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# THE EFFECT OF INCREASING WINDS ON THE DISTRIBUTION OF OVERSOWN SEED AND FERTILISER

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**Abstract**

Distribution patterns of white clover, perennial ryegrass and cocksfoot were measured when oversown with granulated superphosphate in contrasting cross wind speeds, under both airfield and hill country conditions. Increasing velocity of cross wind reduced the variability of spread of all components. Swath width increased, and maximum seed rate declined, with increasing cross wind. Some separation of seed types occurred, with the tighter fractions being moved further downwind. Measured distribution patterns from single flights were used to estimate paddock scale applications by overlapping swaths at normal flight path spacings for a Fletcher FU24-950 aircraft (12 m centres). The proportion of land receiving less than half the target application rate declined from 50%, under near calm conditions, to nil, under conditions of medium cross winds (e.g. 10-12 km/h).

Wind is therefore adesirable factor during oversowing operations and significantly reduces variability of overall distribution.

Keywords: hill country. superphosphate, PAPR, oversowing, topdressing

## INTRODUCTION

Previous studies of seed andlor fertiliser distribution, have mainly been carried out in calm or near calm conditions, (Campbell 1948, Greenall *et al.* 1952, Miller & Mountier 1959, Scott 1970ab, Scott and Grigg 1970). However, most hill country topdressing and oversowing takes place in wind conditions of 5-35 kmlh. Air turbulence rather than actual wind velocity is the factor that usually limits aerial operations.

Scott (1970ab) concluded that granulation of superphosphate decreased swath width, increased the peaked nature of the swath and aided pilot accuracy in placement. Because granulated fertiliser became segregated from seed, and grass seed separated from legume seed, Scott (1970b) concluded that seed and fertiliser should be sown separately. Scott (1970b) and Scott & Grigg (1970) also concluded that cross winds did not effect swath peak or width. However, Scott (1970b) considered that their experiments were not carried out in a large enough range of cross winds to adequately examine cross wind effects.

With the increasing use of more uniformly granulated high analysis fertilisers such as PAPR (partially acidulated phosphate rock), it is now important to clearly understand the factors involved in the patterning of seed when oversown with granulated fertilisers.

This paper reports results from flights carried out to measure the effects of increasing cross wind on the individual component swath patterns of oversown seed and fertiliser. Seven flights were made under airfield conditions and three similar subsequent flights were made in hill country to compare with airfield findings. Swath patterns were then used to model overall paddock distributions under a range of cross wind conditions.

## MATERIALS AND METHODS

Superphosphate was sieved to provide 94% of granules in the range 2-5 mm, to simulate the particle size distribution of PAPR. Bare seed of white clover, perennial

Table 1: Individual mean seed weights and rates of application of seed used in distribution trials.

| Seed type | Mean seed weight mg | Application rate kg/ha |
|---|---|---|
| White clover | 0 67 | 2.4 |
| Perennial ryegrass | 2.20 | 6.4 |
| Cocksfoot | 0.81 | 2.8 |

ryegrass and cocksfoot were each dyed a different colour to enable easy identification before mixing with fertiliser (Table 1).

For airfield trials three parallel rows of 25 funnel shaped collectors were placed at 50 m intervals on a grassed runway at Gisborne airport. Each collector was 50 cm diameter with a 30 cm high collar to prevent particles bouncing out. Within-row spacings of collectors was 1.5 m for low cross wind conditions and 2.0 m for high cross wind conditions. In hill country a single row of 75 collectors was spaced at 3 m intervals down a hill slope. Horizontal distance between collectors averaged 2.3 m.

A Fletcher FU24-950 topdressing aircraft, fitted with clamshell hopper doors (Easton Box), flew across each row over a nominated collector. The hopper doors were opened 100 m before the first row and closed 100 m past the last row. Flight height was determined trigonometrically from photographs, and the aircraft ground speed calculated from elapsed time over 300 m.

Seed was applied with fertiliser at 250 kg/ha and oversown at wind speeds ranging from 0.6 to 12.6 km/h (Figure 1). Under significant cross wind conditions (>5.0 km/h) all flights were made at 20-24 metres above ground level. Wind speed and direction, 2 m above ground level was averaged at 10 second intervals during each flight and the cross wind component (wind vector at right angles to the flight path), of total wind speed was derived for each flight.

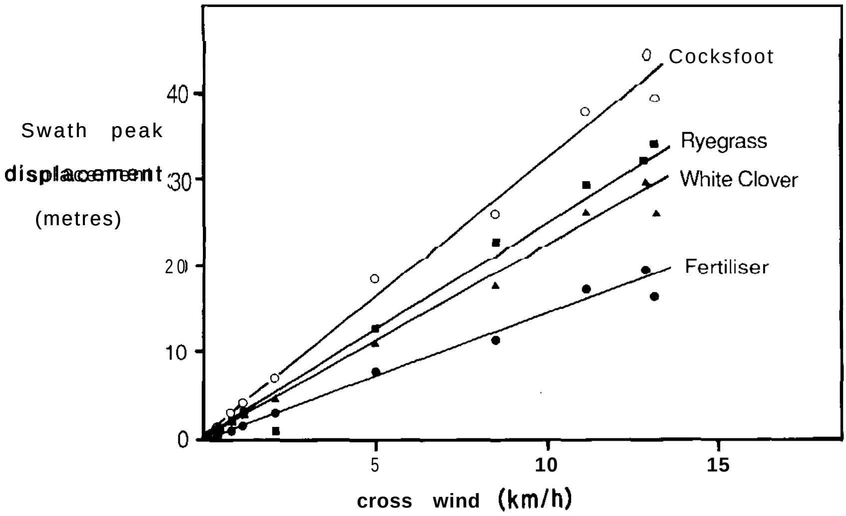


Figure 1: Estimated down wind displacement of swath peak from centre of flight path, for pasture seeds and fertiliser when oversown together in cross winds of 0 to 13 km/h from altitudes of 20-24 metres above ground.

Seed and fertiliser in each collector were removed after each flight, seeds counted and fertiliser weighed. Swath patterns were derived from the mean of each collector for the three rows on the airfield and from the single row in hill country. Results from all flights were used to develop relationships between the distance of swath peak displacement downwind from the aircraft flight path for each seed or fertiliser type.

For contrasting cross wind conditions, estimates of paddock scale distributions of individual components of seed or fertiliser, were obtained by overlapping single swaths at 12 m centres (standard flight path spacing for a Fletcher FU24-950). Maximum and minimum rate of application, together with an estimate of the proportion of land receiving less than half the mean application rate for each component, were determined.

## RESULTS AND DISCUSSION

As cross wind increased seed and fertiliser components landed further down wind from the flight path. Cross wind speed and swath peak displacement were closely related for all components (Figure 1). For flights made in cross wind conditions of 0.6 to 12.6 km/h down wind displacement of each fraction was related to cross wind by the following equations.

| | | |
|---|---|---|
| White clover displacement (m) | = 2.3 • cross wind (km/h) | $r^2 = 0.97$ |
| Ryegrass displacement (m) | = 2.5 • cross wind (km/h) | $r^2 = 0.97$ |
| Cocksfoot displacement (m) | = 3.3 • cross wind (km/h) | $r^2 = 0.97$ |
| Fertiliser displacement (m) | = 1.5 • cross wind (km/h) | $r^2 = 0.92$ |

The strong relationship of swath peak displacement with cross wind, was evident for all seed types and fertiliser. This has enabled some confidence in selection of individual flights to illustrate swath patterns that are achieved when oversowing in calm, low and moderate wind conditions.

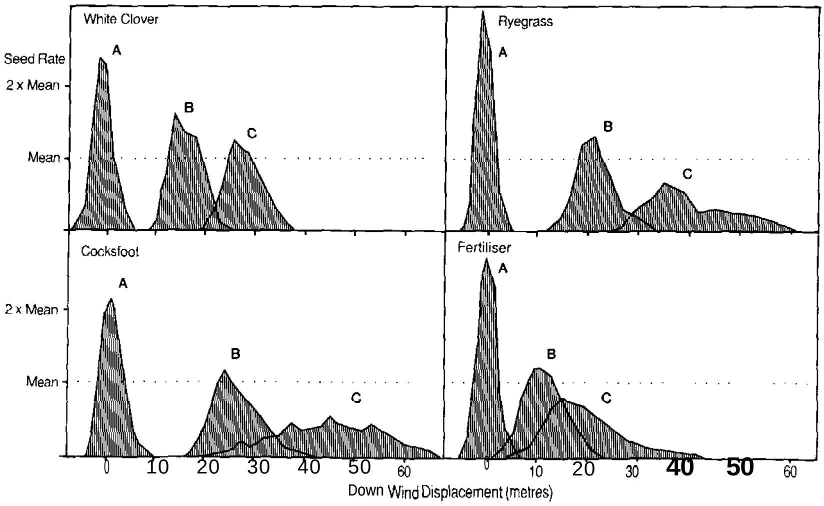


Figure 2: Swath shape and displacement for each species and fertiliser, when oversown in cross winds of 1.6 (A), 8.6 (B), and 12.6 km/h (C) measured in airfield trials. Centre of flight path = 0 metres.

The ordering of seed placement is related to their free fall terminal velocities (Scott 1975). Fertiliser granules landed closest, while white clover, ryegrass then cocksfoot fell successively further downwind from the flight path (Figures 1 & 2). For example when seed was oversown with fertiliser in near calm (0-1 km/h) conditions, the swath centres of all components were within 2 metres of the flight path centre.

When oversown in a 12.6 km/h cross wind, the swath centre of white clover moved 26 m, ryegrass 30 m, and cocksfoot 39 m down wind. Under increasing wind conditions, the swath patterns of individual components of the seed/fertiliser mix produced bell shaped distributions that closely resembled normal distributions (Figure 2). As cross wind increased the peak rate of seed applied decreased and the swath width increased. This occurred for all seed types and for fertiliser. Some skewness of individual distribution patterns occurred. This appeared due to differential segregation of contrasting particle sizes within the seed or fertiliser type (Scott 1975, Gillingham *et al.* 1985).

Results obtained from three hill country flights under low cross wind conditions (0.6 to 1.6 km/h) did not differ significantly from results obtained in the airfield tests under similar wind conditions, and were included in the data used to derive the relationships in Figure 1. This indicates that similar factors were effecting distribution in hill country and on the airfield.

Figure 3 shows the effect of overlapping swaths of uncoated white clover seed on the paddock scale distribution. In conditions of nil or low cross winds, the overall paddock distribution was very uneven (Flight A). Due to the narrow individual seed and fertiliser swaths (Figure 2) and their very peaked shape, some land areas received 3 times the target rate (e.g. perennial ryegrass), while large areas (3050%) received less than half the mean rate (Table 2). At a cross wind of 12.6 km/h (Flight C), the combined effect of a smaller peak height with an increased swath width lowered the maximum application rate from 2.3 times to 1.3 times the mean. A corresponding increase in the minimum application rate occurred i.e. from 0.20 to 0.56 of the paddock mean, for flights A & C respectively. At an intermediate level of cross wind (Flight B) intermediate effects generally occurred (Table 2). These effects were similar for all components of the oversown seed and fertiliser mix.

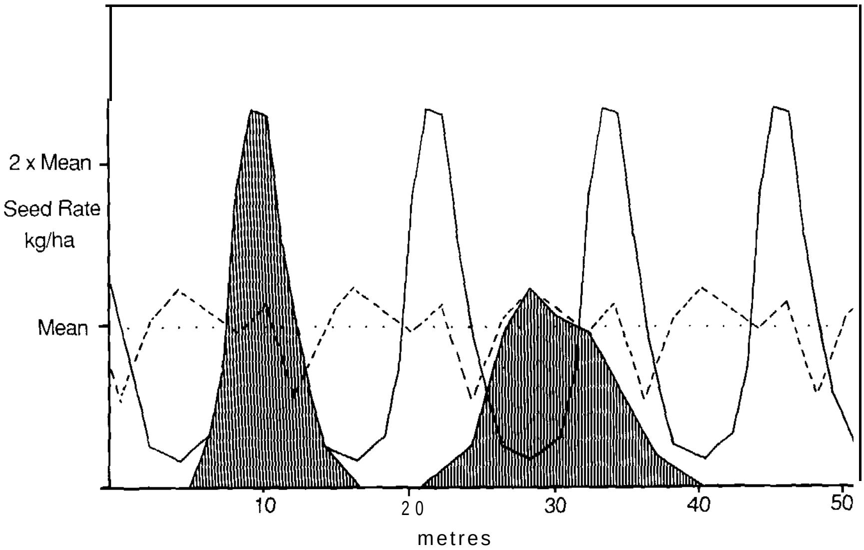


Figure 3: Overall estimated paddock arsrribution of white clover seed oversown in 1.6 km/h (flight A – solid line) and 12.6 km/h (flight C – dashed line) cross wind. Showing effect of swath pattern (shaded) on overall distribution.

In a hill country study Charlton and Grant (1976) found that over 50% of collectors placed throughout the block being oversown, received less than half the

Table 2: Maximum and minimum deviations from the mean application rate (Mean = 100) and % of land receiving less than half target seed application rate, for paddock distributions modelled from single swath pattern of each seed type

| Distribution | White clover | Perennial ryegrass | Cocksfoot | Fertiliser |
|---|---|---|---|---|
| Flight A — 1.6 km/h cross wind | | | | |
| Maximum | 237 | 300 | 214 | 270 |
| Minimum | 22 | 0 | 4 | 4 |
| % rec.<½ | 42 | 55 | 38 | 60 |
| Flight B — 8.6 km/h cross wind | | | | |
| Maximum | 158 | 140 | 136 | 163 |
| Minimum | 30 | 56 | 66 | 66 |
| % rec.<½ | 11 | 0 | 0 | 0 |
| Flight C — 12.6 km/h cross wind | | | | |
| Maximum | 137 | 138 | 149 | 181 |
| Minimum | 56 | 64 | 77 | 48 |
| % rec.<½ | 0 | 0 | 0 | 0 |

mean application rate of white clover seed. In the present study estimates of white clover, ryegrass and cocksfoot distribution, under low wind conditions predict a similar figure (i.e. Flight A, Table 2).

Estimating overall paddock distribution by overlapping swaths at regular spacings has been used as a standard means of estimating practical implications of swath patterns (Greenall et *al.* 1952). It does however assume no pilot error in maintaining accurate track spacings, no variation in spread along the flight path and constant wind. Although not entirely realistic, this approach does provide a good measure of the relative importance of pilot accuracy for any wind conditions. Deviation from parallel, equally spaced flight paths will have the largest effect on distribution in conditions of nil or low cross winds. Due to the narrow, peaked nature of the swath pattern, excessive overlapping of flight paths will, under these conditions, result in some areas receiving greatly excessive amounts of seed and fertiliser, while others will receive little or no seed. As cross wind increases, the relative importance of pilot deviation from the desired track spacing decreases. This is due to increasing swath width with increasing cross wind. Once swath width becomes several times wider than track spacing (e.g. flight C, ryegrass, cocksfoot and fertiliser), the overall distribution is made up of many overlaps. Hence small variations in track spacing will have a reduced effect on distribution, than where swath width is approximately the same as track spacing.

Accuracy of placement has been a priority consideration in some studies (Scott 1970b, Scott & Grigg 1970). However, the present study suggests that pilot accuracy in flying parallel, equally spaced swaths is of greater importance than accurately defining the placement of material. Only at the up wind and down wind boundaries should the flight pattern be altered to limit application to adjacent areas. Altitude could be lowered to aid placement near boundaries.

## CONCLUSIONS

1. In conditions of little or no cross wind it is extremely difficult to achieve satisfactory overall distributions of both seed and fertiliser when flying at standard track 12 m spacings. Overall distribution can be improved in such conditions by reducing flight track spacings and associate seed and fertiliser hopper flow rates. This will, however result in increased application costs.
2. Although individual seed and fertiliser components of oversowing mixes will segregate in conditions of moderate to high cross winds, this still results in very good overall paddock distribution, so long as accurate flight path spacings are maintained.

3. The beneficial effects of cross wind reduce the dependence of precise track spacings, and in fact a better spread could be obtained by a less accurate pilot in windy conditions, than by a accurate pilot in calm weather.

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