined by the spread pattern of the machine. The spread pattern is assessed by a full tray test where every 0.25m or 0.5m width of the spread pattern is measured. The weight of fertiliser from each 0.25m or 0.5m wide tray is weighed and the evenness is assessed by the shape of the plotted graph and the calculated coefficient of variation (CV).

While many manufacturers have sophisticated testing facilities allowing them to rapidly carry out full evenness testing, they will tend to show the better results in their sales literature. Always look for and attribute a higher value to independent tests.

Figure 1:- Fertiliser spreader developments have been mainly confined to twin-disc units over the last number of decades.

What is the Coefficient of variation (CV)?

The Coefficient of Variation (CV) is a measure of how evenly the fertiliser spreads; the lower the value, the more even the spread. Fertiliser manufacturer's complete spreader testing under perfect conditions in test halls where CV values of less than 5% can be achieved. However, this can deteriorate in the field where values up to 15% are acceptable but once the CV goes above 20% a crop and financial loss will result.

Spread pattern shape The triangular shape of the spread pattern as shown in figure 2 indicates that the fertiliser spreader will have a forgiving pattern and be less sensitive to wind or fertiliser quality variation than a more shouldered pattern. The more shouldered pattern in figure 3 indicates a need for very carefully setting to

suit the fertiliser characteristics and spreading conditions. Better spreaders should have both a low CV and a good basic spread pattern – and these should be verified by an independent test.

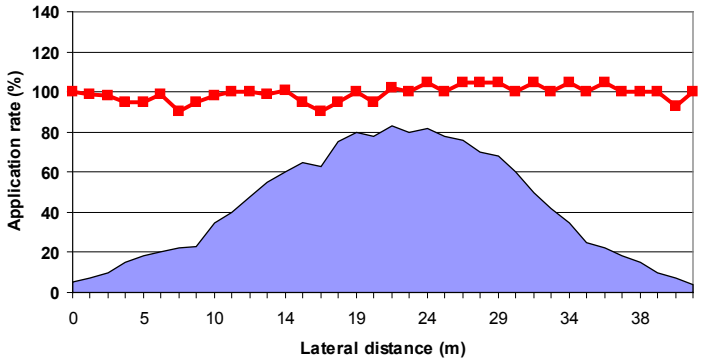


Fig.2: Basic (shaded area) and overlapped (line) spread pattern at 18m: Good pattern.

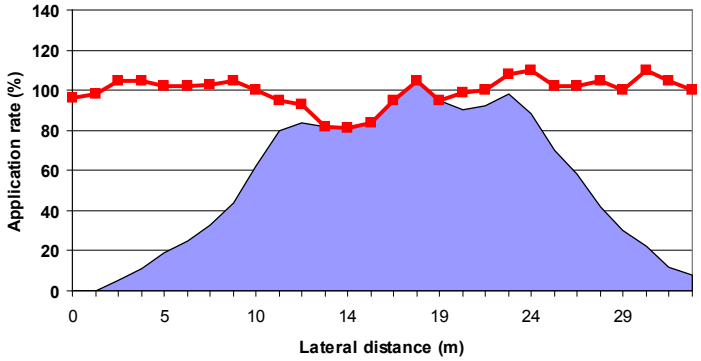
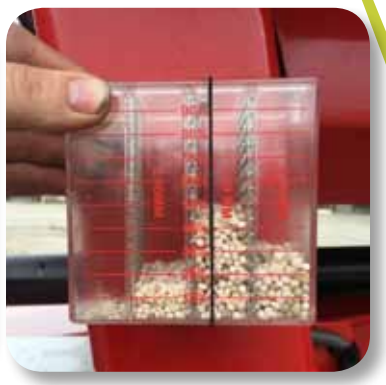


Fig.3:- Basic (shaded area) and overlapped (line) spread pattern at 18m: Poor pattern.

3. Fertiliser Quality



80% of fertiliser granules should be in the 2 to 4 mm range

Fertiliser Characteristics

The physical characteristics of the fertiliser will affect how evenly it spreads and the settings required. The key factors are:

- ***Density of the fertiliser***: Low density fertiliser such as urea (80% normal density), is more difficult to throw
- ***Size of the granules***: Generally larger particles will throw further. Particle size distributions with the majority of particles (80%) in the 2-4mm range will usually allow a good spread to be achieved, but larger diameters (3 – 4.5mm) will probably make it easier achieve wider spread widths. The component parts of blends should ideally have similar size distributions
- ***Shape of the granule***: Rounded particles will roll off the disc more predictably than irregular granules or angular particles
- ***Strength / hardness of granule***: Strong particles will resist break-up on the disc

Stripping in a crop of spring barley due to incorrect fertiliser spreader setting.

Some fertilisers are produced as rounded prills. As long as the density of the product is high and the size distribution is correct, prills will spread at least as well as similar sized granular products.

The importance of physical quality depends on the bout width being used and the spreader. Generally wider bout widths require better physical quality. When purchasing fertiliser, always take physical quality (size distribution, density and strength) into account by asking the supplier for these figures and check the quality using simple sieve boxes and strength testers supplied by spreader manufacturers. These tests can later be used to set the spreader for the particular fertiliser and bout width (see section 4 – Setting the fertiliser spreader).

Granules – Large **Prills- Large** **Prills- Small**

Figure 4:- Fertiliser types

Urea

Urea has lower density which presents a greater spreading challenge and it usually will not spread as wide as denser material. Urea has a particle density of 0.7 to 0.8kg/L while other fertilisers such as CAN have a density of 1.0kg/L. Always look for a urea product with larger particle sizes by asking the supplier for the size distribution figures. Even with a good size distribution it is vital that the correct spreader setting is used and that the limitations of the spreader with urea are observed (maximum bout width etc.). Wind will affect urea more than ordinary fertiliser, so spread in calm conditions if possible.

Blends and granule sizes

A fertiliser with a single nutrient e.g. CAN does not have to have all particles of a similar size; a range of particle sizes can result in an acceptable spread provided very few are below 2mm diameter. Where fertiliser blends are used, then the different nutrient components of the blend must spread similarly, and ideally, have similar size

distributions. Variations in shape of the blend components are not unusual, but the onus should be on the supplier to ensure that all will spread similarly. Blends of urea and conventional density fertiliser need to be considered very carefully to ensure the blend has good spread characteristics. Proper size matching of particles (larger urea with smaller dense fertiliser particles) can help even spreading, but the onus is on the fertiliser supplier to show that this can be achieved.

4. Setting the fertiliser spreader

There are two elements to getting fertiliser spread evenly at the correct rate in the field:

- Setting the spreader to spread evenly with a particular fertiliser at a specific bout width
- Calibrating the spreader to spread the correct rate of fertiliser

Setting for even spreading

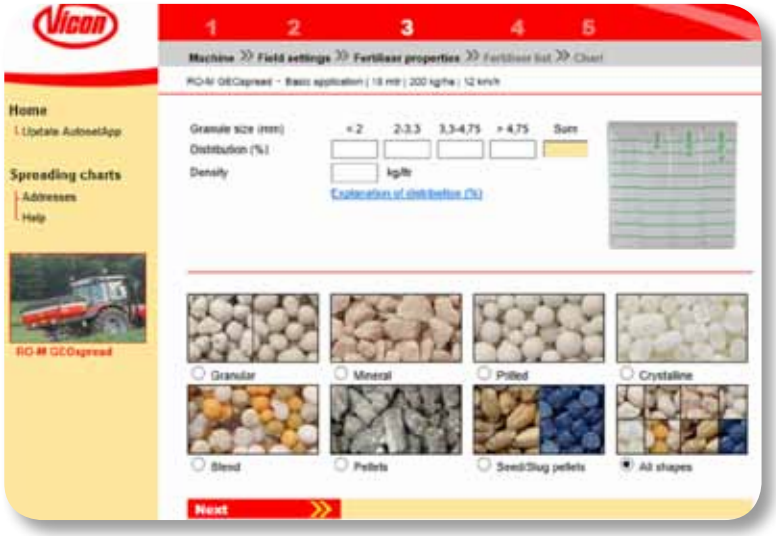
Most modern spreaders need some level of setting or adjustment to enable them to spread different fertilisers at different bout widths. The elements that may be set depending on the machine design include:

- Disc type and speed
- Vane type and position
- Fertiliser drop point on the disc
- Height above crop
- Spreader angle e.g. tilting discs upwards at back to throw further

The setting needed is machine specific and is based on the type of fertiliser being spread and the bout width chosen. Basic information is given in the instruction manual, but increasingly either spreader manufacturer websites or phone apps are used to allow the operator easily access up-to-date setting information.

Typically the operator is asked to identify the fertiliser being used by brand name or, by determining its size distribution (simple sieve box test), granule strength

(simple pen-type tester), density (urea or not) and granule shape (photos). The desired bout width is also entered in the app or web page. From this information an appropriate spread chart is selected and the spread element settings (discs, vanes, drop point etc.) are given. Usually a rate setting guide is also given once the desired rate in kg/ha is entered.



With some spreaders at wider bouts, it is necessary to carry out partial tray tests to check that the settings are correct. Typically 2 to 4 parts of the spread pattern are checked by placing trays in these positions and checking that all collect a similar amount of fertiliser. The spread pattern can be adjusted if they are not similar.

Tray Testing

The evenness of fertiliser spreading (spread pattern) can be assessed by collecting spread material (fertiliser) in a series of trays laid out across the bout width. For a complete spread analysis a full set of 0.25m or 0.5m wide trays laid out across the bout width for a total width of between two and three times the expected bout width is required. Level ground and wind free conditions are also essential. Following spreading over the trays, fertiliser is collected and weighed and from this single pass, the overlapped pattern can be generated and CV's calculated. This level of testing is rarely carried out in the field.

A faster but less accurate tray test is to place one tray every two meters between the bouts and to measure the overlapped pattern by pouring the fertiliser from the trays into a number of small cylinders which reflect the spread pattern. A less accurate CV value can be calculated from these figures.

Finally a simple machine specific tray test can be carried out by using trays in 2 to 4 parts of the spread width to indicate if the spreader is set correctly (figure 5). This may not give an accurate assessment of the overall pattern.

Figure 5:- Tray testing during the season can reveal exactly how fertiliser is being applied. Place trays every 2 to 3 metres across the spread to get a measure of spread pattern.

Figure 6:- Examine the fertiliser granule distribution in the trays and then take fertiliser from trays and weight

Figure 7:- Collecting tubes show spread pattern from tray test and evenness of fertiliser application.

Border spreading

Spreading evenly to the field boundary presents a particular challenge for broadcast spreaders which in their normal field spreading mode would waste considerable fertiliser on the headland and have less fertiliser on the crop. Manufacturers now deploy a range of mechanisms to modify the pattern to give a relatively even spread without losses.

These include: changing discs or vanes; tilting the spreader down at the boundary side; changing disc speed; reversing disc direction or changing drop point to use a different disc vane; adding a deflector to modify the particle throw etc. With all broadcast spreaders, headland mechanisms are essential.

Even spreading on headlands and short ground

Achieving even spreading on the field headland where the field runs meet the boundary run can be quite challenging as the operator struggles to turn on or off the spreader at the correct distance from the boundary run. GPS based switching can automate this process and improve accuracy on wide spreading machines. Similarly, on partial bouts where the bout width is narrowing (short ground), it can be difficult to get the correct rate and even application. Modern spreaders offer position based technology which can effectively shut down the rate and, where necessary, the working width in these areas.

Figure 8:- Fertiliser spread pattern where boundary mechanism not in place

5. Calibration of fertiliser spreader

Calibration of fertiliser spreaders is essential for accurate application rate of fertiliser.

Fertiliser **application rate** is affected by

- Bout Width
- Forward Speed
- Regulator Setting

- **Bout Width**

Bout width is the distance from the centre of one tractor pass to the centre of the previous tractor pass. Spreaders can be set for different bout widths; the bout width is a key element for application rate setting.

The accurate application of fertiliser over the working width depends on how accurate the bouts are. With cereals, tramlines ensure constant bout widths. On bare soil or on grassland, either the bouts must be marked temporarily or a GPS guidance system should be used. Trying to estimate bout widths of more than 10m by sight is risking accuracy.

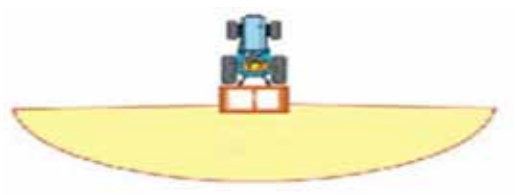


Figure 9:- Determine fertiliser spread width

- **Forward Speed**

It is essential to have an accurate forward speed measurement, whether your tractor gives a direct speed reading or its read from a chart in conjunction with a tachometer (rev counter). The tractor's speed measurement should be calibrated as tyre sizes and other factors will impact on accuracy. This is carried out by measuring a precise distance (e.g. 100m) and timing the tractor as it passes the start and finish of that distance. For example if it took 50 seconds, then its speed is 2m/s or 7.2 km/h (m/s x 3.6 = km/h). Various GPS based devices can give a forward speed measurement. Similarly an accurate indication of pto speed is essential to allow the spreader to be operated effectively.

- **Regulator Setting**

Regulator setting of the shutter controls the amount of fertiliser leaving the hopper to the discs or spout. The wider the shutter opening, the higher the application rate will be.

Calibration Procedures

Fertiliser flows at different rates depending on humidity, granule shape and size. The machine handbook, mobile phone applications, and fertiliser databases on the internet from manufactures give approximate guides to operators for regulator settings.

Calibration of different spreader makes and models will vary. The spreader manufacturer's instructions should be followed in all cases.

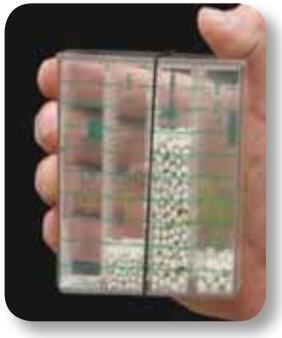


Figure 10:- A fertiliser sieve test will determine the fertiliser quality. Aim for granules of 2 to 4mm in size.

Static Calibration Method

Some spreader manufacturers allow a static calibration where a collection device is attached and flow rate is measured over a set time using a stop watch and scales. The discs or vanes may need to be disconnected.

As an example, if the flow rate for the machine is measured at a particular regulator setting the rate per ha can be calculated from the formula:

Fertiliser Calibration Formula

$$\text{App. Rate kg/ha} = \frac{600 \times \text{Flow rate (kg/min)}}{\text{Forward Speed (km/h) X Bout width (m)}}$$

Figure 11:- For twin disc machines multiply fertiliser weight by to 2 to get application rate.

Technology and calibration aids from manufactures have greatly aided this process. Check manufactures online support and mobile phone apps when calibrating your fertiliser spreader.

More high spec machines at the top of the market offer self-calibrating options, which involves weigh-cells and forward speed sensors to monitor and adjust the regulator setting on the machine while in work.

Figure 12:- In cab controls to change fertiliser spreader application rates

Preparing the tractor and fertiliser spreader for work

Before spreading the tractor and spreader should be checked and set-up according to the manufacturer's instructions. While this will vary from machine to machine the following should be checked:

- Tractor forward speed and pto speed indicators working or tachometer working with speed chart.
- Adequate front ballast for stability
- Spreader attached securely to tractor; level from side to side and centred (link arm stabilisers); top link in correct position to minimise spreader angle changes and correct length for required spreader angle
- Lift controls set to allow correct disc height (as determined by the manufacturer) from crop or ground
- PTO guard intact and secure and all other guards in place
- Check vanes, discs, agitators and shutters/outlets for wear
- Lubricate as per instruction manual

6. Loading the fertiliser applicator

When handling fertiliser great care should be taken to ensure personal safety. Fertiliser can be handled in small bags (50kg), large bags (375-500kg) or as a bulk product.

Fertiliser in 50 kg bags is heavy for manual lifting; back injuries are common place when handling such loads. Use safe lifting and handling techniques.

Big bags of fertiliser can be handled with a front loader, self propelled loader or rear-mounted bag lifter. Avoid excessive speed and distance when travelling with big bags of fertiliser on the loader.

When opening the bulk bags never stand underneath the bags/loader, use a knife with a long handle to open the bag from one side to avoid crushing and fatal injuries.

Loose ‘bulk’ fertiliser is a safe cost effective alternative to bagged fertiliser where it can be handled on farm. The use of contractors to spread fertiliser using large trailed machines with bulk fertiliser is common in some situations, but the onus is still on the farmer to ensure the job is done satisfactorily.

7. Preparing the fertiliser spreader for storage

Fertiliser is corrosive so it is vital to clean the spreader after use and lubricate / protect according to the manufacturer’s instructions. Store the spreader safely.

Notes

Sustainable Grassland 2017

Building on our Natural Advantages

Precise Application of Fertiliser

Technical Bulletin Series – No. 3

May 2017

The Fertilizer Association of Ireland in association with Teagasc

www.fertilizer-assoc.ie

Design & Print Modern Printers 056 7721739