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NO-TILL ORGANIC CULTURE OF GARLIC UTILIZING DIFFERENT COVER CROP RESIDUES AND STRAW MULCH FOR OVER-WINTERING PROTECTION, UNDER TWO SEASONAL LEVELS OF ORGANIC NITROGEN

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Garlic is a crop that can be grown organically with a minimum of effort. It is usually planted in the Fall so that cloves have time to grow and develop roots, and meet chilling requirements for proper bulbing in the Spring. On a small scale, garlic is best grown on raised beds, which provide good soil drainage that limits rotting of planting stock and slows degradation of wrapper leaves as the bulbs mature.

In 2003 and 2004, we evaluated the potential for no-till planting into beds with a frost killed, standing cover crop in place. Three cover crops, Sorghum Sudangrass a thick grassy cover crop, Lablab (soybean like legume) and Sunhemp, a tropical legume, were evaluated. As supplemental treatments, the plots were mulched or not mulched with straw. Mulching is a common practice in colder northern areas to limit frost heaving, but benefits are not well known in Virginia where the soil may not freeze deeply, and in particular there is a question of its use when residue from a cover crop is in place. Two levels of organic nitrogen (N) were applied to the plots over the life of the planting, using several N sources. This application was split between Fall (2/3) and Spring (1/3) with total N rates of 90 and 180lbs/acre.

Methods:
The experiment was conducted at the Kentland Ag Research Farm near Virginia Tech (~ elevation 1700ft.). Three replicates of each of the three cover crops were planted during the first week of August into permaculture raised beds, with each replicate 3' wide and 30' long. After the frost killed the standing cover crops (Fig. 1), we took measurements of the biomass, pressed the dead material flat against the soil, and planted the plots (October 24, 2003). Cloves of the cultivar 'Musik', a hard neck type, were set into the raised beds and in double rows approximately 12-15" apart, with cloves set ~6-7" apart in the rows. Cloves were planted approximately 5-6" deep using a soil test probe to make holes and to simulate no-till planting (Fig. 2). On November 3, cover crop plots were either covered with straw at 4-5" depth, or not, as an additional experimental treatment. On this date nitrogen treatments were also made across the respective straw treatments. Two-thirds of the total nitrogen rate was applied for the respective Low and High N treatments (60 or 120 lbs N/acre), using an organic 5-5-3 material (Harmony). On April 7, 2004, a second application of nitrogen was made using sodium nitrate (16% N, at 20 and 40 lbs/acre for respective Low/High treatments), and again on April 30 as blood meal (13% N, at 10 and 20 lbs/acre). Thus all cover crop plots were split experimentally by straw / no-straw application, and straw treatments were split by a low and high seasonal nitrogen level. Final plot length for nitrogen subplots was 7.5'.

Plots were harvested on July 2, and bulbs were hung in a protected shed and air-dried for 3 weeks. Bulbs were cleaned, weighed, and sorted as marketable or not, based on condition and size. Mean weight, diameter and clove counts of marketable bulbs were taken for a 10 bulb sub-sample in each treatment. Internal clove decay was also noted.

Results:
Data for the experiment is presented in Table 1. Note that statistical separation of means within treatments is represented by letter designation, and results followed by same letters are not significantly different.

Cover Crop Effect: The levels of biomass residue are presented by footnote in Table 1, with Sunhemp and Sorghum Sudangrass providing the most at 1.5 and 1.2 tons/acre residue respectively. There was bulb loss following planting in all three cover crop treatments. Bulb loss was just over 44% after S. Sudangrass, while in the other two crops, loss was 12% lower.

S. Sudangrass also had a lower percent of marketable bulbs than both Lablab and Sunhemp and less marketable yield than Lablab, and a higher percent of individual clove decay compared to Sunhemp. Total yield, mean bulb weight and diameter, and clove counts were not affected by cover crop type. From the results, it appears that Lablab provided the best environment for over-wintering, followed by Sunhemp. Why S. Sudangrass was detrimental is unclear, but may be related to the legume N fixing abilities of the other two cover crops, or the root mass differences, resulting in more nitrogen tie-up during root decay of the more extensively rooted S. Sudangrass, or perhaps more root residues were in contact with bulbs, causing faster degradation of wrappers - the main reason for lack of marketability.

Straw Effect: When averaged across all treatments, the application of straw significantly increased total and marketable yield, the percent of marketable bulbs, and increased bulb weight, diameter and clove counts per bulb. There was also a trend for greater bulb loss when plots were not mulched, though mulching had no effect on clove decay percentages. At this location in the mountain region, it appears that mulching is beneficial for winter protection of cloves, even when significant residue exists from cover crops.

Nitrogen Level Effect. Interestingly, the two nitrogen levels had minimal differences, though marketable yield was improved by the "High" seasonal level of 180lbs total N/acre. Trends suggest an overall improvement for the other yield parameters at the higher N level, but also an increase in internal clove decay, though not significantly so. Given the slow release nature of the materials used (with exception of sodium nitrate), and the levels of decaying root biomass left by cover crops to tie up N, these results are not surprising.

There was only one significant interaction (data not shown), between straw and nitrogen treatments, in which the use of straw in combination with the higher N rate worked together to improve yields.

Table 1. Effects of cover crop type, straw mulching and applied nitrogen on garlic (cv. Musik) survival, yield and quality. 2003-2004 season.

Treatment1 Cover Crop	**Bulb Loss (%)**	**Total Yield (gr/plot)**	**Mrkt. Yield (gr/plot)**	**Mrkt. Bulbs (%)**	**Bulb Weight (gr)**	**Bulb Diameter (cm)**	**Clove Count (# / bulb)**	**Internal Clove Decay (%)**
Sorghum Sudangrass	44.3a	697a	512b	65b	51.2a	4.8a	6.2a	4.9a
Lablab	32.4ab	958a	859a	88a	58.0a	5.0a	6.8a	1.9ab
Sunhemp	31.2b	871a	777ab	89a	52.8a	4.8a	6.5a	0.9b

Straw Mulch								
Mulched	33.9a	961a	872a	85a	60.9a	5.3a	7.2a	2.3a
Non-Mulched	38.2a	723b	560b	75b	47.0b	4.5b	5.8b	2.8a
Total Nitrogen Level								
Low - 90lbs/acre	36.1a	806a	678b	78a	52.5a	4.8a	6.4a	2.0a
High - 180lbs/acre	36.1a	878a	754a	83a	55.4a	5.0a	6.6a	3.0a

[1] Cover crop sown in early August, killed by frost and rolled prior to planting on October 24. Biomass (tons/acre) for each cover crop: (Sorghum Sudangrass: 1.12; Lablab: 0.47; Sun Hemp: 1.5). Mulching: mulched or not mulched with 3-4 inches of straw on 11/5/03; Total applied nitrogen from organic nitrogen sources, 2/3 applied in Fall and 1/3 in Spring; Materials: Fall-Harmony 5-5-3; Spring-Blood Meal 13-0-0, and Sodium Nitrate 16-0-0.

Fig. 1. Plot preparation of Sorghum Sudangrass following winter kill

Fig. 2. Setting of garlic cloves with minimal disturbance to simulate no-till.

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