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AIR SEEDER TESTING

by

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SUMMARY:

Laboratory and field test procedures used in evaluating air seeders are discussed. Distribution uniformity, seed depth placement uniformity and fertilizer banding capability results are given for three air seeders. Comparisons to hoe drill seeding are also made.

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AIR SEEDER TESTING

INTRODUCTION

The use of air seeders (pneumatic applicators) for applying seed and fertilizer offers several advantages over conventional seeding methods previously used on the prairies. These include the ability to cover large areas between tank fillings, reduced field operations, simple hook-up and transport of wide implements, fewer moving parts for reduced maintenance and breakdowns and multiple uses for conventional cultivators.

With the introduction of increased numbers and types of air seeders to the Canadian prairies' machinery market, much interest has been generated concerning field performance of these applicators.

During the 1980 crop season the Prairie Agricultural Machinery Institute became involved in the evaluation of three air seeders. This paper discusses some of the aspects of pneumatic application of both seed and fertilizer which are important in terms of field performance, and summarizes the results obtained in the air seeder evaluation.

EVALUATION PROCEDURES

The air seeders evaluated were initially inspected and set up in accordance with the manufacturer 's instructions. Manufacturers were encouraged to have a representative present at any time throughout the evaluation period, and especially during the initial stages to ensure proper applicator set-up and operation.

LABORATORY EVALUATION

The air seeders were set up in the laboratory for evaluation of metering accuracy and calibration. Distribution uniformity at various application rates was determined. In addition, the effect of ground speed, slope, field roughness and depth of material in the tanks on metering rate were simulated in the lab.

Distribution Uniformity: Laboratory tests were conducted to determine uniformity of material application across the width of the machines. Material samples were collected and weighed from each individual shank outlet (FIGURE 1) at various application rates. The coefficient of variation was obtained for each application rate in wheat, barley, oats, rapeseed and 11-51-00 fertilizer on three machines as follows:

$$\text{Coefficient of Variation (CV)} = \frac{\text{standard deviation of sample weights (g)}}{\text{average sample weight (g)}} \times 100$$

The Prairie Agricultural Machinery Institute has accepted as its basis for rating uniformity of distribution for seeding implements, the following rating scale:

CV greater than 15% - unacceptable
CV between 10 and 15% - acceptable
CV less than 10% - good

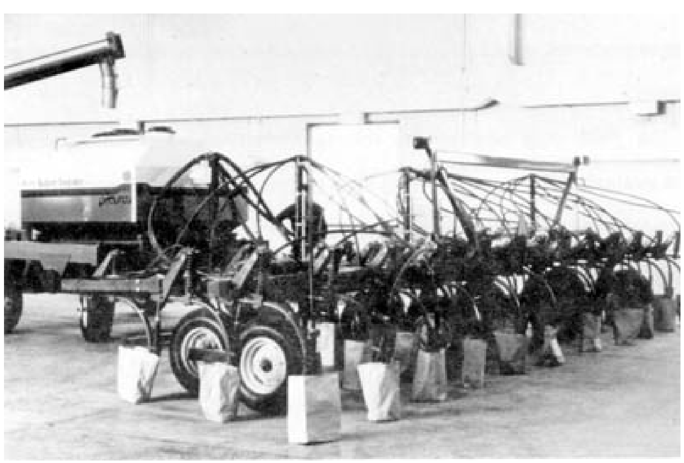

FIGURE 1. Distribution Uniformity Determination.

FIELD EVALUATION

The air seeders were operated in a variety of field conditions to apply seed only, seed and fertilizer together and for banding fertilizer. Ease of operation and adjustment, rate of work, quality of work, power requirements and operator safety were evaluated.

Seed Placement: Upon emergence of the crop, seed placement measurements were taken on level and gently rolling field areas. Seed depth measurements were taken randomly across the width of the cultivator at intervals varying from one to three shank spacings for each cultivator. Plants were removed from the seedbed and the distance from the seed to the point at which the plant emerged from the soil surface was recorded (FIGURE 2). This was done for two widths of the seeding implement at each of three locations in each field seeded. The mean and standard deviation of depth measurements were determined for each set of data taken.

FIGURE 2. Seed Placement Measurements.

Fertilizer Band Placement: Banding is a relatively new method of fertilizer application on the prairies. Experimental results suggest that placing fertilizer in compact bands from 35 mm below seed depth to twice seed depth is desirable for fall fertilizer application. This necessitates the use of chisel points to obtain sufficient depth and minimize soil disturbance and special boots to minimize fertilizer spreading behind each shank.

The two air seeders evaluated in con junction with heavy duty cultivators were setup for banding with the manufacturer's banding boots attached to cultivator chisel points. Fertilizer banding was not done with the air seeder mounted on a field cultivator due to its light duty cultivator shank characteristics.

Fertilizer band placement measurements were taken in the field for the two machines used for banding. A shop vacuum was used to remove loose soil from around the fertilizer band within the shank furrow. Fertilizer band dimensions were measured and recorded at various locations in each field.

EQUIPMENT EVALUATED

FRIGGSTAD PA1-40 PNEUMATIC APPLICATOR

The Friggstad PA1-40 was a pneumatic seed and fertilizer applicator which was attached between the cultivator hitch members of a Friggstad 10.7 m B3-31 heavy duty cultivator equipped with 35 shanks on 305 mm spacing (FIGURE 3). Seed and fertilizer were metered through two adjustable fluted rolls mounted below the applicator tanks, while an air-cooled diesel engine powered fan forced the metered material through the distribution system. The distribution system consisted of a five-port primary header mounted on the applicator, feeding five eight-port secondary headers mounted on the cultivator. Tubes from the secondary headers connected to the seed boots behind each shovel. One port on each of the five secondary headers was blocked to accommodate the number of cultivator shanks. The cultivator was equipped with three row mounted harrows and a Friggstad H3-40 packer drawbar with seven sections of Inland spiral packers. Special boots for use in conjunction with chisel points were available for use in banding fertilizer.

FIGURE 3. Friggstad PA1-40 Pneumatic Applicator.

PRASCO SUPER SEEDER MODEL 75-55 PNEUMATIC APPLICATOR

The Prasco Super Seeder Model 75-55 was a pneumatic seed and fertilizer applicator which was attached to a 10.7 m John Deere 1610 heavy duty cultivator equipped with 35 shanks on 305 mm spacing (FIGURE 4). Seed and fertilizer were metered through two adjustable fluted rolls mounted below the applicator tanks, while a hydraulically powered fan forced the metered material through the distribution system. The distribution system consisted of a six-port primary header mounted on the applicator, feeding four ten-port secondary headers mounted on the cultivator. Tubes from the secondary headers connected to seed boots behind each shovel. To accommodate 35 shanks, two of the six primary header ports were blocked. In addition, three of the secondary headers each had one port blocked, while the fourth secondary header had two ports blocked. The cultivator was equipped with six sections of Prasco frame mounted spiral packers. A single row of Prasco tine harrows was mounted on each packer section. Special boots for use in conjunction with chisel points were available for use in banding fertilizer.

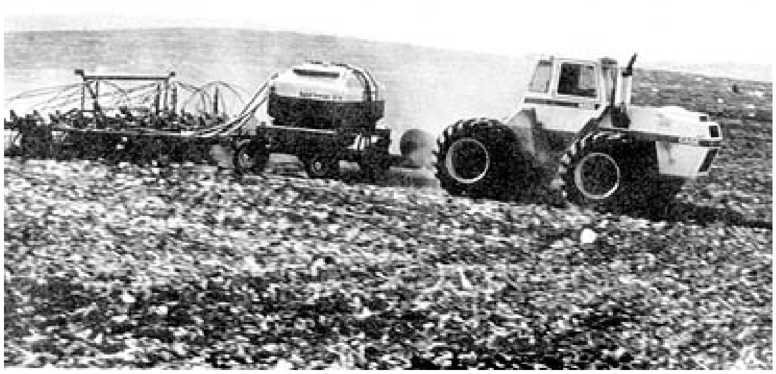

FIGURE 4. Prasco Super Seeder Model 75-55.

WIL-RICH 4150 AIR SEEDER

The Wil-Rich 4150 was a pneumatic seed and fertilizer applicator which was mounted on the hitch members of an 8.4 m Wil-Rich field cultivator equipped with 47 shanks on 180 mm spacing (FIGURE 5). Seed and fertilizer were pneumatically distributed from two tanks, each with two separate compartments, through a network of tubes, to seed boots attached to the rear of each cultivator shank. Seed and fertilizer were metered through rubber metering rollers mounted below each tank compartment, while a power take-off driven fan forced the metered material through the distribution system. The cultivator was equipped with Wil-Rich frame mounted packers. A single row of Wil-Rich tine harrows was mounted with the packers.

FIGURE 5. Wil-Rich 4150 Air Seeder.

RESULTS AND DISCUSSION

FRIGGSTAD PA1-40 PNEUMATIC APPLICATOR

Distribution Uniformity: FIGURE 6 shows distribution uniformity for the Friggstad PA1-40 in wheat, barley and oats at various seeding rates at a ground speed of 9 km/h and a fan speed of 5000 rpm. Distribution uniformity was acceptable for seeding rates below 130 kg/ha for wheat, 110 kg/ha for barley and 90 kg/ha for oats. FIGURE 7 shows the actual distribution pattern obtained in Neepawa wheat at an average seeding rate of 80 k g/ha at 9 km/h with a fan speed of 5000 rpm. Uniformity of distribution at this seeding rate was acceptable with a coefficient of variation of 12%.

Distribution uniformity tended to deteriorate at higher seeding rates due to the increase in flow rate (kg/min) of material entering the constant air supply from the fan. Similarly, due to the air supply remaining constant, changes in distribution pattern uniformity could occur at different forward speeds or for different machine widths. For example, FIGURE 6 shows a decrease in distribution uniformity in wheat from a CV of 10 to 12% with a change in application rate from 40 to 85 kg/ha.

As there were eight ports on each of the five secondary headers, a total of 40 seed boots could be used with the Friggstad PA1-40. Since the 10.7 m Figgstad B3-31 had only 35 shanks, one port was blocked on each of the secondary headers to accommodate the 35 shanks. Blocking the secondary headers significantly reduced the distribution uniformity. FIGURE 8 shows distribution uniformity in 11-51-00 fertilizer when all eight ports were used on each secondary header, as would be the case with a 40 shank cultivator, and when one port on each secondary header was blocked, as was done with the 35 shank test machine. When one port was blocked on each secondary header, fertilizer distribution was uniform only at application rates below 115 kg/ha. At higher application rates, the CV varied from 15 to 18%. When all secondary header ports were used, however, distribution uniformity was good at all application rates with the CV varying from 5 to 7%.

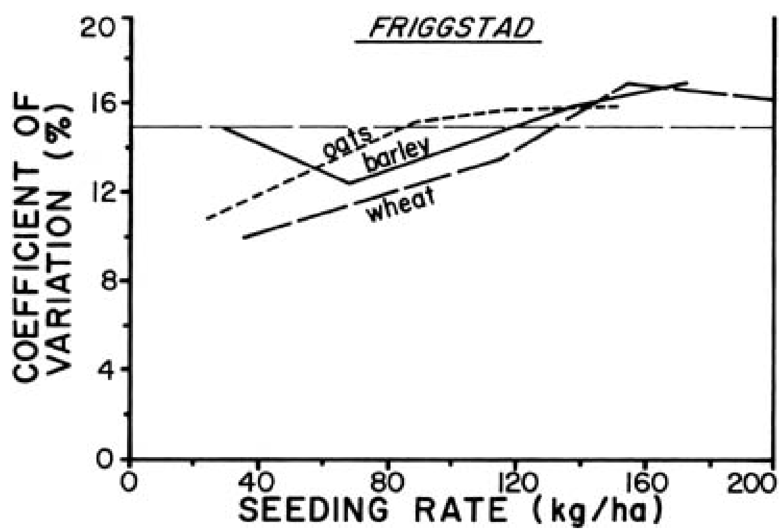

FIGURE 6. Seeding Uniformity in Cereal Grains with the Friggstad PA1-40.

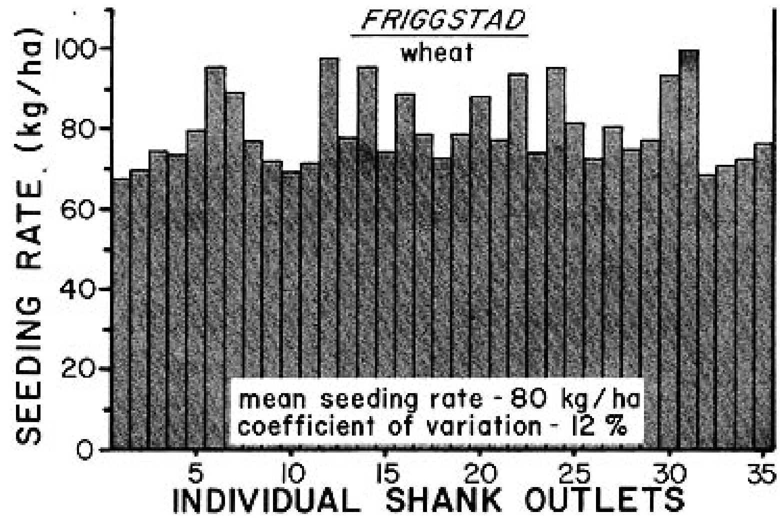

FIGURE 7. Distribution Pattern in Wheat at 80 kg/ha with Friggstad PA1-40.

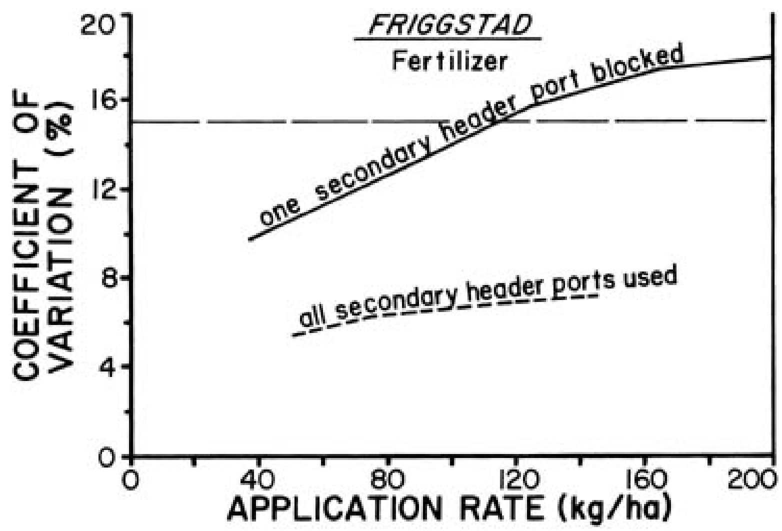

FIGURE 8. Distribution Uniformity in 11-51-00 Fertilizer with the Friggstad PA1-40.

Seed Placement: FIGURE 9 shows the Friggstad seed boot mounted with a 50°, 405 mm sweep. The V-shaped deflector attached at the base of the Friggstad seed boot effectively spread the seed into wide bands behind each cultivator shank (FIGURE 10). After complete crop emergence, no distinct rows were evident and even with the 305 mm shank spacing, there was sufficient stubble for windrow support at harvest time.

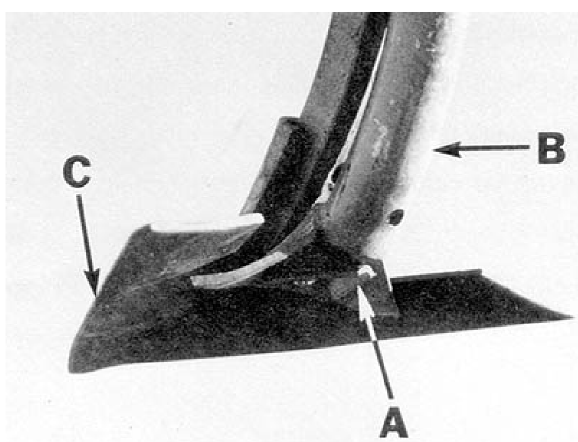

FIGURE 9. Friggstad Seed Boot: (A) V-Shaped Deflector, (B) Seed Boot, (C) Sweep.

FIGURE 10. Wheat Emergence with the Friggstad PA1-40.

Although seed and fertilizer were usually placed at individual sweep working depth, seeding depth across the width of the machine varied due to cultivator frame geometry (hitch length, frame section widths, distance between shank rows, position of wheels, type of axle) and non-uniform field surfaces.

FIGURE 11 presents the results of a random sampling of seed placement across the width of the Friggstad PA1-40 and 10.7 m heavy duty cultivator. Seeding depth varied from 30 to 95 mm. Most of the seed was located within plus or minus one standard deviation (18 mm) of the 69 mm mean seeding depth as indicated by the shaded band. In areas with sharp hill crests or gullies, seed depth variation became much greater due to cultivator frame geometry. The shanks on the Friggstad B3-31 cultivator were sufficiently rigid to maintain a fairly uniform sweep pitch, with resultant uniform tillage depth, over a wide range of soil conditions. Consequently, field tillage conditions did not adversely affect vertical seed distribution.

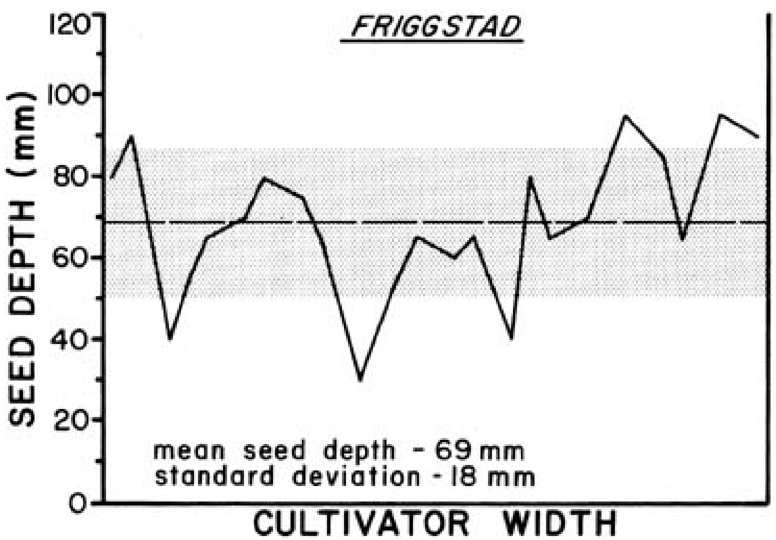

FIGURE 11. Seed Placement with the Friggstad PA1-40.

Fertilizer Band Placement: FIGURE 12 shows the Friggstad banding boot which was attached to the shanks in conjunction with chisel points, replacing the seed boots and sweeps. Measurements taken in the field indicated that fertilizer granules were placed in a band approximately 30 mm in width. Depth of fertilizer placement ranged from the individual chisel tip depth to 10 mm above chisel tip depth. Fertilizer placement was most accurate with new chisel points. Using worn chisels with rounded points decreased fertilizer band placement accuracy considerably.

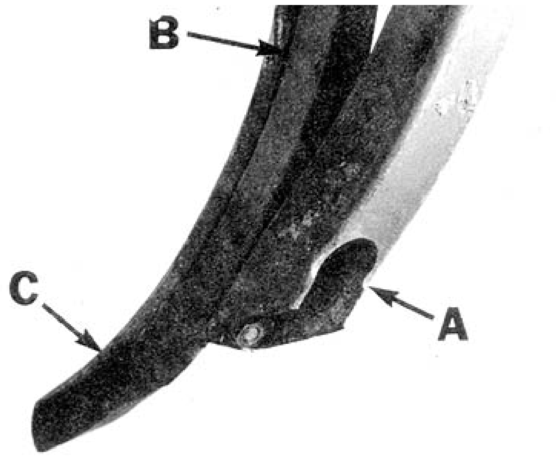

FIGURE 12. Friggstad Fertilizer Banding Boot: (A) Banding Boot, (B) Cultivator, (C) Chisel Point.

PRASCO SUPER SEEDER MODEL 75-55 PNEUMATIC APPLICATOR

Distribution Uniformity: FIGURE 13 shows the distribution uniformity for the Prasco Super Seeder Model 75-55 in wheat, barley and oats at a ground speed of 10 km/h and a fan speed of 3500 rpm. Distribution uniformity was acceptable (ie. CV less than 15%) for all seeding rates. FIGURE 14 shows the actual distribution pattern in Neepawa wheat at an average seeding rate of 77 kg/ha at 10 km/h with a fan speed of 3500 rpm. Distribution at this seeding rate was acceptable with a coefficient of variation of 10%.

Distribution uniformity changed only slightly over the range of seeding rates shown in FIGURE 13. The trend was for distribution uniformity to improve with increased seeding rates. For example, FIGURE 13 shows an improvement in distribution uniformity in wheat from a CV of 13 to 10% with a change in seeding rate from 40 to 85 kg/ha. This is opposite to the Friggstad PA1-40, which showed a deterioration in uniformity with increased seeding rates. Changes in uniformity are attributed, in both cases, to the increase in flow rate (kg/min) of material entering the constant air supply from the fan. The opposing trends between the two machines is attributed to differences in primary and secondary header configurations and differences in distribution hose diameters between the two machines. For example, with the Prasco, seed entered the secondary headers from the bottom for division into individual secondary header ports, while with the Friggstad, seed entered from the top. Also, with the Prasco, smaller secondary distribution hoses were used, resulting in higher air velocity. Changes in distribution patterns, other than those shown, could occur at different forward speeds and for different machine widths.

The Prasco primary header had six ports while the four secondary headers each had 10 ports. To accommodate the 35 shanks on the 10.7 m (35 ft) John Deere 1610, two of the primary header ports were blocked. Also, one port on each of three secondary headers were blocked while a fourth secondary header had two ports blocked. Blocking the two primary header ports opposite each other did not greatly decrease overall distribution uniformity since it resulted in a symmetrical pattern with each open port being adjacent to a block port. Blocking the secondary header ports, however, significantly reduced distribution uniformity. FIGURE 15 shows the distribution uniformity in 11-51-00 fertilizer when all 10 ports were used on each secondary header as would be the case with a 40 shank cultivator and when five of the secondary header ports were blocked as was done with the 35 shank test machine. With the five ports blocked, the distribution was non-uniform and the CV varied from 18.3 to 26.3%. When all secondary ports were used, application was uniform with the CV varying from 10 to 15%. Ports adjacent to blocked secondary ports for the three secondary headers with only one port blocked tended to run at lower rates than average. All ports on the secondary header with two ports blocked tended to run at higher rates than average.

FIGURE 16 shows a similar trend in distribution uniformity with the Prasco in Tower rapeseed. With five of the secondary header ports blocked, the CV varied from 17.5 to 19.2%. When using all secondary ports, the CV varied from 8.5 to 9.5%.

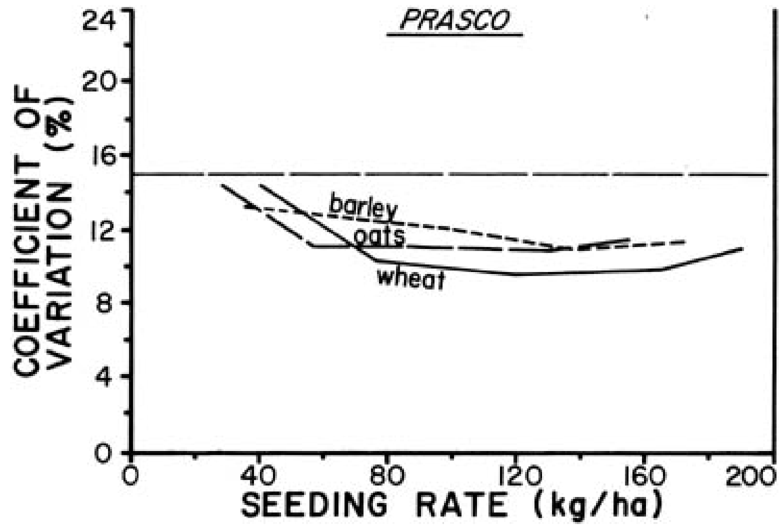

FIGURE 13. Seeding Distribution Uniformity in Cereal Grain with the Prasco 75-55.

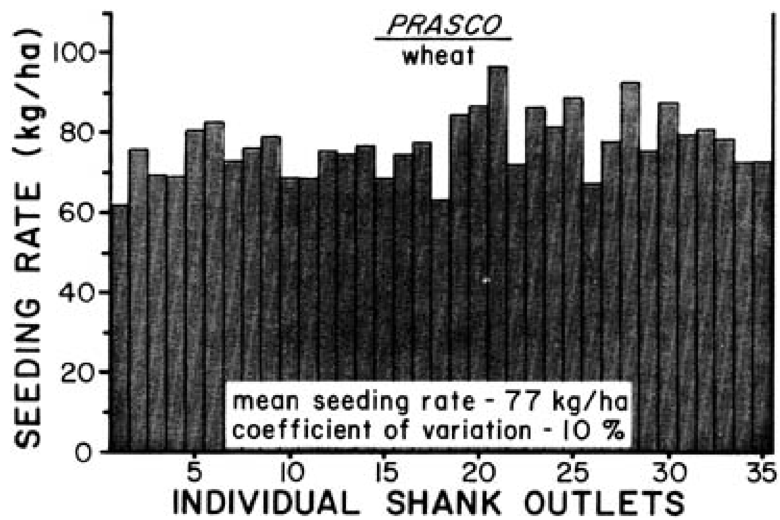

FIGURE 14. Distribution Patterns in Wheat at 77 kg/ha with the Prasco 75-55.

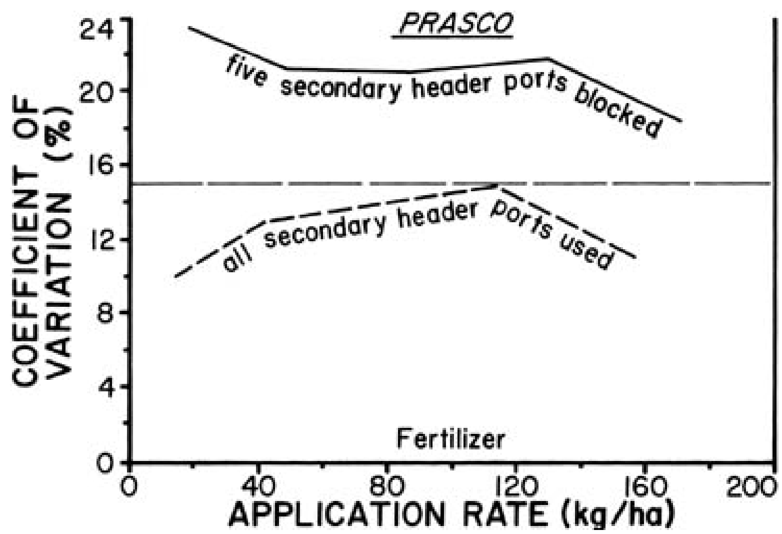

FIGURE 15. Distribution Uniformity in 11-55-00 Fertilizer with the Prasco 75-55.

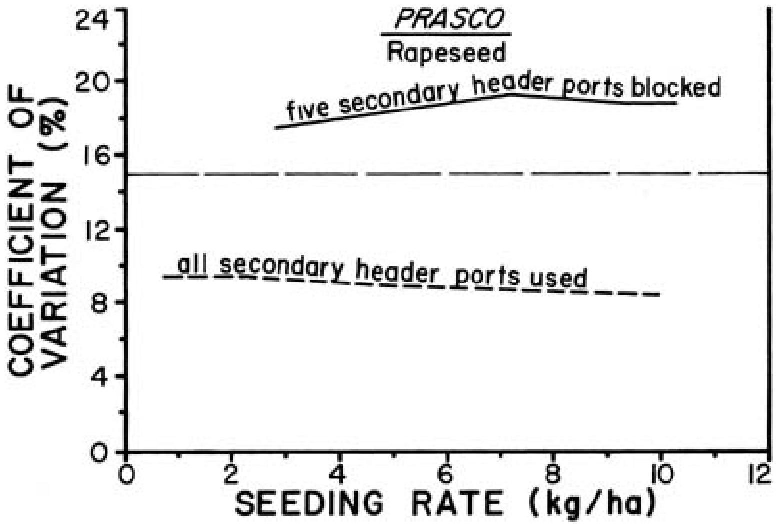

FIGURE 16. Distribution Uniformity in Tower Rapeseed with the Prasco 75-55.

Seed Placement: FIGURE 17 shows the Prasco seed boot mounted on a John Deere 1610 shank with a 50°, 405 mm sweep. This seed boot provided limited spreading action behind the shank. FIGURE 18 shows that the crop emerged in distinct rows in band widths ranging from 60 to 90 mm. With 305 mm shank spacing, distance between rows varied from 215 to 245 mm. This row spacing provided less windrow support than seed boots equipped with spreaders. However, if light windrows were laid across the row, windrow support was adequate.

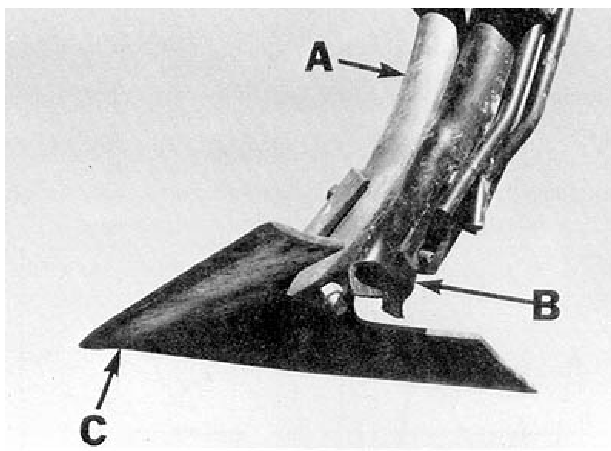

FIGURE 17. Prasco Seed Boot: (A) Shank, (B) Seed Boot, (C) Sweep.

FIGURE 18. Wheat Emergence with the Prasco 75-55.

As with the Friggstad, seed and fertilizer for each individual sweep was usually placed at sweep working depth. However, seeding depth varied across the width of the machine due to cultivator frame geometry and non-uniform field surfaces.

Random sampling of seed placement across the width of the Prasco 75-55 and 10.7 m John Deere heavy duty cultivator resulted in seeding depth variation from 38 to 115 mm (FIGURE 19). Most of the seed was located within plus or minus one standard deviation (22 mm) of the 71 mm mean seeding depth as shown by the shaded band. In areas with sharp hill crests or gullies, seed depth variation became much greater due to cultivator frame geometry.

The shanks on the John Deere 1610 cultivator were sufficiently rigid to maintain a fairly uniform sweep pitch, with resultant uniform tillage depth, over a wide range of soil conditions. Consequently, field tillage conditions did not adversely affect vertical seed distribution.

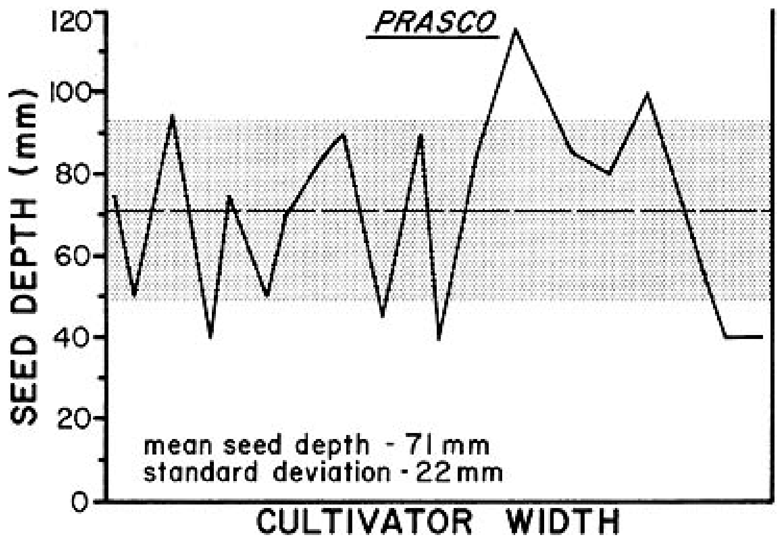

FIGURE 19. Seed Placement with the Prasco 75-55.

Fertilizer Band Placement: FIGURE 20 shows the Prasco banding boot which was attached to the John Deere 1610 shanks in conjunction with chisel points, replacing the seed boots and sweeps. Measurements taken in the field indicated that most fertilizer granules were placed in a band approximately 25 mm in width. Depth of fertilizer placement ranged from chisel tip depth to about 13 mm above chisel tip depth. Worn, rounded chisel tips resulted in decreased and fertilizer band placement accuracy.

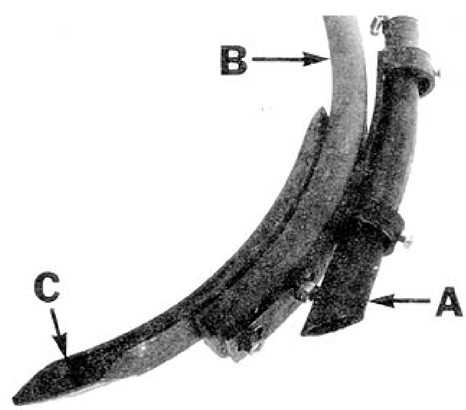

FIGURE 20. Prasco Fertilizer Banding Boot: (A) Banding Boot, (B) Cultivator Shank, (C) Chisel Point.

WIL-RICH 4150 AIR SEEDER

Distribution Uniformity: FIGURE 21 shows distribution uniformity for the Wil-Rich 4150 air seeder in wheat, barley and oats at a ground speed of 8 km/h. Distribution uniformity was good (i.e. CV less than 10%) for all seeding rates. FIGURE 22 shows the distribution pattern in Neepawa wheat at an average seeding rate of 105 kg/ha at 8 km/h with a fan speed of 3750 rpm. The distribution pattern at this seeding rate was good, with a coefficient of variation of 4.3%.

FIGURE 23 shows good distribution uniformity obtained with the Wil-Rich 4150 in 11-51-00 fertilizer at 8 km/h. Seeding distribution in rapeseed was also good with a CV of 3% at all seeding rates.

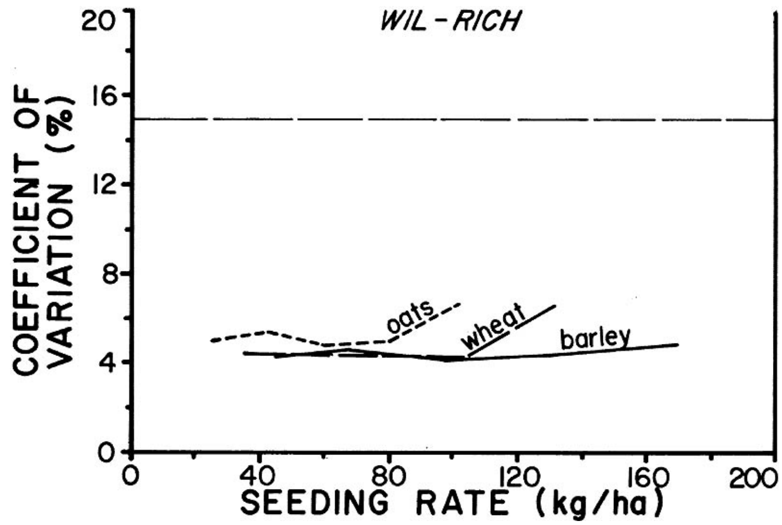

FIGURE 21. Seeding Distribution Uniformity in Cereal Grains with the Wil-Rich 4150.

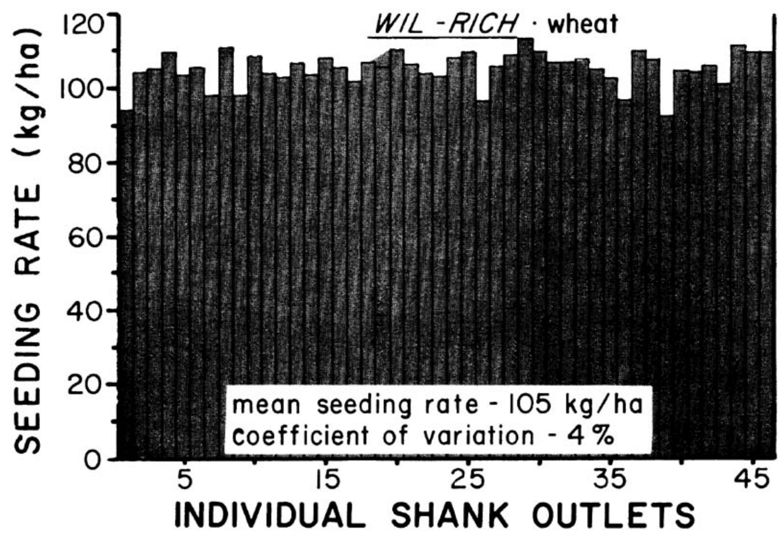

FIGURE 22. Distribution Pattern in Wheat at 105 kg/ha with the Wil-Rich 4150.

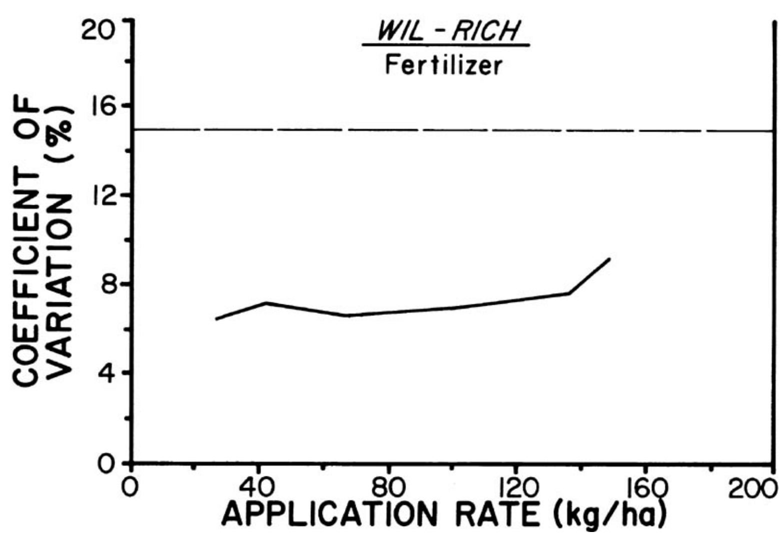

FIGURE 23. Distribution Uniformity in 11-51-00 Fertilizer with the Wil-Rich 4150.

Seed Placement: FIGURE 24 shows the Wil-Rich seed boot mounted on a Wil-Rich 8.4 m field cultivator with a 47°, 190 mm sweep. The seed boot provided very little spreading action behind the cultivator sweep. Plants emerged in distinct rows in band widths ranging from 40 to 70 mm (FIGURE 25). With 180 mm shank spacing, distances between rows varied from 110 to 140 mm. This row spacing provided adequate windrow support in all conditions.

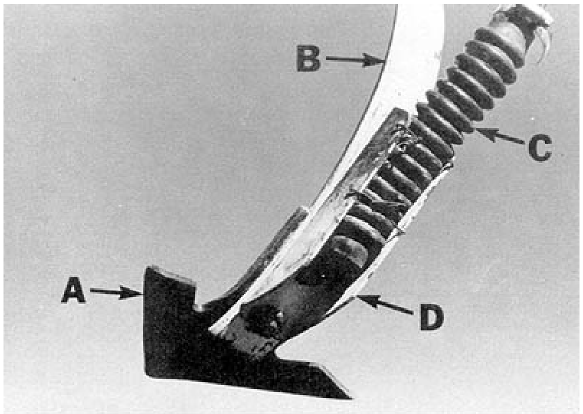

FIGURE 24. Wil-Rich Seed Boot: (A) Sweep, (B) Shank, (C) Seed Boot, (D) Boot Attachment.

FIGURE 25. Wheat Emergence with the Wil-Rich 4150.

As with the other two machines, seed and fertilizer were usually placed at individual sweep working depth. However, seeding depth across the width of the machine varied due to cultivator frame geometry, non-uniform field surfaces and field tillage conditions.

Seeding depth variation depended on nominal seeding depth. FIGURE 26 presents the results of a random sampling of seed placement across the width of the Wil-Rich 4150 and 8.3 m Wil-Rich field cultivator at a seeding depth less than 50 mm in secondary tillage conditions. Seeding depth varied from 20 to 70 mm. Most of the seed was located within plus or minus one standard deviation (12 mm) of the 46 mm mean seeding depth as indicated by the shaded band.

FIGURE 27 presents seed placement results for the Wil-Rich 4150, in secondary tillage, for seeding depths greater than 50 mm. Seeding depth varied from 35 to 115 mm with most of the seed located within one standard deviation (18 mm) of the mean seeding rate of 66 mm. Higher seed depth variation at seeding depths greater than 50 mm was attributed to frequent shank spring trip action at the deeper seeding depths. The Wil-Rich 4150 air seeder was not used for seeding in primary conditions due to light duty shank spring characteristics.

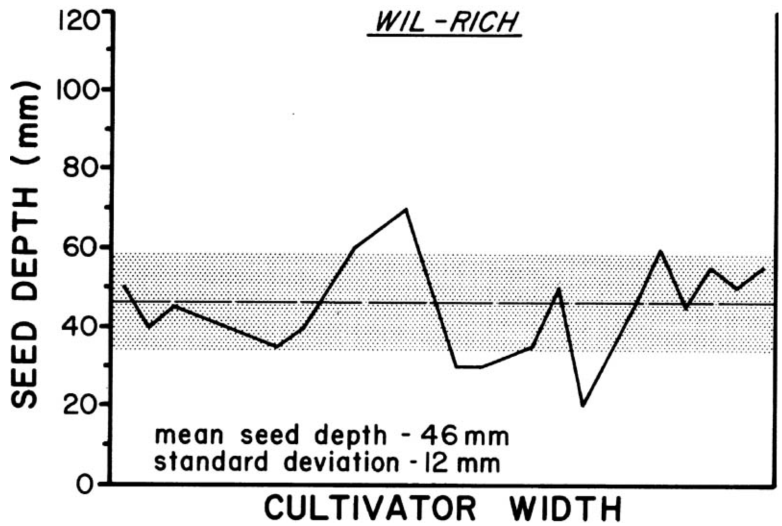

FIGURE 26. Seed Placement with the Wil-Rich 4150 at a Nominal Seeding Depth less than 50 mm.

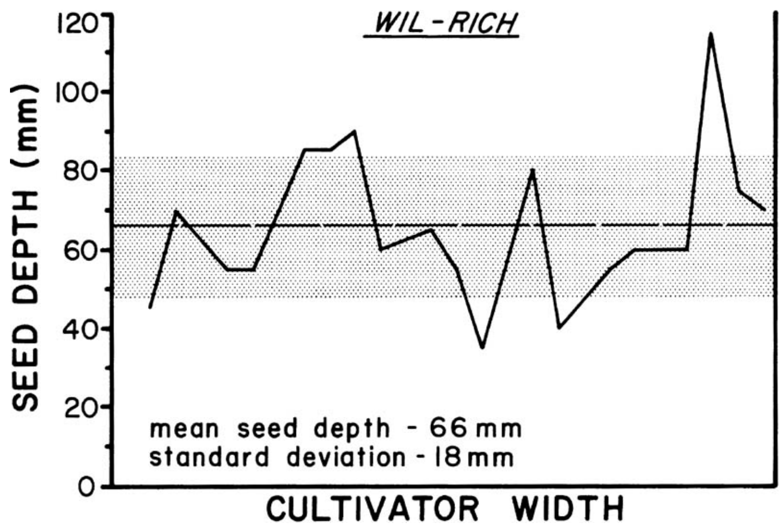

FIGURE 27. Seed Placement with the Wil-Rich 4150 at a Nominal Seeding Depth greater than 50 mm.

Fertilizer Banding: Although fertilizer banding boots for use in conjunction with chisel points were available, the cultivator shank characteristics of the field cultivator were deemed to be too light for proper fertilizer banding. The banding boots could be used with the air seeder mounted on Wil-Rich heavy duty cultivators.

COMPARISON OF AIR SEEDERS TO HOE DRILLS

Seed placement results (FIGURE 28) for an 8.3 m Noble hoe drill while seeding in field conditions similar to those seeded with the air seeders resulted in a seed depth variation across the hoe drill width from 35 to 80 mm. Most seeds were placed within plus or minus one standard deviation (13 mm) of the 59 mm average seeding depth. As shown in TABLE 1, this indicates superior seed depth uniformity to that obtained with the Friggstad and Prasco. Hoe drill seed depth uniformity was better than the Wil-Rich at seeding depths greater than 50 mm and similar to Wil-Rich at seeding depths less than 50 mm.

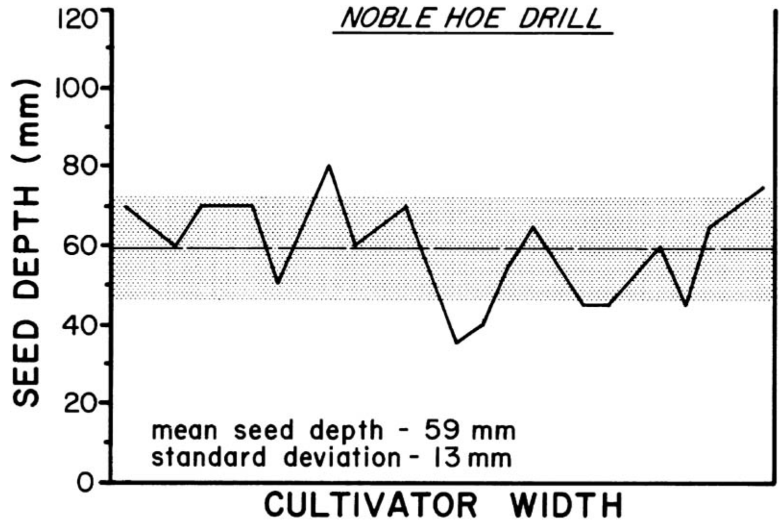

FIGURE 28. Seed Placement with the Noble Hoe Drill.

TABLE 1. Seed Placement Accuracy

Machine	Tillage Conditions	Average Tillage Depth (mm)	Standard Deviation Of Depth (mm)
Friggstad	Primary or Secondary	69	18
Prasco	Primary or Secondary	71	22
Wil-Rich	Secondary	46	12
Wil-Rich	Secondary	66	18
Hoe Drill	Secondary	59	13

Seed and fertilizer distribution uniformity across the machine width for the air seeders using primary and secondary header division (Friggstad and Prasco) were generally inferior to that obtained with hoe drills, especially if some of the ports on the headers were blocked off. Using all header outlet ports significantly improved distribution uniformity. Distribution uniformity using the rubber metering rollers delivering material into individual divider cups (Wil-Rich) was comparable to hoe drill uniformity.

AIR SEEDER ADJUSTMENTS

Seed depth measurements as presented were taken on level or gently rolling field areas with the applicator-cultivator adjustments set for optimum uniformity. This was done by checking the seeding depth from both front and rear shanks as Well as across the cultivator width.

Due to the geometry of a cultivator frame, improper cultivator hitch height can result in rows of shanks operating at significantly different depths. FIGURE 29 shows poor crop emergence in a field seeded to fall rye with the Prasco 75-55. This crop was seeded with the front row of shanks seeding deeper than the rear row, resulting in late emergence of front row plants.

Improper lateral levelling of cultivator frame sections can also result in cultivator sections seeding at different depths. FIGURE 30 shows how improper cultivator wing section adjustment resulted in streaky emergence in barley with the Friggstad PA1-40.

For best seeding results it is recommended that cultivator levelling be checked and appropriate adjustments be made when changing fields to ensure adequate, uniform seed placement.

FIGURE 29. Uneven Crop Emergence due to Improper Cultivator Hitch Adjustments.

FIGURE 30. Uneven Crop Emergence Due to Improper Cultivator Wing Section Adjustment.

CONCLUSIONS

Distribution uniformity was acceptable for normal seeding rates with all three air seeders evaluated. The seeders utilizing pneumatic header division with blocked secondary ports, obtained lower uniformity than that obtained with cup dividers placed below rubber metering rollers. Using all secondary header outlets increased uniformity significantly. Uniformity with the cup dividers and rollers was comparable to uniformity obtained with most conventional hoe drills.

Higher variation in seed depth placement can be expected when seeding with an air seeder and heavy duty cultivator than with a conventional hoe drill. Seed placement was acceptable for normal seeding of cereal grains in level and gently rolling fields with all three air seeders. Seed depth variation was slightly higher with the two heavy duty cultivators and with the field cultivator at seeding depths greater than 50 mm than with conventional hoe drills. Seed placement with the field cultivator at seeding depths less than 50 mm, in level and gently rolling field conditions, was comparable to that obtained with conventional hoe drills.

Seed placement observations showed that seed and fertilizer were placed on the furrow bottom at individual sweep working depth. The seed depth variation occurring across the width of the machines was attributed to the variation between working depths of each cultivator sweep due to cultivator frame geometry and non-uniform field surfaces.

Cultivator leveling adjustments were very important in obtaining good, even crop emergence. Adjustments were required frequently with changing field conditions.

Fertilizer banding with the pneumatic applicators in conjunction with heavy duty cultivators required special banding boots and chisel points for minimal soil disturbance and fertilizer placement in compact bands. Fertilizer placement was nore accurate with new chisel points than with worn chisel points