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EFFICACY OF HILL-DROP APPLIED TEMIK 15 G AND POTENTIAL COST SAVINGS WHEN COUPLED WITH NEW TECHNOLOGY SEED

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Abstract

Tests were conducted to determine the relative effectiveness of hill-drop application of aldicarb (Temik 15 G), as compared to a normal-drill application pattern, and drill-application to hill-drop planted cotton seed. Hill-drop application of Temik 15 G to hill-drop seeded cotton was shown to be equal or better than drill-applied Temik 15 G (5 lbs/acre rate) at greatly reduced rates per acre. Drill-applied Temik 15 G was equally effective when applied to drill-seeded or hill-seeded cotton. A Temik 15 G placement experiment showed that distribution of this insecticide had to be no more than two inches from germinating seed or seedling to retain effectiveness. We hypothesize that hill-drop placement has great potential for reducing costs related to in-furrow-at-planting pesticides, seed-treatments, and expensive biotechnology seed.

Introduction

Hill drop planted cotton is an old practice, invented in days when poor quality, fuzzy cotton seed (not acid delinted) was the norm. The intent of planting 3 - 5 seed in a hill was to help assure that each hill had at least one or two plants surviving later in the season. A particular advantage, one that survives to this day, was the soil crust-busting energy of multiple sprouted seed pushing up in concert. Indeed, many of today's cotton farms cultivating high clay content soils use hill-drop planting as a normal technique.

Costs of planting an acre of cotton sky-rocketed in recent years. Chemical costs from in-furrow and seed-coat applications, direct seed costs, and technology fees associated with Roundup Ready® and Bollgard® have pushed costs to the $50 to $ 70 per acre range. This is especially true in cases where growers do not husband the seed at planting time.

In-furrow application is an inefficient use pattern for some, if not all, insecticides, nematicides, fungicides, and other pesticides. During application most of the chemical falls between the sites of seed deposition. Germinating seed and small seedlings have a low ability to uptake a pesticide outside of the immediate zone of their very limited root system. Theoretically, if an application of a pesticide were focused on the seed-zone and avoided the inter-seed-zone spaces, efficacy may be retained while the product rate and cost were reduced. This hypothesis would best be realized if seeds were placed in groups and spaced relatively far apart, e.g. hill-dropped.

We conducted studies to investigate several aspects of aldicarb (Temik 15 G®, Aventis Crop Sciences, Research Triangle Park, NC) performance when hill-drop applied as compared to the normal, in-furrow-at-planting, drill application technique. Our objectives were three-fold: (1) to determine if Temik 15 G applied within seed-hills, at very low rates per acre would control thrips as well as a standard Temik 15 G application, (2) to determine how close (to seed hills) hill-dropped Temik 15 G has to be to retain effectiveness, and (3) to consider the potential cost savings of hill-drop placement of both seed and Temik 15 G.

Materials and Methods

Tests were conducted on the Tidewater Research Station, Plymouth, NC, during 2000 and 2001. Each test utilizeded randomized complete block design with four replications. An efficacy test was conducted in each year. Treatments consisted of drilled and hill-drop applications of Temik 15 G imposed on both drill-seeded cotton or on seeds planted in 12-inch and 16-inch hill-drop patterns. The rates of Temik 15 G were 0.165 g/row foot (equal to 5 lbs./acre on 38 inch row spacing) drill applied and 0.043 g, 0.086 g, and 0.129 g/hill, hill-drop applied (equal to ca. 1.3, 2.6, and 3.9 lbs/acre on 12 inch spacing and 0.98, 1.96, and 2.94 lbs/acre on 16 inch spacing). Row spacing was 38 inches. Drill-seeded planting was achieved with a White Air Planter. Hill-dropped seed were planted by hand into open furrows created by operating the same planter without the press wheel, thus leaving open furrows. Seed were dropped at measured intervals (12 inch or 16 inch) with the aid of a three-foot PVC pipe (3/4 inch I.D.) fitted with a funnel on top (an extended funnel used to focus seed into the furrow). The foot was used to close the seed furrow. Temik 15 G was applied with an insect applicator, or bazooka, fitted to a three-foot section of PVC pipe. Our bazooka was calibrated, by using a small diameter rubber tubing segment fitted into the slide orifice, to deliver 0.043 g of Temik 15G per dose and desired rates were achieved by using 1, 2, or 3 doses. Each dose was focused on the seed hill with a spread maximum of ca. 2.5 inches. In 2001 a similar test was conducted. However, only the

16-inch hill-drop spacing was used and the Temik 15G rate was increased to 0.069 g/dose. Again 1, 2, or 3 doses per hill were used to achieve rates of 0.069 g, 0.138g and 0.207 g per hill (equal to ca. 1.6, 3.2, and 4.8 lbs/acre). The cotton cultivar used in was DP 451 BG/RR in both tests. Agronomic and pest management practices were in accordance with NC State University recommendations except for the thrips control techniques used in the tests. Both 2000 and 2001 treatments were irrigated soon after planting to help create a favorable germination and early growth environment.

We also conducted a Temik 15 G placement experiment in 2001 to determine the efficacy of off-the-hill distribution of Temik 15 G in 16-inch hill-drop planted cotton. Using techniques similar to those described above, Temik 15 G was applied at 0.069 g, on the seed-hill or off the seed-hill by two, four, six, and eight inches. The spread of the Temik 15 G dose within the seed furrow did not exceed two inches. An untreated control was included.

Each test was evaluated by counting thrips adults and larvae on seedling cotton plants. Samples of five randomly collected seedlings were gathered from each plot. Seedlings were cut, placed into a mason jar containing a 0.0125% detergent-water mixture, and vigorously shaken to dislodge thrips from the plants. Jars were taken to the laboratory and processed within ca. four hours. Processing consisted of pouring the sample into a 100 mesh sieve and washing the plants, over the sieve, in a low-pressure stream of tap water. The sieve trapped thrips and samples were washed from the sieve, and into labeled vials with 70% ethanol. These preserved samples were stored at room temperature. Contents of each vial were emptied into a petri dish and examined under a binocular microscope. Thrips adults and larvae were counted.

Yield was determined in the 2000 efficacy test only. A John Deere 9920 cotton picker was used to pick each plot. Seed cotton was captured by means of a bagging attachment and bags of seed cotton were weighed in the field.

Data were subjected to the Analysis of Variance and Fisher's Least Significant Difference Test with the aid of the Agricultural Research Manager software (ARM 6.15 for Windows, Gyllings Data Management, Inc.).

Results

Efficacy tests showed that thrips control was maintained or improved by hill-drop application (H.D.), compared to the standard drilled application of Temik 15 G in drill-seeded or hill-drop seeded cotton (Tables 1 and 2).

Selected data from the 2000 experiment are shown in Table 1. Since the experiment did not contain an untreated control (UTC), data from an adjacent test UTC are included in Table 1 for comparison purposes. Thrips numbers in the area were very high at 25 days after planting (DAP) and peaked at 32 DAP. The drill-applied Temik 15 G in 12" hill-drop seeded plots showed significantly lower numbers at 25 days over the normal drill-applied / drill-seeded application. However, this difference did not persist to 32 days, although numbers remained lower in the 12" hill-drop treatment. Only one hill-drop applied, hill-drop seeded treatment was significantly different from a drill-applied Temik treatment at 25 days (1.0 lb/acre, H.D. / H.D. versus 5 lbs/acre, drilled / H.D.). This difference was not sustained on the 32 day sampling. Most of the significant differences in this test, or perhaps lack thereof, appeared to be caused by within plot variation, not associated with the treatment(s). For instance the 1.3 lb/acre-12" H.D. and 1.0 lb/acre-16 inch H.D. treatments (significantly different at 25 days) each received the same Temik 15 G application, of 0.043 grams per hill, and the only difference between these treatments was the hill spacing within the row; differences in these treatments were not sustained at 32 days. In general the higher hill-drop applied rates on both 12 inch and 16 inch seed hills showed lower thrips numbers compared to the drill-applied and the lowest rates of hill-drop applied Temik 15 G. There were no instances where the normal practice of drill-applied Temik 15 G showed consistent and significantly higher efficacy over the scoring period than hill-drop applied Temik. Yields of seed cotton from all treatments were statistically equal. As compared to the outside UTC, yield increases due to Temik 15 G treatment ranged from 626 lbs. to 1024 lbs. of seed cotton per acre.

The 2001 test did not include the 12-inch hill-drop seed placement and Temik 15 G rates were somewhat higher (to 0.069 g/hill versus 0.43 g/hill in 2000) in the hill-drop applied plots (Table 2). Again an outside UTC from an adjacent test was included in Table 2 for comparison purposes. Thrips were very abundant in the UTC at 29 DAP and peaked at 36 DAP. All H.D.-applied Temik 15 G, to 16 inch H.D.-seeded cotton, were significantly different than the standard 5 lbs/acre drill-applied Temik 15 G to drill-seeded cotton on both dates. Drill-applied Temik 15 G to H.D.-seeded cotton was not significantly different than the 1.6 lb/acre H.D.-applied Temik 15 G to H.D.-seeded cotton across both sampling dates. There was only one instance where H.D.-applied Temik 15 G to H.D.-seeded cotton was significantly separated from another H.D.-applied Temik 15 G, H.D.-seeded treatment (1/6 lb/hill, H.D versus 4.8 lb/hill, H.D. at 36 DAP).

Thrips population levels in the placement experiment clearly showed the distance limitations for Temik 15 G distribution (Table 3). The centered placement treatment was significantly different, on both scoring dates, from all treatments except the

2 inches off-the-hill placement. The 2 inches off-the-hill placement showed numerically higher thrips numbers and indicated the distance limit for Temik 15 G uptake by germinating cotton seeds and/or seedlings.

Discussion

Experiments conducted in 2000 and 2001 clearly showed that hill-drop applied Temik 15 G used on hill-drop seeded cotton is, rate for rate, as efficacious as drill-applied Temik 15 G used in drill-seeded or hill-drop seeded cotton. The lowest rate used in hill-drop applications, 0.043 grams/ hill in 2000, was roughly equivalent to 5 lbs/acre if the hill-drop application was distributed in ca. a three-inch zone. In the 2001 experiment this rate was increased by 60% to 0.069 g/hill, roughly equivalent to 6.3 lbs of Temik 15 G per acre (assuming a three-inch in-row distribution and 16 inch hill spacing). Thrips numbers on hill-drop applied treatments in the 2001 experiment seem to reflect this increased rate (e.g. fewer thrips in these treatments). The higher dose rates in the hill-drop treatments extended thrips control for a longer period. Although hill-drop equipment is not available to U.S. cotton growers at the present time perhaps increased interest in hill-drop technology will be motivated by potential cost savings. Currently, the product catalogue from the sugar beet equipment manufacturer Gilles Biekenkoppers Enrooiers, in Belgium, shows a planter touted to be capable of spot-placement of granular pesticide within the seed furrow.

The manufacture of Temik 15 G, Aventis Crop Sciences, may see both negative and positive implications in these data. It is obvious that reduced rates could lead to lower sales. However, profitable growers have dollars to pay bills and are the foundation of a healthy cotton industry. By placing Temik 15 G close to the target, hill-drop application may duplicate prohibitively costly treatments (e.g. as a high rate nematode treatment at 14+ lbs/acre) and broaden use possibilities. For example, our 0.207 gram per hill treatment on 16-inch spacing, or 4.8 lbs/acre, was roughly equivalent to 19 lbs/acre drill-applied (Table 2). There may also be regulatory advantages and environmental benefits if lower use rates per acre are possible. In addition, current and experimental seed treatment insecticides may be marketed at a relatively low cost (versus Temik 15 G, drill-applied) and hill-drop application may be an alternative to seed treatments, and the low rates achieved by seed treatment methodology. Seed treatment cost go down when growers use fewer seeds but drill-applied pesticides do not.

Cost savings may be a major motivation for cotton growers to adopt hill-drop planting. Temik 15 G is recommended for thrips control in North Carolina cotton at 3 to 5 lbs/acre (Bacheler and Van Duyn 2001). It is the most popular at-planting insecticide for thrips control. Table 4 presents the potential percent Temik 15 G savings associated with three hill-drop application patterns when compared to drill-application of 3 lbs./acre and 5 lbs./acre. These data indicate possible cost savings well in excess of 50%.

Seeds of cotton and other crops are now viewed by industry as vehicles for marketing value- added products. The most notable current examples in cotton are Bollgard® and Roundup Ready® genes, Gaucho® and Adage® insecticide seed treatments, and several fungicide seed treatments, such as Baytan-Thiram® and Allegience®. In total these products greatly add to the seed associated cost per acre for the cotton farmer. Perhaps a considerable reduction in seed use may be achieved by employing hill-drop seeding. The North Carolina Cooperative Extension Service recommends seeding rates of four to six seed per foot (Edmisten 2001) and Monsanto Company determines the technology fee for Bollgard® and Roundup Ready® seed on a seeding rate of 62500 seed per acre (3.6 seed/foot and 4.5 seed/foot for 30 inch and 38 inch row spacings, respectively) (Dan Pitts, personal communication). These recommendations are relevant ballpark figures. Table 5 presents the estimated seed required to plant 1000 row feet and potential percent seed savings in drill-seeded versus hill-drop planted (3 seed/hill) cotton. Data suggest a substantial savings for hill-drop seeding at each seeding rate, especially when compared to six drill-planted seed/foot. Tables 6 and 7 present theoretical costs per acre comparisons for drilled-planted and hill-drop seeded Bollgard® and Roundup Ready® cotton seed that is treated with Temik 15 G in 30 and 38-inch row spacings. In 30 inch rows (Table 6) the theoretical cost per acre for both 16 inch and 20 inch hill-drop planting patterns (3 seed per hill) are reduced by ca. 50% or more compared to drill-planted cotton (at 3.6 seed per foot). Growers in North Carolina successfully use hill-drop patterns of 14 inches to 16 inches in wide row cotton (36-inch or 38-inch rows) and 16-inch to 20-inch hill-drop patterns would likely be successful in 30-inch row cotton. Somewhat higher percent savings are indicated for a 38-inch row width (Table 7) versus 30-inch row cotton (Table 6). This change of relationship in savings between 30-inch rows and 38-inch rows reflects the different drill-seeding rates (per foot) affected by the number of row feet in each row width pattern, but unchanging seeding per acre. This relationship is demonstrated in Table 5. For 38-inch rows, savings of up to ca. 42% are indicated for the 16" hill-drop spacing (20 inch hill spacings seems excessive for wide row cotton). Theoretical dollar savings due to hill-drop planting for a 1000 acre cotton farm are shown in Table 8 and needs no explanation.

Acknowledgements

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References Cited

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Table 1. Mean thrips larvae per five seedlings at 25 and 32 days after planting and mean estimated seed cotton yields from drill-applied (drilled) and hill-drop applied (H.D.) Temik 15 G to drill-seeded (drilled) or hill-drop seeded (H.D.) cotton. Plymouth, NC. 2000 .*

Temik 15 G rate, Placement and seed-placement	Thrips larvae at 25 days after planting	Thrips larvae at 32 days after planting	Estimated seed cotton yield per acre
5 lb/a, drilled / drilled	8.50 ab	20.50 ab	3133 a
5 lb/a, drilled / 12" H.D.	4.00 c	16.00 b	3225 a
5 lb/a, drilled / 16" H.D.	6.00 abc	24.50 ab	2827 a
1.3 lbs/a, H.D. / 12" H.D.	5.00 bc	31.75 a	2999 a
1.0 lb/a, H.D. / 16" H.D.	9.25 a	19.75 ab	3057 a
2.6 lbs/a, H.D. / 12" H.D.	3.00 c	10.00 b	3083 a
2.0 lbs/a, H.D. / 16" H.D.	4.75 bc	10.75 b	3087 a
3.9 lbs/a, H.D. / 12" H.D.	3.25 c	10.00 b	3118 a
2.9 lbs/a, H.D. / 16" H.D.	4.75 bc	9.75 b	3030 a
Outside UTC**	96.00	205.50	2201

* Means within the same column followed by a same letter do not differ significantly, Fishers LSD ($P \leq 0.05$).
** From an adjacent replicated test.

Table 2. Mean thrips larvae per five seedlings at 29 and 36 days after planting from drill-applied (drilled) and hill-drop applied (H.D.) Temik 15 G to drill-seeded (drilled) or hill-drop seeded (H.D.) cotton. Plymouth, NC. 2001. *

Temik 15 G rate and placement / seed-placement	Thrips larvae at 29 days after planting	Thrips larvae at 36 days after planting
5 lb/a, drilled / drilled	6.00 a	68.00 a
5 lb/a, drilled / 16" H.D.	4.25 ab	58.00 ab
1.6 lbs/a, H.D. / 16" H.D.	1.25 bc	36.75 bc
3.2 lbs/a, H.D. / 16" H.D.	0.75 c	13.50 cd
4.8 lbs/a, H.D. / 16" H.D.	1.50 bc	5.75 d
Outside UTC**	93.25	133.8

* Means within the same column followed by a same letter do not differ significantly, Fishers LSD ($P \leq 0.05$). ** From an adjacent replicated test.

Table 3. Mean thrips larvae from plots receiving differing placements of hill-drop applied Temik 15 G in hill-drop seeded cotton. Plymouth, NC. 2001.*

Treatment (distance from seed hill)	Thrips larvae at 29 days after planting	Thrips larvae at 36 days after planting
UTC	114.75 b	251.00 a
Centered	4.75 c	55.25 c
2 inches off-seed-hill	33.50 c	120.25 bc
4 inches off-seed-hill	106.00 b	185.75 ab
6 inches off-seed-hill	122.75 b	276.25 a
8 inches off-seed-hill	174.75 a	252.75 a

* Means within the same column followed by a same letter do not differ significantly, Fishers LSD ($P \leq 0.05$).

Table 4. Grams of Temik 15 G required per 1000 row feet and potential savings (%) from drill-application and hill-drop application on three in-the-row spacings.

Application technique Drilled	Temik 15 G @ 3 lbs/acre 99 g / 1000 row ft. (0%)	Temik 15 G @ 3 lbs/acre 99 g / 1000 row ft. (0%)
12 inch hill-drop @ .048 g/hill	48 g / 1000 row ft. (52%)	48 g / 1000 row ft. (71%)
16 inch hill-drop @ .048 g/hill	35 g / 1000 row ft. (64%)	35 g / 1000 row ft. (78%)
20 inch hill-drop @ .048 g/hill	29 g / 1000 row ft. (71%)	29 g / 1000 row ft. (82%)

Table 5. Estimated seed required to plant 1000 row feet in drill-seeded and hill-drop seeded cotton at thee seeding rates and potential savings (%).

Planting technique Drill-seeded	Seeded @ 3.5 seed/ft. 3500 (0%)	Seeded @ 4.5 seed/ft. 4500 (0%)	Seeded @ 6.0 seed/ft. 6000 (0%)
12 inch hill-drop seeded	3000 (14%)	3000 (33%)	3000 (50%)
16 inch hill-drop seeded	2500 (29%)	2500 (45%)	2500 (58%)
20 inch hill-drop seeded	1800 (49%)	1800 (60%)	1800 (70%)

Table 6. Theoretical cost per acre comparisons for drilled and hill-drop distributions of high technology seed and Temik 15 G when planted on 30 inch row spacings.

Seeding or application	Bollgard®*	Roundup Ready®*	Temik 15 G®**	Total / acre
Drilled	$32.00	$9.00	$18.90 @ 165 g/1000 rf	$59.90
12 inch hill-drop	$27.42	$7.71	$5.48 @ 48 g/1000 rf	$40.61
16 inch hill-drop	$20.57	$5.78	$4.11 @ 36 g/1000 rf	$30.46
20 inch hill-drop	$16.45	$4.63	$3.29 @ 29 g/1000 rf	$24.37

*cost per 62500 seed (Monsanto Co. 01/06/02) and seeded at 3.6 seed per foot.
** cost at 6.3 lbs/acre (= to 5 lbs/acre on 38" rows) and $3.00 per pound (Aventis Co. 01/06/02).

Table 7. Theoretical cost per acre comparisons for drilled and hill-drop distributions of high technology seed and Temik 15 G when planted on 38 inch row spacings.

Seeding or application	Bollgard®*	Roundup Ready®*	Temik 15 G®**	Total / acre
Drilled	$32.00	$9.00	$15.00 @ 165 g/1000 rf	$56.00
12 inch hill-drop	$21.12	$5.94	$4.37 @ 48 g/1000 rf	$31.43
16 inch hill-drop	$15.84	$4.46	$3.27 @ 36 g/1000 rf	$32.57
20 inch hill-drop	$12.67	$3.56	$2.62 @ 29 g/1000 rf	$18.85

*cost per 62500 seed (Monsanto Co. 01/06/02) and seeded at 3.6 seed per foot.
** cost at 6.3 lbs/acre (= to 5 lbs/acre on 38" rows) and $3.00 per pound (Aventis Co. 01/06/02); rates shown as grams per 1000 row feet.

Table 8. Theoretical dollar savings per 1000 acres of cotton using hill-drop planting and application techniques in contrast to drill-seeded and drill-application techniques for high technology seed and Temik 15 G on 30 inch and 38 inch row spacings.*

Hill-drop spacing	30 inch cotton rows	38 inch cotton rows
12 inch hill-drop	$19290	$24570
16 inch hill-drop	$29440	$32430
20 inch hill-drop	$35530	$37150

* assuming the use of Bollgard and Roundup Ready seed and Temik 15 G at costs shown in Tables 6 and 7.