REMOVAL OF PLASTIC SHEET MATERIAL WITH NORMAL COTTON GINNING EQUIPMENT

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Abstract

U.S. cotton is known to be relatively free of contamination but occasionally pieces of sheet plastic are found in cotton bales produced in the U.S. To better understand how ginning equipment handles pieces of sheet plastic five types of plastic commonly found in U.S. seed cotton fields or used in handling seed cotton were cut into several different sized pieces and added to seed cotton. This mixture was processed in a research ginning system with normal ginning equipment sequence and all outputs from the system were examined for plastic materials. Overall the cylinder-type cleaners removed 10% of the material, the extractor-type cleaners removed 56% of the material, and 17% was retrieved from the lint. Plastic pieces of larger area or that were thinner were more likely to contaminate the lint. Gin managers need to be aware that contamination by sheet plastic is an issue and inform producers and gin employees that they need to be vigilant in not allowing plastic to enter the gin because gin cleaning machinery does not remove all of the contamination.

Introduction

U.S. cotton growers and ginners have always been concerned with producing bales with the least amount of contaminants possible. Particular emphasis has been on fibrous non-cotton materials because of the difficulty for the mills to remove that material from the cotton lint and the damage that type of material causes to the industry. In fact U.S. cotton is perceived as being the cleanest available as documented by a National Cotton Council (2008) survey of cotton mills. Of lesser concern than the fibrous plastics has been the sheet plastic contamination, such as plastic shopping bags. This material may become entrained in the seed cotton after the bags are discarded by consumers, are then blown into the cotton field, and then picked up by the harvesting equipment. However, there have been other sheet plastic materials of concern including irrigation tubing and agricultural mulch (National Cotton Council, No date). In 2012, the Joint Cotton Industry Bale Packaging Committee chairman issued a Contamination Prevention Alert (National Cotton Council, 2012) stating that contamination has been increasing slightly in U.S. cotton and asking producers and ginners to pay increased attention to the issue.

Several years ago John Deere (JD) released the model 7760 harvester which forms a seed cotton module onboard and wraps it in plastic. Several systems are available for removing the plastic from the modules in the gin but most cut the module cover. JD placed an RFID tag in the module cover to facilitate cutting the cover such that smaller pieces of plastic are not created, however, many systems do not use this marker to determine the location for cutting the cover. JD (John Deere, 2008) and others (Cotton Incorporated, 2013) have issued recommendations regarding the cutting of the plastic used in the module wrap. The different systems for removal of the wrap handle the plastic in different ways and the module collapses when the plastic is removed. Therefore, it is possible for pieces of the wrap to be covered by the collapsing module during removal of the wrap.

Some sheet plastic material is removed by cotton ginning equipment but some of the plastic has been found in the lint by mills, Figures 1 and 2. The gin cleaning equipment was designed to remove plant parts from the seed cotton, cylinder cleaners generally remove smaller plant parts such as leaf parts and extractors generally remove larger and heavier material such as hulls. However, no references were found regarding the removal of sheet plastic material from the cotton stream in the gin plant. The purpose of this study was to obtain data to better understand the removal of sheet plastic material from the cotton in the gin.

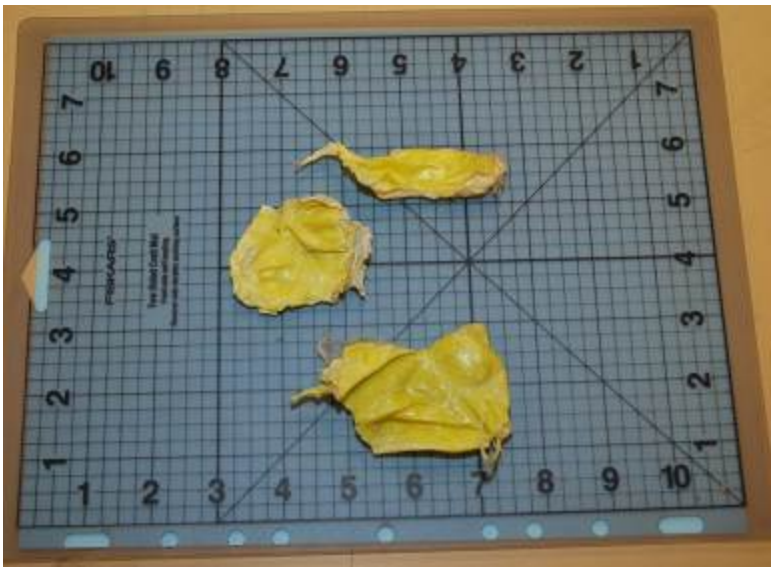

Figure 1. Photograph of material found in a bale of U.S. cotton by a mill, scale in inches. Courtesy of Lance Murchison, National Cotton Council.

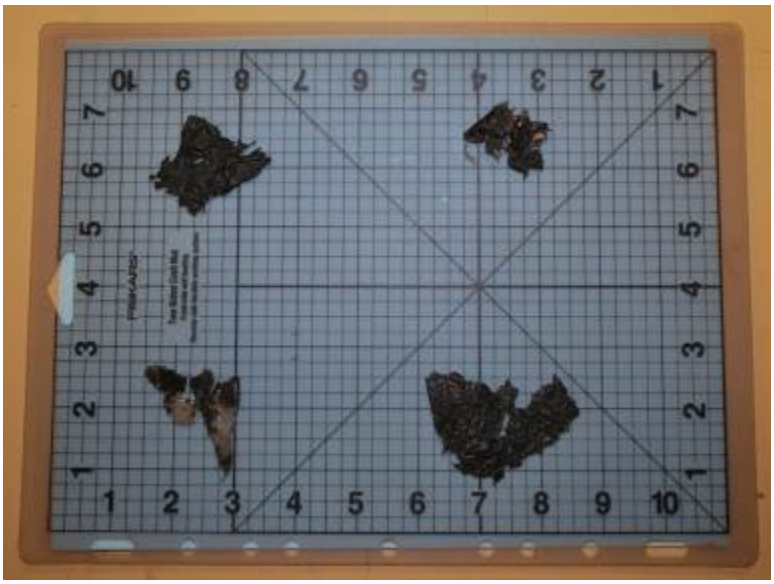

Figure 2. Dark plastic material found in a bale of U.S. cotton by a mill. Courtesy of Lance Murchison, National Cotton Council.

Materials and Methods

Table 1 lists the materials included in the study. All plastic materials included in the study had been used and weathered. The JD module wrap material is comprised of two layers and the material was occasionally observed to delaminate during module manipulation at the gin. Therefore, three materials were included in the study from this material, each of the layers and samples including both layers. The JD module wrap was obtained from a commercial gin and had been used this season. The shopping bags and ice bags were obtained from a cotton field after harvesting located near a gas station which included a market. The agricultural mulch film was obtained from a field in Missouri in which cotton had been grown but the mulch was used the previous year in watermelon production. The irrigation tubing had been used for one season at the Stoneville Experiment Station.

Table 1. Description of sheet plastic materials included in the study.

Material	Appearance	Thickness, in.
JD module wrap, both layers	Yellow/opaque	0.006
JD module wrap, inside layer	White/opaque	0.003
JD module wrap, outside layer	Light/clear yellow	0.003
Polyethylene irrigation tubing	White	0.010
Shopping bag	Beige or off white	0.0005
Polyethylene agricultural mulch film	Black	0.001
Ice bag	Clear/clear blue	0.0015

The seven types of sheet plastic materials were cut in the pieces of several sizes, and a predetermined number inserted into the seed cotton as it entered the gin stream, Table 2. The gin processing was performed in the micro-gin at the USDA Agricultural Research Service in Stoneville, MS. The processing included: 1) shelf dryer with temperature set to 100° F, 2) inclined cylinder cleaner, 3) stick machine, 4) shelf dryer with no heat, 5) Trashmaster cylinder cleaner, 6) extractor-feeder, 7) gin stand with moting, 8) a single saw-type lint cleaner. The 35 different types of plastic samples were randomly assigned the order in which they were processed, shown in Table 2. Each treatment was begun by mixing the plastic pieces into 20 lb (approximately) of seed cotton. After ginning the first 20 lb of seed cotton the waste from each machine was examined along with the lint and seed, including the seed roll in the gin stand, to find the plastic. Additional lots of 20 lb of seed cotton, with no plastic contamination added, were ginned followed by examination for plastic materials until all plastic was retrieved or no additional plastic was retrieved. No more than 80 lb of seed cotton were processed per treatment. The next plastic material was then processed. The retrieved plastic samples were kept. In some cases the plastic samples which had been inserted into the gin stream were found whole in other cases the plastic samples had been damaged or partially shredded. The calculations of where the material ended were made based on percentages, by weight in most cases or by number if the pieces all ended in the waste in whole pieces. At the end of the study the entire gin system was examined but no additional plastic material was found.

Table 2. Description of plastic pieces inserted into the seed cotton before ginning.

ID	Plastic description	Size	Thickness, in	Area, (in^2)	Number of pieces inserted
1	JD module wrap- clear yellow layer	1" x 1"	0.003	1	15
2	JD module wrap- opaque layer	3" x 6"	0.003	18	4
3	JD module wrap- opaque layer	1" x 1"	0.003	1	15
4	JD module wrap- clear yellow layer	1" x 3"	0.003	3	4
5	JD module wrap- clear yellow layer	2" x 4"	0.003	8	4
6	Poly pipe	1" x 1"	0.01	1	15
7	Shopping bags	3" x 6"	0.0005	18	4
8	Shopping bags	3" x 3"	0.0005	9	4
9	Shopping bags	2" x 4"	0.0005	8	4
10	JD module wrap- both layers	1" x 1"	0.006	1	15
11	Plastic mulch	3" x 6"	0.001	18	4
12	JD module wrap- clear yellow layer	3" x 6"	0.003	18	4
13	Plastic mulch	1" x 3"	0.001	3	4
14	JD module wrap- both layers	1" x 3"	0.006	3	4
15	Poly pipe	3" x 6"	0.01	18	4
16	JD module wrap- opaque layer	2" x 4"	0.003	8	4
17	Ice bags	1" x 3"	0.0015	3	4
18	JD module wrap- both layers	3" x 3"	0.006	9	4
19	Poly pipe	1" x 3"	0.01	3	4
20	Shopping bags	1" x 1"	0.0005	1	15
21	Ice bags	3" x 6"	0.0015	18	4
22	JD module wrap- opaque layer	1" x 3"	0.003	3	4
23	Poly pipe	3" x 3"	0.01	9	4
24	JD module wrap- opaque layer	3" x 3"	0.003	9	4
25	JD module wrap- clear yellow layer	3" x 3"	0.003	9	4
26	Poly pipe	2" x 4"	0.01	8	4
27	JD module wrap- both layers	2" x 4"	0.006	8	4
28	JD module wrap- both layers	3" x 6"	0.006	18	4
29	Ice bags	1" x 1"	0.0015	1	15
30	Plastic mulch	1" x 1"	0.001	1	15
31	Plastic mulch	2" x 4"	0.001	8	4
32	Shopping bags	1" x 3"	0.0005	3	4
33	Ice bags	2" x 4"	0.0015	8	4
34	Ice bags	3" x 3"	0.0015	9	4
35	Plastic mulch	3" x 3"	0.001	9	4

Results and Discussion

Figures 3, 4, 5, and 6 show photographs of some of the plastic retrieved from the waste or lint during the study. Some pieces were not damaged by the processing and others were considerably changed.

Figure 3. Pieces of JD module wrap, both layers attached, after testing.

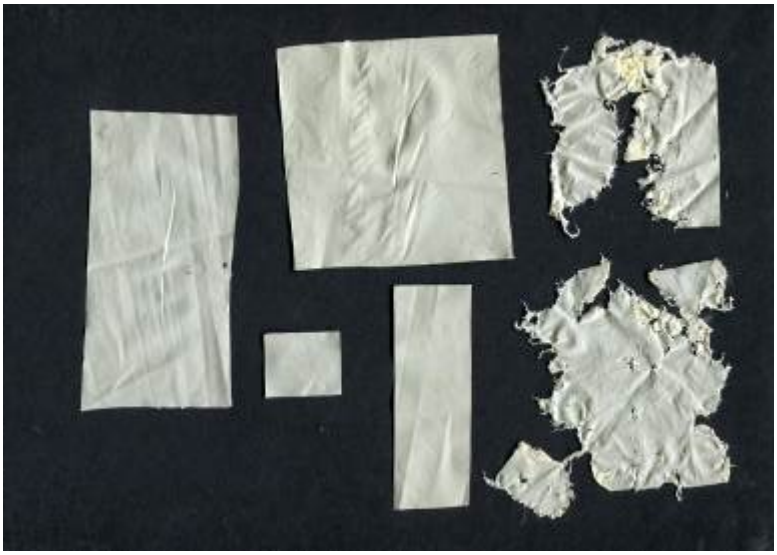

Figure 4. Pieces of the opaque inside layer of JD module wrap after testing.

Figure 5. Pieces of agricultural plastic mulch after testing.

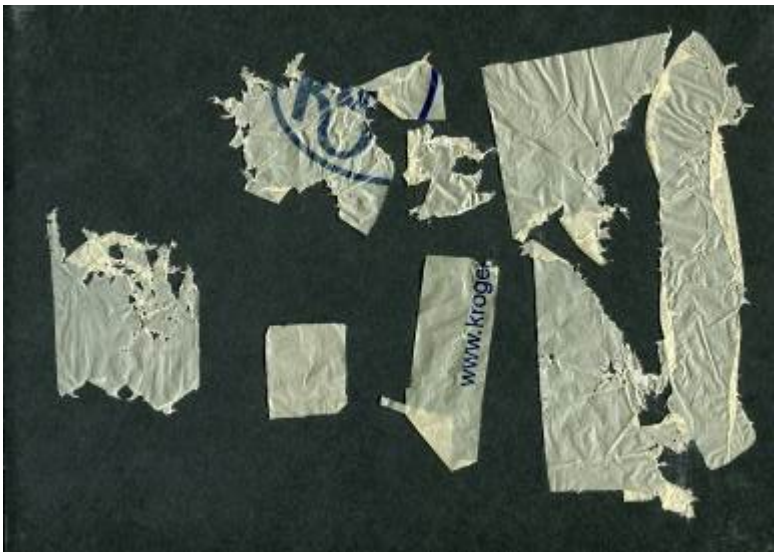

Figure 6. Pieces of shopping bag after testing.

Table 3 shows the percentage of the plastic added to the seed cotton which was found in the lint. In some cases none of the plastic ended in the lint but in other cases more than half of it was retrieved from the lint. In many cases the plastic pieces in the lint had obvious damage, in other cases there was virtually no visible damage. The data has been sorted to make it easier to see relationships with all of the plastic from one source together arranged from small to larger sizes. In general, pieces with smaller area were removed more effectively than larger pieces, and Figure 7 shows the percentage of the plastic retrieved from the lint plotted vs. the area of the plastic piece. It was clear that larger pieces tended to be incorporated into the lint more frequently than smaller pieces. Perhaps the smaller pieces were removed similarly to leaf by the cleaning equipment. Similarly Figure 8 shows the percentage of the plastic retrieved from the lint plotted vs. the thickness of the plastic. In this case the thinner plastic tended to be incorporated into the lint more frequently than thicker plastic. Perhaps the thicker plastic made the plastic pieces behave more like gin trash and the thinner plastic was more flexible, similar to the lint. A new variable was created by dividing the area by the thickness for each piece. A plot of the percentage of plastic found in the lint vs. this

variable shows more clearly that both factors influenced the result, Figure 9.

Table 3. Percentages of plastic materials recovered in the lint and total recovered from different sources.

Description of plastic	Size	Total in cylinder cleaners, %	Total in extractors, %	Total in motes, %	Retrieved from lint, %	Total retrieved, %
Shopping bags	1" x 1"	67	20	0	0	87
Shopping bags	1" x 3"	0	54	11	9	73
Shopping bags	2" x 4"	0	51	6	36	93
Shopping bags	3" x 3"	0	28	0	36	64
Shopping bags	3" x 6"	0	0	2	84	87
Plastic mulch	1" x 1"	40	33	7	0	87
Plastic mulch	1" x 3"	0	22	25		70
Plastic mulch	2" x 4"	0	0	1	55	55
Plastic mulch	3" x 3"	0	0	11	68	79
Plastic mulch	3" x 6"	0	0	6	67	73
Ice bags	1" x 1"	40	53	0	0	93
Ice bags	1" x 3"	0	75	0	0	100
Ice bags	2" x 4"	0	50	4	9	63
Ice bags	3" x 3"	0	0	0	49	49
Ice bags	3" x 6"	0	0	5	36	42
JD wrap-yellow layer	1" x 1"	27	73	0	0	100
JD wrap-yellow layer	1" x 3"	0	100	0	0	100
JD wrap-yellow layer	2" x 4"	0	100	0	0	100
JD wrap-yellow layer	3" x 3"	0	69	13	11	93
JD wrap-yellow layer	3" x 6"	0	0	32	59	91
JD wrap-opaque layer	1" x 1"	47	53	0	0	100
JD wrap-opaque layer	1" x 3"	0	100	0	0	100
JD wrap-opaque layer	2" x 4"	0	100	0	0	100
JD wrap-opaque layer	3" x 3"	0	100	0	0	100
JD wrap-opaque layer	3" x 6"	0	27	7	58	92
JD wrap- both layers	1" x 1"	33	67	0	0	100
JD wrap- both layers	1" x 3"	0	100	0	0	100
JD wrap- both layers	2" x 4"	0	100	0	0	100
JD wrap- both layers	3" x 3"	0	100	0	0	100
JD wrap- both layers	3" x 6"	0	100	0	0	100
Poly pipe	1" x 1"	67	33	0	0	100
Poly pipe	1" x 3"	0	100	0	0	100
Poly pipe	2" x 4"	25	75	0	0	100
Poly pipe	3" x 3"	0	100	0	0	100
Poly pipe	3" x 6"	0	72	11	9	91
Average		**10**	**56**	**4**	**17**	**88**

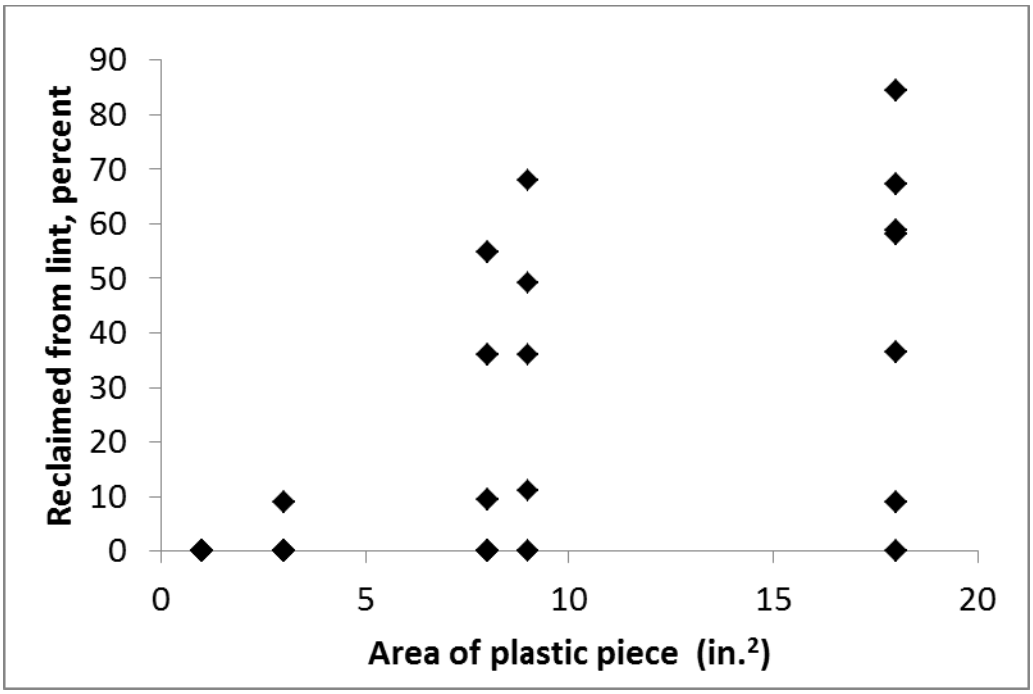

Figure 7. Percentage of plastic material found in lint as a function of the area of the plastic piece.

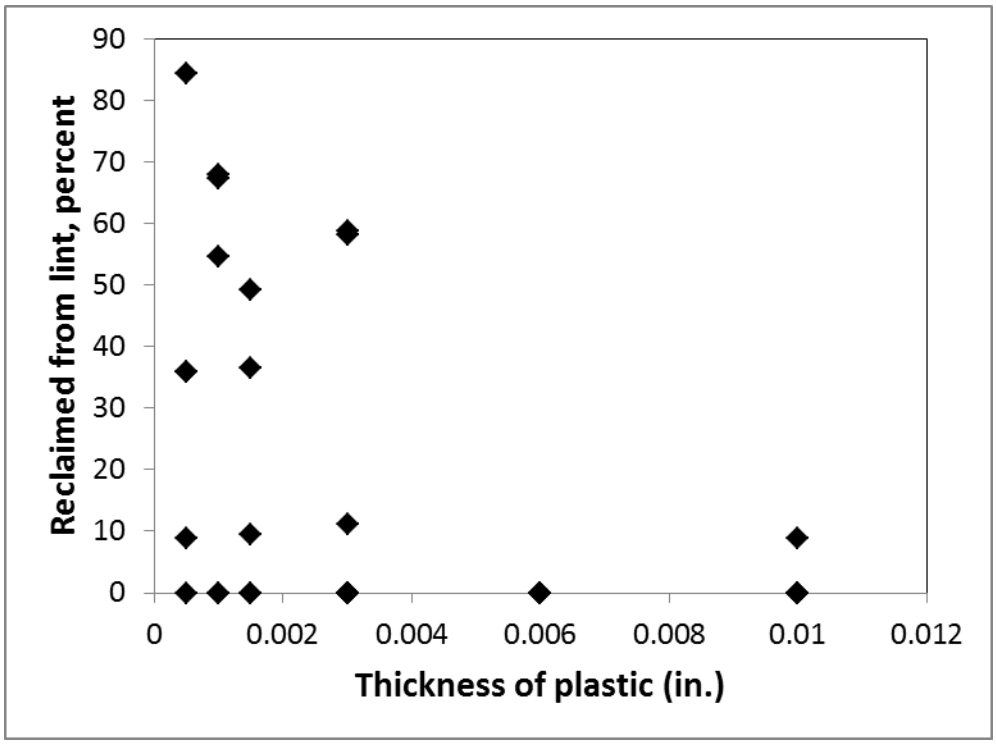

Figure 8. Percentage of plastic material found in lint as a function of the plastic thickness.

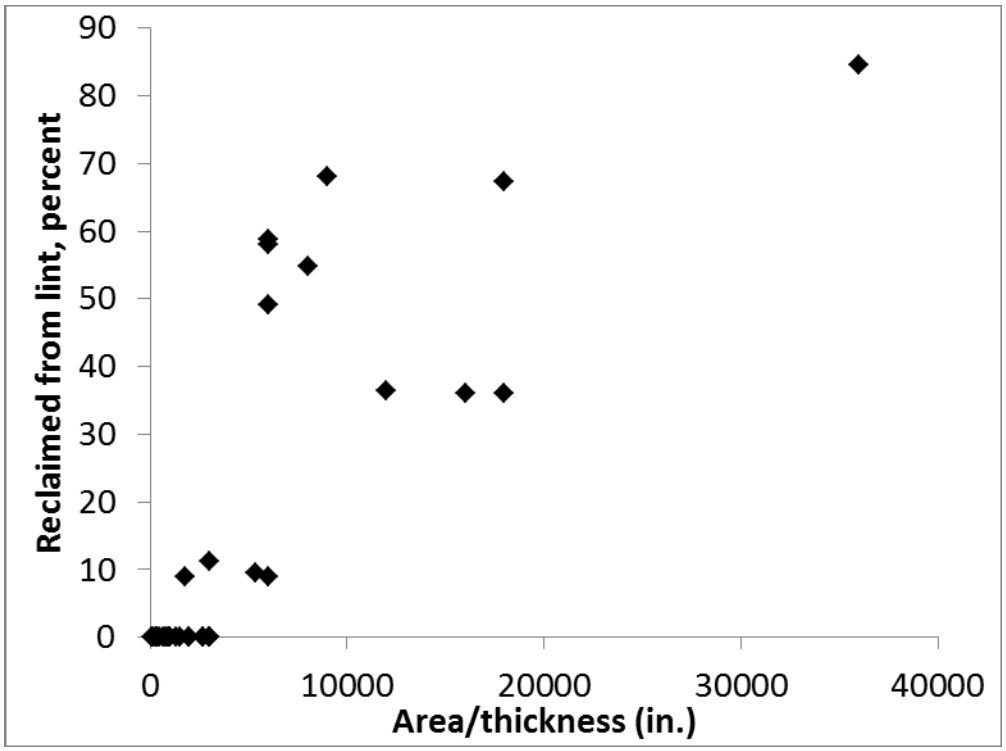

Figure 9. Percentage of plastic material found in lint as a function of the area of the plastic piece divided by the plastic thickness.

Table 3 also shows what proportion of the plastic was retrieved from each major waste stream: cylinder cleaner, extractor or motes. The cylinder cleaner category included an incline cleaner in the first stage and a Trashmaster in the second stage. The extractor category included the stick machine in the first stage plus the extractor on the gin stand. The motes included the gin stand plus saw-type lint cleaner motes. A small amount of plastic was found in the seed from the plastic mulch, only. Clearly the extractors were the better machines for removing the material, overall. The stick machine removed more than the extractor over the gin stand, separate data not shown in the table, presumably because the stick machine cleaned before the gin stand extractor. But for some of the smaller samples more material was removed in the cylinder cleaners than in the extractors. The incline cleaner removed about the same amount of plastic as the Trashmaster, separate data not shown. Because the incline cleaner was ahead of the Trashmaster but didn't remove much more of the material the Trashmaster may be more efficient for removing the material than the incline cleaner.

Overall the cylinder cleaners removed about 10% of the material, the extractor cleaners removed 56% but about 17% was retrieved from the lint. However, for certain test materials more than half were retrieved from the lint. For example, with the largest pieces of plastic from shopping bags virtually all that was retrieved was in the lint. These data show that normal gin processing equipment removed much of the plastic but did not remove nearly all of it. Most importantly plastic material should be kept from entering the gin. More attention to the issue by producers and gin employees would help control the problem. If the problem becomes more persistent additional cleaning machines to remove more of the plastic may be needed at gins.

Conclusion

A study was conducted in which sheet plastic materials of types which have been found or may be found in seed cotton were intentionally introduced to seed cotton and the amount of plastic retrieved from all waste streams and the cotton lint after passing through the normal gin processing equipment was recorded. For small pieces of the lighter plastics the cylinder cleaners were more efficient in removing the contaminant. The stick machine was the most efficient overall in removing the plastic, but pieces of plastic were found in all waste streams plus the seed and lint. In many cases the plastic pieces in the lint had obvious damage, but in other cases there was virtually no visible damage. As a general rule larger plastic pieces and plastic which was thinner was more likely to contaminate lint.

A significant amount of the plastic material was found in the lint, with an average of 17% of the plastic retrieved. This is a troublesome result and gins managers are cautioned to take all reasonable measures to avoid having plastic enter the gin. Education of producers, to avoid having plastic mixed into the module, and the staff at the gin, to carefully remove any plastic encountered including module wrap, is necessary.

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Disclaimer

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