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Planting No-till Cotton after Small Grains

Guangyao (Sam) Wang, Ron Rayner, Randy Norton, Ayman Mostafa, and Shawna Loper

The acreage of small grain / cotton double cropping systems has steadily increased in central Arizona recently. Double cropping of small grains and cotton allows growers to effectively use the long growing season, particularly in the low desert region of central Arizona and potentially increase profitability. With this system, short-season small grain varieties are planted from late November to early December and harvested from mid-May to early June. Cotton is then seeded into the grain stubble and residue and harvested in mid to late November. This article includes recommendations for planting no-tillage cotton after small grains in low-desert central Arizona. Management of cotton planted after small grains is more intensive compared to spring-planted cotton. However, this publication focuses mainly on the cotton planting and stand establishment in the double cropping system.

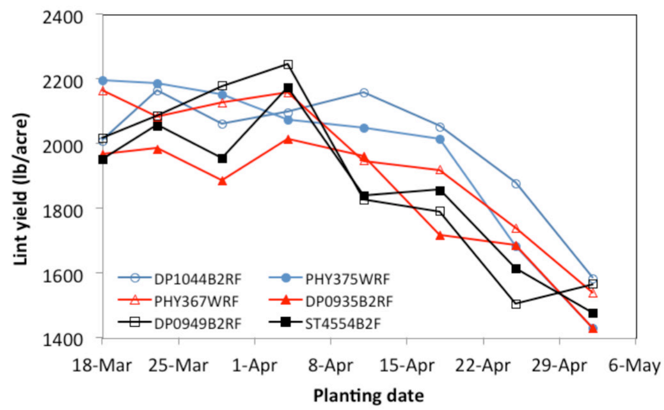

Figure 1. Cotton lint yield as affected by planting dates at Maricopa Ag Center in 2011

Considerations for a Successful Small Grain/ Cotton Double Crop System

Cotton must be planted as soon as possible after the small grain harvest to provide the late planted cotton with the longest growing season possible. A typical sequence of tillage for conventional cotton includes disking, ripping, disking again, landplaning, listing, and shaping beds. If straw is not baled and removed, the field may need to be plowed before disking to avoid straw interfering with other tillage operations. These operations take several days to prepare a field for cotton planting. No-till planting, on the other hand, reduces the time between small grain harvest and planting, and therefore allows earlier cotton planting. A study at Maricopa Agricultural Center in 2011 showed that lint yield was reduced by 20 to 30 lb / acre per day delay in planting date from April 10 to May 2, depending on cotton variety (Figure 1). This is mainly due to the fact that the primary fruiting cycle of cotton crops that are planted in late April and early May falls into a heat stress period in July and August. While reductions of cotton yields resulting from late planting during mid-May to mid-June have not been studied in central Arizona, it is reasonable to believe that planting cotton as early as possible during this period would give growers the best chance to produce the highest lint yield. However, it is possible that planting cotton in mid-May to late June could result in the primary fruiting cycle occurring after the most intense heat stress, avoiding detrimental effects of heat stress that normally occur in cotton planted in early May, but still with enough heat units and season length for a high-yielding cotton crop.

No-till planted cotton also results in reduction of operational costs. It is estimated that a no-till versus a conventional tillage planting system may reduce production costs $85 to $110 / acre in labor and equipment. With no-till, growers are able to use more workers and equipment for harvest of grain crops and management of other crops in their fields. When planted at the same time, no-till planting or minimum tillage can produce similar cotton lint yield compared to conventional tillage in some cases (Adu-Tutu et al., 2004).

Grain straw management

Straw from the harvested grain crop can be shredded and spread back over the field or baled and removed from the field. The former approach provides for a much higher residue cover in the field during early cotton growth. This residue cover serves as mulch providing excellent weed control and could decrease herbicide use over the growing season. Additionally, the straw also adds to soil organic matter, improves soil tilth, and increases soil moisture holding capacity (Adu-Tutu et al. 2003). Potential drawbacks of leaving residue on the soil surface include cooler soil temperatures and a 1-2 day delay of cotton germination compared to bare soil. This could potentially increase seedling disease incidence, although it happens rarely in central Arizona when cotton is planted in May and June. In either case, the grain stubble should be cut to lower than six inches. Stubble left taller than this can shade the cotton seedlings can result in taller and thinner seedlings, reducing cotton growth and lint yield.

Pre-plant and post-plant nitrogen (N) management

Grain straw has a very high carbon (C): nitrogen (N) ratio (80:1, the ratio of total carbon and total nitrogen in the residue). Grain straw mulch therefore leads to reductions in plant available NO_3-N, as the NO3-N in the soil is tied up during soil microbial breakdown of the straw residue (Wang and Nolte, 2010). When wheat straw is incorporated into the soil, pre-plant N fertilizer is recommended for cotton at a rate of 15 lb/acre of N per ton of grain straw (Doerge et al., 1991). When straw is left on soil surface or removed from the field, the pre-plant N rate should be decreased, although no specific information are available on optimum pre-plant N rates for this situation.

It is important to analyze cotton leaf petioles for cotton N status and N recommendations during the cotton growing season (Silvertooth and Norton, 2011). Nitrogen fertilizer should be managed to ensure that the crop does not cut out too early (so the growing season is fully utilized) and does not have N concentrations too high to interfere with the defoliation process (Silvertooth, 2001a). Plant mapping techniques can also be used to monitor crop growth and manage fertilizer input. Height to node ratios can be used to monitor the vegetative and reproductive balance of the crop while fruit retention can be used to evaluate crop fruit load status (Silvertooth, 2001b).

Figure 2. Yetter™ equipment attached to the front of planter disk to push away grain straw and loosen up the soil.

Equipment for no-till planting

A traditional cotton planter can be used for no-till cotton planting with a row cleaner or residue manager such as those manufactured by Yetter™ attached to each planter (Figure 2). The row cleaner pushes the residual grain straw away from planting rows and helps ensure good seed to soil contact when planting. However, row cleaner's spiked wheels should not be used to till the soil. If the soil surface is hard, as is often the case when cotton is planted into dry soil and then irrigated to induce germination, the wavy disc blade of the Yetter™ in Figure 2 can be replaced with a plain disc blade that cuts deeper into the soil and ensure that seeds are buried properly during planting. While seeding rate should be higher than early planting because of shorter growing seasons, planting depth in the no-till planting is similar to conventional planting.

Variety choice and a case study

Currently there is very limited information on variety choices for the double cropped small grains-cotton production system. A common approach is to plant short-season (early maturity) cotton varieties that respond well to late planting. This is especially true for areas with shorter growing seasons, such as Marana. However, variety trials at "A Tumbling T Ranches" in Goodyear, AZ in 2010 and 2011 showed that cotton yields in wheat-cotton double-cropping are determined more by specific variety than by maturity-type, indicating that early maturity type cotton may not always be the best choice (Table 1). Lint yield ranged from 1607 to 2089 lb/acre in 2010 and 1266 to 1903 lb/acre in 2011, indicating significant yield potential for cotton crops planted after durum wheat.

Durum wheat (Variety 'Orita') was planted on November 22, 2009 and November 27, 2010 and 300 lb/acre of N was applied to the crop in both wheat growing seasons. Durum wheat was harvested on May 15, 2010 and May 20, 2011 with 3.8 and 3.5 ton/acre of grain yield in 2010 and 2011, respectively. Wheat straw was shredded and spread on soil surface before cotton planting.

In the 2010 and 2011 cotton variety trials, experimental design was a randomized complete block with four replications. Cotton varieties were no-till planted on flat with 38-inch row spacing at a rate of 60,000 seed/acre on May 30 in both 2010 and 2011. Nitrogen fertilizer was applied at a rate of 50 lb/acre of N in the form of urea one week after cotton germination. Flood irrigation was used to keep plants free of water stress and insects were controlled as needed. Mepiquat chloride (Pix) was applied at a rate of 12 oz/acre on July 26 and 16 oz/acre on August 5 in 2010 and 12 oz/acre on August 7 and 16 oz/acre on August 19 in 2011. In addition, 16 oz/acre of Pix was applied on September 6, 2010 and September 12, 2011 to stop vegetative growth and prepare the crops for defoliation. Cotton was last irrigated, defoliated, and harvested on September 28, October 23, and November 6 in 2010 and September 29, October 21, and November 4 in 2011, respectively.

Irrigation management

Normally only one irrigation event is needed for cotton emergence due to warm weather in May and June. The residue cover on soil surface in no-till systems can reduce

Table 1. Lint yield and fiber quality results from the Variety Trial, Goodyear, AZ, 2010.

Year	Variety*	Lint yield† (lb/acre)	Lint Turnout (%)	HVI Color	Staple (32nds)	Strength (g/tex)	Length (inch)	Uni-formity (%)	Micro-naire	Leaf Grade	Premium (cent/lb)	Value‡ ($/acre)
2010	DP1044B2RF M-F	2089 a	32.4	31	38	31.4	1.18	83.1	4.2	3	4.5	$1,181
	DP1032B2RF M	1904 ab	34.9	31	38	30.2	1.18	81.7	4.2	2	4.6	$1,078
	FM9170B2F M	1892 b	32.8	31	39	32.1	1.20	82.4	3.9	3	3.4	$1,048
	PHY375WRF E	1824 bc	32.9	31	37	29.2	1.17	81.9	4.3	3	4.2	$1,025
	DP0912B2RF E	1774 bcd	31.8	31	37	30.7	1.13	82.1	4.8	3	4.1	$995
	PHY367WRF E	1748 bcd	31.8	31	38	31.9	1.17	82.5	4.3	3	4.6	$990
	ST4288B2F M	1669 cd	29.1	31	37	30.1	1.17	81.5	4.4	3	3.0	$919
	DP1034B2RF M	1618 d	33.6	21	39	29.5	1.22	83.0	4.1	3	4.7	$917
	DP1028B2RF E-M	1618 d	34.0	21	37	29.2	1.16	81.9	4.4	2	4.8	$918
	DP161B2RF M-F	1616 d	29.0	31	39	32.0	1.21	82.3	4.1	3	4.5	$913
	PHY565WRF M-F	1615 d	31.5	31	39	32.3	1.21	82.9	3.9	3	4.6	$914
	ST4498B2F E-M	1607 d	30.5	31	38	32.9	1.16	83.2	4.3	4	4.0	$900
	Mean	1748	32.0	-	38	31.0	1.18	82.4	4.2	3	4.3	$983
	LSD↨	192	1.7	-	1	1.8	0.04	NS	0.3	0.8	NS	120
	P value§	0.003	0.0002	-	0.02	0.007	0.01	0.25	0.002	0.04	0.29	0.006
2011	DP1219B2R2 E	1903 a	34.0	31	39	33.4	1.20	81.5	4.3	2	4.8	$1,081
	ST5458B2F M	1693 b	32.7	31	38	30.5	1.18	81.7	4.7	4	3.5	$939
	PHY499WRF M	1606 c	35.3	41	38	32.0	1.17	83.7	4.7	4	2.0	$866
	DP1044B2RF M-F	1566 cd	32.0	31	38	30.0	1.19	82.5	4.2	2	4.7	$888
	DP0912B2RF E	1536 d	32.2	31	37	29.6	1.14	82.9	4.8	2	4.6	$869
	DP0935B2RF M	1525 d	33.2	31	37	29.8	1.15	81.8	4.6	1	4.4	$861
	DP1032B2RF M	1430 e	34.4	31	38	31.0	1.17	81.9	4.3	2	4.8	$812
	DP1212B2R2 E	1380 e	31.8	31	39	31.4	1.21	84.0	4.8	4	4.0	$773
	DP161B2RF M-F	1370 e	28.2	31	40	30.6	1.23	82.6	4.1	3	4.7	$776
	10R020B2R2 E	1365 e	32.2	21	37	28.9	1.17	83.0	4.4	2	5.2	$781
	FM2484B2F M	1266 f	31.1	31	39	30.6	1.21	82.1	3.8	3	4.7	$718
	Mean	1513	32.5	-	38	30.7	1.18	82.5	4.4	2	4.3	$851
	LSD↨	69	1.2	-	1	1.5	NS	NS	0.2	1.0	0.8	43
	P value§	0.0001	0.0001	-	0.02	0.003	0.07	0.05	0.0001	0.004	0.0001	0.0001

* Cotton variety with estimated maturity type: E: Early season, M: Mid-season, F: Full season. 10R020B2R2 is a Monsanto/Delta and Pine line with early maturity.
† Means followed by the same letter are not statistically different according to a Fisher's least significant difference means separation test.
‡ Value calculated from CCC loan schedule base price of $0.52/lb + premium/discount.
↨ LSD stands for Least Significant Difference. If the difference between any two particular means in the same column is larger than LSD, there is significant difference between the two means at a probability level of 5%.
§ A value of $p<0.05$ indicates significant difference among measurements of all varieties at a probability level of 5%.

evaporation rate, resulting in longer moisture retention in shallow soil compared to bare soil. This is important for seedling growth because most roots are shallow and no-till could result in longer irrigation intervals in early stages of growth. However, the irrigation water may run slower in no-till fields due to grain straw left on the soil surface and crop residue can increase the amount of irrigation water compared to conventional tillage (Martin et al., 2005).

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THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE AND LIFE SCIENCES
TUCSON, ARIZONA 85721

GUANGYAO (SAM) WANG
Cropping Systems Specialist and Assistant Professor Maricopa Ag Center /School of Plant Sciences

RON RAYNER
A Tumbling T Ranches, Goodyear, AZ

RANDY NORTON
Resident Director, Safford Ag Center & Area Associate Agent/ANR

AYMAN MOSTAFA
Area Assistant Agent, Agriculture

SHAWNA LOPER
Assistant Area Agent, Agriculture

CONTACT:
GUANGYAO (SAM) WANG
samwang@cals.arizona.edu

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