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PREFACE

This is the eighth edition of the *Journal*, formerly named the *New Jersey Grain and Forage Journal*. The name change reflects the fact that submissions to this journal come from researchers and Extension educators from the Mid-Atlantic region. Articles from New Jersey, Delaware and Maryland are included in this edition.

A goal of this publication is to provide summaries of research, demonstration and outreach activities to farmers and producers, industry personnel, researchers and educators. Other goals are to assist in information sharing across state borders and to increase collaborative efforts in research and extension activities. The web-based format has helped to expand the range of distribution at a low cost, something essential as dollars to support such activities has declined at most of our Land Grant institutions.

I would like to acknowledge and thank Rutgers Cooperative Research and Extension for their on-going support of this project, as well as the following people who served as reviewers for this edition: Richard Taylor, University of Delaware; Robert Kratochvil, University of Maryland; Greg Roth, Penn State University; and William Bamka, Rutgers University. Lastly, thank you to the Cook College/NJAES Resource Center for their assistance in publishing this web-based journal.

I hope that these results will be of interest and use to you. Your suggestions are always welcome, as it is our desire to meet your most important needs.

Sincerely,

Daniel Kluchinski, Editor
Mid-Atlantic Grain and Forage Journal

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Table of Contents

Multi-Year Research Project Results

Research Update

Single-Year Research and Demonstrations

Evaluation of Perennial Cool Season Forage Grasses Under Simulated Management Intensive Grazing

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Research Question

The increased interest in grazing dairy cows and other livestock in the region have caused graziers to question if traditional hay-type forage grass varieties will perform best under management intensive grazing, or if introduced varieties claiming higher forage quality will provide a competitive advantage. Traditional grass varieties managed for grazing have been primarily tall fescue and orchardgrass. New varieties of both species are being introduced. Perennial ryegrass is a standard grazing grass in many areas of the world, but its adaptability in this region is uncertain. Performance and persistence of these grasses need to be tested to allow producers to make more informed decisions.

Literature Summary

Forage grass variety testing has been traditionally accomplished at universities in the region under a hay cutting schedule. There was little data on many new forage grass varieties being introduced in the region. No information was available comparing how these new varieties would perform and persist beside standard, hay-type grasses under an intensive harvest schedule.

Study Description

Thirty-eight perennial grass varieties were seeded in a complete randomized design with four replications per variety at the Western Maryland Research and Education Center in September 1999. The entire plot area was harvested on a schedule to simulate management intensive grazing. Plots were harvested 10 times in 2000 due to excellent summer rainfall and 6 times in both 2001 and 2002 due to dry conditions. A 30 square foot area of each plot was cut with a flail-type harvester. This total wet sample was weighed in the field. A 500-gram subsample was taken, frozen and later dried to determine dry matter (DM) yields. Stand counts were completed in September 2000 and in April and November of 2001 and 2002. A nitrogen application rate of 200 lbs per acre per year was maintained with applications made in 50 lb increments in March, May, June and September.

Applied Questions

Did the introduced grazing-type varieties of tall fescue and orchardgrass perform and persist as well as the standard hay-type varieties?

In general, the hay-type grass varieties provided more DM yield than the grazing-type grasses even under intensive cutting schedule. However, several grazing-type tall fescues and orchardgrass varieties provided DM yields that were not statistically different from the yields of the hay-type grasses.

Did the perennial ryegrass varieties perform and persist competitively with the other grasses in the study?

A number of the ryegrasses provided DM yields comparable to some of the orchardgrasses only during the first year of the study. The Poly II ryegrass provided the top yield of all the varieties for the first year, but did not maintain yield in year two and did not persist in year three. The perennial ryegrasses were severely stressed by weather extremes and either did not yield well in the second and third years of the study or did not persist for the three years.

Recommendations

Tall fescue and orchardgrass varieties provide more DM yield over several years and are appear better adapted than the perennial ryegrass varieties. Producers requiring only DM yield can effectively use standard hay type grass varieties in grazing systems. Producers concerned with increased grass palatability and animal performance may select improved grazing type forage grasses to test on the farm. Grass species and varieties successful in grazing systems in other countries or other regions of this country need to be tested to assure adaptability to this region prior to marketing.

Evaluation of Perennial Cool Season Forage Grasses Under Simulated Management Intensive Grazing

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Introduction

Livestock graziers and Extension agents in the mid-Atlantic region have been concerned with the application of grass variety trial data collected under hay-type harvest management for use in variety selection for management intensive grazing systems. In addition, forage grass varieties successful in other regions of this country or in other countries are being introduced with little information on their adaptability to diversity of soils, microclimates and livestock grazing systems in the U.S. In September 1999, 38 perennial grass varieties (seven fescues, 11 orchardgrasses, 11 perennial ryegrasses, and 9 blends or other species) were seeded in small plots to be mechanically harvested to simulate a management intensive grazing (MIG) system. Plant material was harvested when grasses were six to ten inches tall with a flail-type harvester. Total dry matter yields were highest for the fescues, followed by the orchardgrasses, and then the ryegrasses. Stand counts were completed twice annually showing which varieties did not persist due to environmental or management stress. In addition to the data collected, the plots have been used as the site of 12 pasture walks, seminars and trainings for producers and seedsmen, five trainings for NRCS, Forest Service, and Extension personnel and two experiment station field days allowing over 800 persons to compare the grasses *in situ*. Livestock producers, industry and university specialists in 16 states and six other countries have received this data to date. Plot data has been used in grazier decision-making in selecting improved grass varieties across the mid-Atlantic region.

Materials and Methods

Thirty-eight perennial grass varieties (seven tall fescues, 11 orchardgrasses, 11 perennial ryegrasses, nine mixtures or other species) were seeded September 14, 1999 at the Western Maryland Research and Education Center (WMREC) in a completely randomized design with four replications per variety. Plot area was six feet by ten feet. Seeding was completed in a tilled seedbed using a 12-row Kincaid cone unit planter with double-disk openers on six-inch row spacing. Seeding rates per acre were 25 lbs. for tall fescue, 20 lbs. for orchardgrass, and 30 lbs. for perennial ryegrass varieties. The other species were seeded at rates calculated to provide approximately six million seeds per acre or about one seed per square inch. Seeding rates for tall fescue, orchardgrass and perennial ryegrass were based on practices of successful graziers in the area. These rates are higher than most university recommendations and with the exception of the perennial ryegrass; they exceed the one seed per square inch recommendation.

Soil tests at the beginning of the trial indicated no additional phosphorous or potassium were required and soil pH was satisfactory. Nitrogen was applied prior to seeding at a rate of 50 lbs. per acre. A nitrogen application of 200 lbs. per acre was maintained during each of the harvest seasons (2000-2002) applied in 50 lb. increments in mid-March, early May, early June, and early September.

To simulate MIG, the grasses were harvested when six to 10 inches tall as determined by the grasses with the most vigorous growth. The entire plot area was harvested at each cutting. A uniform cutting height of three inches was maintained for all varieties. A flail-type harvester with a 36-inch cutting width was used to harvest the center of each plot. The harvester was designed and built by the University of Wisconsin Experiment Station. It was powered by a John Deere F935 tractor. Plots were harvested 10 times in 2000 due to above average summer rainfall and six times in 2001 and 2002 due to dry conditions.

The total wet grass sample from the 30 sq ft. harvest area was weighed in the field. A subsample of approximately 500 grams was collected from each sample and frozen. These subsamples were later dried at 70°C for 72 hours at the Central MD Research and Education Center. Dry matter yields were calculated on a per acre basis. Comparative stand counts based on the percentage of soil coverage were recorded in September 2000 and in April and November of both 2001 and 2002.

Results and Discussion

The dry matter yields for all varieties totaled for each of the three years and as a total for the entire three-year test are summarized in Table 1. The stand evaluations, which are closely related to dry matter yields, are included in Table 1. For dry matter (DM) yields across species tall fescue varieties exceeded orchardgrass varieties and orchardgrass exceeded the ryegrasses. In general, the hay-type tall fescues (Martin 2, Fawn, and Select) provided more DM yield than the grazing-type fescues even under the intensive cutting schedule. However, Barcarella, a fine-leaved grazing-type tall fescue, produced the second highest yield behind Martin 2. Benchmark, a standard hay-type orchardgrass, produced the top yield of this species. The more recumbent growth habit of the grazing-type orchardgrass varieties seemed to correspond with a less vigorous growth. Note that Barolex tall fescue and Barexcel orchardgrass were released as named varieties by the conclusion of this study. Several of the ryegrass varieties produced yields statistically equal to some orchardgrass varieties during 2000. During the first year of this study, the summer was wet and cool and these conditions provided 10 cuttings for the season, increasing ryegrass yields. Poly II, a hybrid ryegrass, topped all DM yields in the first year but lost stand density by 2001 and was depleted by 2002. Two other ryegrass varieties (Bronsyn and Impact) did not persist into the third year of the study. In spite of freeze desiccation in December 2001 and two years of severe drought in 2001 and 2002, the majority of the ryegrass varieties did persist but with disappointing yields.

The three mixture treatments were primarily ryegrass in the first year, then tended toward either fescue or orchardgrass in years two and three. The move to fescue or orchardgrass dominance in year two and three significantly affected the three year yield total.

Grasslands Maru *(Phalaris* spp.) does not form a sod. However, it was persistent and performed well in dry conditions. The festulolium produced very well in 2000, but declined in 2001 and 2002. Surprisingly, timothy, reed canarygrass, and smooth bromegrass check varieties persisted quite well under the intensive harvest regimen. Kentucky bluegrass developed a sod and persisted very well.

Table 1. Dry matter yield (ton/A) and stand (%) of 38 perennial grasses using a simulated grazing harvest schedule. Keedysville, Maryland, 2000-2002.[a]

Variety	Yield (ton/A)				Stand (%)	Species
	2000	2001	2002	Total	11/10/2002	
Martin # 2	5.50	4.17	4.80	14.46	100	tall fescue
Barcarella	5.22	3.83	4.46	13.51	100	tall fescue
Fawn	5.14	3.65	4.06	12.85	100	tall fescue
Select	5.32	3.35	3.69	12.37	100	tall fescue
Barolex (FA6BTR1)	4.88	3.54	3.92	12.33	98	tall fescue
Barcel	4.99	3.18	3.71	11.88	100	tall fescue
TF-33	4.88	3.12	3.74	11.74	100	tall fescue

Variety	Yield (ton/A)				Stand (%) 11/10/2002	Species
	2000	2001	2002	Total		
Benchmark	4.92	3.03	3.55	11.50	90	orchardgrass
OG9705G	4.89	2.87	3.38	11.14	91	orchardgrass
Barexcel (Bar DGL 9BTR-F)	4.66	2.80	3.03	10.49	88	orchardgrass
Haymate	4.41	2.68	3.23	10.33	90	orchardgrass
PP4	4.35	2.47	3.38	10.20	97	mixture
PP6	4.37	2.34	3.24	9.96	96	mixture
Bar DGL 9BTR-G	4.16	2.79	2.94	9.89	91	orchardgrass
Bar DGL 9BTR-KL	3.83	2.79	2.98	9.59	88	orchardgrass
Grasslands Maru	3.90	2.51	3.09	9.50	73	*Phalaris* spp.
Bar DGL 7BTR-A	3.92	2.55	3.01	9.48	83	orchardgrass
Palaton	3.54	2.58	3.27	9.40	50	reed canarygrass
Baridana	3.78	2.62	2.95	9.34	91	orchardgrass
Bar DGL 8BTR-E	4.04	2.47	2.81	9.32	80	orchardgrass
Toro	3.56	2.76	2.61	8.94	88	timothy
Bar DGL GN89-A	3.67	2.46	2.73	8.87	90	orchardgrass
Cambria	3.68	2.34	2.49	8.51	85	orchardgrass
PP3	4.36	2.37	1.72	8.46	49	mixture
Bounty	2.93	2.32	3.15	8.39	78	smooth bromegrass
Poly II	5.64	2.71	0.00	8.35	1	perennial ryegrass
Duo	4.16	2.01	1.97	8.14	65	*festulolium*
Aubizque	3.66	1.88	2.00	7.54	65	perennial ryegrass
Elgon	4.05	2.05	1.14	7.24	35	perennial ryegrass
Belramo	3.58	1.73	1.44	6.75	64	perennial ryegrass
Grand Daddy	3.62	1.70	1.39	6.70	28	perennial ryegrass
Barfort	3.41	1.96	1.34	6.70	45	perennial ryegrass
Mara	3.30	1.63	1.41	6.35	33	perennial ryegrass
Barnhem	3.29	1.60	1.39	6.27	46	perennial ryegrass
Bronsyn	3.79	2.12	0.00	5.92	1	perennial ryegrass
BG-34	3.11	1.45	1.24	5.79	25	perennial ryegrass
Impact	3.57	1.98	0.00	5.55	23	perennial ryegrass
Liberator	1.50	1.08	2.19	4.77	100	Kentucky bluegrass
coefficient of variation	17.03	14.06	12.18	12.88		
$LSD_{0.05}$	0.99	0.50	0.48	1.67		

[a] Seeded September 14, 1999; Yields (ton per acre DM basis); Yields indicated represent the sum of 10 cuttings in 2000, 6 cuttings in 2000, and 6 cuttings in 2002; Varieties are listed by rank for total yield; Mean of 4 plots; Stand score based on a score of 1 to 100, 100= perfect stand.

The purpose of this small plot variety study was to allow producers and the grass seed industry the opportunity to select those perennial cool season forage grasses best adapted to the MIG forage systems in the Mid-Atlantic region. One assumption tested was that introduced grass varieties can out-perform the hay-type grasses traditionally grown in the region.

Dry matter yield of tall fescue and orchardgrass varieties showed that the hay-type grasses can produce higher DM yields although several of grazing-type grasses produced DM yields not statistically different from the yields of the hay-type varieties (Table 1). Stand counts showed that tall fescue forms a dense sod and is very persistent under stress (Table 1). Orchardgrass can produce a dense stand but it is still a bunchgrass and stand density declines with time and amount of stress.

Tall fescue and orchardgrass varieties will continue to provide the backbone of the cool-season grazing in this region. Producers will need to determine whether the nutritional needs of their livestock and the soil conditions they have on the farm warrant a more productive grass in terms of dry matter or quality. In 2004, the 3,000 grass samples from this study will be analyzed to determine forage quality at the USDA Beltsville research station. This data will be used to calculate potential milk yield per acre for each of the grass varieties in this study. Data from the analyses will be reported at a future date.
Although perennial ryegrass provides the primary grass of some of the major grazing regions of the world, the extreme climatic conditions and lack of irrigation capabilities on farms of the mid-Atlantic region pose a significant challenge to perennial ryegrass production. Severe winter desiccation, summer heat, and drought reduce the productive potential of this high quality forage grass.

In this study, maintaining a cutting height of three inches instead of two inches may have impacted yields, especially the bluegrass and perennial ryegrass. Information gathered from visits to many grazing farms shows that perennial ryegrass can perform well on deep fertile soils under carefully managed grazing, intensive fertility, and irrigation. Hybrid ryegrass (Poly II) and *Festulolium* (Duo) performed very well in the first season and can be considered in short rotation grass stands or in mixtures to maximize first year yields. Grass mixtures of several species produce well in the first year and persisted as the ryegrass contribution in the mixture declined and the tall fescue or orchardgrass portion began to dominate the stand.

Grasslands Maru, reed canarygrass, timothy, and smooth bromegrass are more adapted to hay production or less intensive grazing than the intensive schedule maintained in this study. Kentucky bluegrass was included to remind producers that there is still a place for a persistent sod-forming grass.

The grazing systems on farms across the mid-Atlantic region are as diverse as the farmers managing these pastures and the livestock they are feeding. Taking into account the diversity of soils, climatic conditions, animal nutritional needs and the intensity of grazing management to be employed on the farm, many of the grasses tested herein could have a place on-farm although each producer must look at all relevant factors and available data to make the best decision.

The perennial grass variety study to be seeded at WMREC in 2005 will continue to test forage grasses under simulated MIG. This study will have several tall fescue and perennial ryegrass entries with endophyte-infected, alkaloid-free seed designed to increase the resistance and persistence of grasses. This technology may provide producers new varieties within the next few years.

Corn Response to Starter and Seed-Placed Fertilizer in Delaware

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Research Question Starter fertilizers containing nitrogen and phosphorus are commonly used by many corn growers in Delaware, however, concerns over high P concentrations in many Delaware soils have raised questions about the need for using P in starter fertilizers. Our goals were to evaluate frequency of response from different types of starter fertilizers and to compare methods of applying starter fertilizers.

Literature Summary The last major evaluation of starter fertilizer use in Delaware was done nearly 25 years ago. This work suggested that starter fertilizer applications usually resulted in profitable yield increases and that starters should contain both nitrogen and phosphorus. Soil test phosphorus levels of many soils in Delaware are significantly greater now than 25 years ago. Recent research in other states has shown little need for using starter fertilizers containing phosphorus on soils testing high in phosphorus.

Study Description Field length strip trials at 30 locations throughout Delaware were utilized during a three-year study to compare two treatments: starter fertilizer versus no starter fertilizer. In addition, small-plot studies were conducted during 2001 and 2002 to compare starters containing different types of fertilizer and to compare traditional two-by-two fertilizer placement with seed-furrow placement. Starter fertilizer responses were determined by measuring plant populations, days to silking, grain harvest moisture, and grain yields.

Applied Question *How often and at what magnitude does corn respond to starter fertilizer in Delaware?*

Across all 30 strip trials, the average yield increase of strips containing starter fertilizer compared to strips that contained no starter fertilizer was 7 bu/A (4.3 percent). There were 22 strips that contained a combination of both nitrogen and phosphorus, and when these fertilized strips were compared to non-fertilized strips, 18 of the strips had an average yield increase of 5 bu/A or greater and the average yield increase of these 22 strips was 8 bu/A (4.7 percent).

Are fertilizer responses a result of having only nitrogen in the starter or a combination of nitrogen and phosphorus?

It is not possible to answer this question from the strip trials, so small-plot studies were conducted to address this question. The results of the small-plot studies were not conclusive because there were no consistent responses to starter fertilizers in these small-plot studies. We believe this question will need to be answered in future studies that utilize strip-trial methodology.

Do pop-up fertilizers have an advantage over traditional two-by-two placements of starter fertilizer?

This study provides no evidence to suggest that pop-up fertilizers resulted in faster early-growth responses or greater yield responses when compared to traditional two-by-two placements. Higher rates of pop-up fertilizers did cause visual plant injuries but did not reduce plant populations.

Recommendations

Results of this study suggest that the use of starter fertilizers during corn production will often result in yield increases that are profitable. Unfortunately, this study does not allow a determination of which nutrients or nutrient combinations are providing the response. If pop-up fertilizers are used, low rates of fertilizer should be used to prevent fertilizer injury of the corn, especially on sandy soils.

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Introduction

Applying a small amount of fertilizer near the corn seed while planting is a common practice. There are questions, however, about the need for starter fertilizers when soils have high nutrient concentrations, particularly regarding the application of phosphorus (P) in the starter. A number of studies have examined the role of starter fertilizers in corn. Jokela (1992) found a high probability of obtaining a yield response to starter fertilizers containing P and potassium (K) when soil test levels were medium or lower, but the probability of a response was much lower on soils testing higher in P and K. A Missouri study (Scharf, 1999) found an average yield increase of 13 bu/A for plots receiving starter fertilizer when compared to plots with no starter fertilizer in no-till corn; but, he reported that the most profitable starter fertilizer contained only nitrogen (N).

In Delaware, few formal studies have been done since the early 1980s, and there has been little work done on soils that are considered excessive in soil test P. University recommendations typically suggest that starter fertilizer responses can be obtained with the application of fertilizers containing only N if soil test P levels are very high or excessive. However, many corn growers who use starter fertilizer will typically apply both N and P regardless of the soil test P concentration. Our objectives in this project were to: 1) determine the likelihood and magnitude of starter fertilizer responses, 2) compare seed-placed fertilizers to traditional placement (2” by 2”) and rates, and 3) compare starter fertilizers containing only N with traditional starters containing N and P.

Materials and Methods

Strip Plots

Strip trials were conducted during the 2000, 2001, and 2002 growing seasons to determine the magnitude and frequency of grain yield responses to the application of starter fertilizer in corn. These strip trials were done in cooperation with corn growers throughout Delaware and consisted of field-length strips that compared the grower’s standard starter fertilizer to no starter fertilizer. All management factors (e.g., planting date, hybrid, type and rate of starter, tillage, and irrigation) were determined by the corn grower. The two treatments were planted as side-by-side comparisons that utilized either three or four replications at each site. A two-by-two placement of fertilizer, which means the fertilizer was placed two inches below and two inches to the side of the seed, was used at most sites. Pop-up fertilizer (refers to the placement of fertilizer directly into the seed furrow) was used at three sites. The two pop-up fertilizers used in the studies were Riser (7-17-3 and is a registered trademark of Platto Chemical Co.) and NA-CHURS (6-24-6 and is a registered trademark of NA-CHURS/Alpine Solutions). Harvest was done with the grower’s combine and grain yields were determined by using either a weigh wagon or a yield monitor on the combine.

The cost of starter fertilizer ranged from about $8 per acre to as much as $17 per acre depending on the fertilizers used. The average cost of the fertilizer used in the strip trials was $12 per acre. At these fertilizer costs, a grower would need a yield increase of slightly less than 5 bu/A from the starter fertilizer to recover the fertilizer cost, assuming a price of $2.50/bu for corn grain. Therefore, our assumption in this discussion is that any response of 5 bu/A or greater would be profitable.

Small Plots: 2001

In 2001, small-plot research trials were conducted at three locations in Sussex County, DE (Table 1). Plots were planted with a four-row (30-inch) research planter equipped to allow application of either dry fertilizer or liquid fertilizer in a two-by-two placement, in the seed furrow (i.e., pop-up fertilizer), or on the soil surface behind the press wheels of the planter. Nineteen fertilizer treatments were evaluated and each treatment was replicated six times at each site in a randomized-block design. All treatments were applied either as a two-by-two placement or pop-up placement. The fertilizers used in this study were dry triple superphosphate (0-46-0), liquid urea ammonium nitrate (30-0-0), liquid ammonium polyphosphate (10-34-0), and liquid ammonium sulfate (8-0-0-9). Individual plots were four rows wide and 50 feet in length. Plant populations were determined by counting the number of plants in two 20-ft sections of row when the corn was about three inches tall (V2 growth stage). Grain yields were determined by harvesting 30 feet of the center two rows of each plot with a small-plot combine and were adjusted to 15.5 percent moisture. Grain moisture was determined by a moisture meter on the combine. Silking percentage was determined by counting the number of plants with visible silks in two 20-ft sections of row within each plot.

Table 1. Soil characteristics for small plot studies, 2001.

Site [a]	Soil Type	Soil pH	O.M. (%)	P	K	Mn	Zn
				Mehlich 3 (ppm)			
1	Hammonton Loamy Sand	5.8	1.9	81	72	5.9	3.4
2	Fallsington Sandy Loam	5.3	1.9	244	90	14.7	2.0
3	Woodstown Sandy Loam	5.8	1.4	88	74	11.0	5.0

[a] Site 1 was located at the Georgetown Research and Education Center, while Sites 2 & 3 were located in fields of local area corn growers. Soil samples were taken from the surface 8-inch layer of soil in the fall of 2001 following corn harvest.

Site 1 had a previous crop of corn, was planted on April 20 into ideal soil conditions, and was irrigated as needed throughout the season. Site 2 had a previous crop of soybeans, was planted on May 4 into dry soil conditions, and was not irrigated throughout the growing season. Site 3 had a previous crop of corn and was planted on May 8 into dry soil conditions; this site was irrigated during the season, however, the irrigation system was not used to help with stand establishment. The hybrid planted at each site was Pioneer 33A14 and all three sites used conventional tillage. Nitrogen fertilizer was applied at all three locations at rates considered to be optimum for grain production, and this N fertilizer was dribbled in a surface band between the rows when the corn was about 8 to 12 inches tall at a uniform rate across all plots within each site.

Small Plots: 2002

In 2002, small-plot studies were established at five locations throughout Sussex County (Table 2). Plots were planted with the same planter used for the 2001 studies; however, the actual treatments applied were different from the 2001 studies. A randomized-block design was used with six replications of each treatment at all sites except Site 5, which had only four replications. The fertilizers used in this study were Riser, Germinator (9-18-3 and is a registered trademark of Growmark FS), liquid urea ammonium nitrate (30-0-0), liquid ammonium polyphosphate (10-34-0), liquid ammonium sulfate (8-0-0-9), dry triple superphosphate (0-46-0), and a dry mixture of 7.5-25-7.5 that was made by mixing ammonium sulfate (21-0-0), triple superphosphate (0-46-0), and muriate of potash (0-0-60). The fertilizer placement methods used were pop-up, two-by-two, combination of two-by-two and pop-up, or surface application behind the press wheels of the planter.

Individual plots were four rows wide and the length of each plot varied among the sites but ranged from 110 to 180 feet depending on the distance between the irrigation wheels. Plant populations were determined by counting the number of plants in two 25-ft sections of row within each plot just prior to silking. Silking percentage was determined by counting the number of plants with visible silks in two 25-ft sections of row within each plot. To monitor the N status of the corn, leaf chlorophyll meter (LCM) measurements were collected with the model 502 Minolta SPAD meter (Spectrum Technologies, Plainfield, IL) as described by Blackmer and Schepers (1995). These readings were taken at the R3 (milk stage; Ritchie and Hanway, 1984) stage of development. The LCM measurements were taken midway between the leaf tip and leaf base and midway between the leaf margin and midrib from 30 representative plants selected from the center two rows of each plot. These measurements were then averaged for each plot.

Table 2. Soil characteristics for small plot studies, 2002.

Site [a]	Soil Type	Soil pH	O.M. (%)	P	K	Mn	Zn
				Mehlich 3 (ppm)			
1	Evesboro Loamy Sand	5.9	1.6	226	141	15	3.1
2	Rumford Loamy Sand	5.8	1.1	161	98	5	9.1
3	Woodstown Sandy Loam	5.5	2.1	237	267	21	6.3
4	Sassafras Sandy Loam	5.7	1.3	103	53	6	4.9
5	Woodstown Sandy Loam	5.9	1.4	77	64	9	3.7

[a] Site 4 was located at the Georgetown Research and Education Center, while Sites 1, 2, 3, and 5 were located in fields of local area corn growers. Soil samples were taken from the surface 8-inch layer of soil in the spring just prior to planting.

Grain yields were determined by harvesting 85 feet of the center two rows of each plot with a small-plot combine and were adjusted to 15.5 percent moisture. Grain moisture was determined by a moisture meter on the combine. Site 4 was no-tilled, while the other four sites were conventionally tilled. All five sites were planted to Pioneer 33B51. Site 1 had a previous crop of corn and was planted on May 15. Site 2 had a previous crop of winter wheat/soybean and was planted on May 8. Site 3 had a previous crop of corn and was planted on May 9. Site 4 had a previous crop of winter wheat/soybean and was planted on April 23. Site 5 had a previous crop of corn and was planted on May 10. Nitrogen fertilizer was applied at all five sites at rates considered to be optimum for grain yield production; this N fertilizer was dribbled in a surface band when the corn was about eight to 12 inches tall. All five sites had excellent stand establishment and were irrigated throughout the growing season.

Laboratory Procedures

All soil samples were collected from the 0- to 8-inch surface layer and immediately dried at 38°C and then ground to pass a 2-mm sieve. The soil samples were analyzed for pH, organic matter (OM), and Mehlich 3 (M3) nutrients, which included phosphorus (P), potassium (K), manganese (Mn), and zinc (Zn). Soil pH was determined by using a soil to water ratio of 1:1 and OM was determined by loss on ignition (Sims and Heckendorn, 1991). Mehlich 3 analyses were performed as follows: 1 g of soil was mixed with 10 ml of the extracting solution (0.2 M CH_3COOH + 0.25 M NH_4NO_3 + 0.015 M NH_4F + 0.013 M HNO_3 + 0.001 M EDTA) for 5 minutes and filtered through Whatman #42 filter paper (Mehlich, 1984). The M3 extracts were analyzed by inductively coupled plasma atomic emission spectroscopy (ICP-AES).

Statistical Analysis

All statistical analyses were performed by using standard procedures of SAS Version 8.0 (SAS Institute, 1998). All LSD values were determined using the General Linear Models (GLM) procedure. When no statistically significant differences were observed among treatments, this is designated as NS.

Results and Discussion

Weather conditions in 2000 were ideal for corn production; in fact, the state average corn yield was the best on record in both Delaware and Maryland. The 2001 season was another excellent year for corn production. The 2002 growing season was wet during the planting season with unusually cool temperatures during April and May. After the cool and wet spring, the remainder of the growing season was hot and extremely dry. In fact, the 2002 growing season was the driest year on record in Sussex County.

Strip Plots

Across all 30 strip trials, the strips with starter fertilizer averaged 7 bu/A more grain than strips without starter (Table 3). In these strip trials, 22 of the sites had some combination of both N and P in the starter fertilizer (not including the pop-up sites), 18 of these 22 sites had a yield increase of 5 bu/A or more and the average yield increase across these 22 sites was 8 bu/A or about 5%. Bill Mitchell, a former Extension Specialist with the University of Delaware, reported an average yield increase of 6 bu/A from the starter fertilizer trials he conducted from 1970 through 1984 (Mitchell, 1984); this 6 bu/A increase in grain yield from starter was about a 5% increase. In our strip trials, five sites had only N without P in the fertilizer material. Of these five sites, only one had a yield increase greater than 5 bu/A. We believe, however, that it would be inappropriate to make conclusions of N-only versus N and P combinations with such a small number of N-only trials. Two sites (25 and 28) had only pop-up fertilizer while one site (22) had N applied in a two-by-two placement with pop-up (Riser) also applied in the seed furrow. The yield increase at site 22 was dramatic, but it is not possible to determine if this yield increase was due to N, the Riser, or a combination of both.

It is often assumed that the probability of a response to starter fertilizer decreases as the planting date becomes later in the spring (i.e., warmer soil temperatures) and as soil test P level increases (Scharf, 1999). Based on these strip trials, it appears that there is little relationship between planting date or soil test P level and the frequency or magnitude of response to starter fertilizers containing P. Another common assumption is that responses to starter fertilizer are not as likely when animal manures are applied. The yield responses from these strip trials suggest that poultry litter applications had little impact on determining if responses to starter fertilizer would occur.

Small Plots: 2001

Visual observations of the number of emerged plants (data not shown) at selected times during emergence showed that the pop-up treatments resulted in delayed emergence compared to all other treatments. These delays in emergence, however, were only statistically significant at Site 3. At all three sites, there were visual signs of fertilizer burn on roots of all pop-up treatments, except for the 2 gal/A rate of 30-0-0 and the 5.5 gal/A rate of 10-34-0. Nonetheless, most damaged plants recovered from the early fertilizer injury and were able to emerge and grow normally. There were statistically significant differences observed in established plant populations (Table 4); however, there were no consistent trends among treatments. It is important to note that the highest rate of pop-up fertilizers should have resulted in severe stand reductions based on most University recommendations, but this was not observed. Though severe stand reductions were not observed, application rates this high are not recommended when using pop-up fertilizers.

Table 3. Summary of 30 strip plots with and without starter fertilizer, 2000-2002 [a].										
Site	Year	Grain Yield (bu/Are)		Yield Resp (bu/A)	P (FIV)	Starter Fertilizer [b] (lb/A)	Planting Date	Poultry Litter (ton/A)	Till	Irr
		No Starter	Starter							
1	2000	178	186	8	23	10-32-0	May 8	0	CT	Y
2	2000	174	181	7	177	21-73-0	May 1	0	NT	Y
3	2000	185	195	10	235	11-36-0	May 15	2.5	NT	Y
4	2000	180	197	17	214	23-15-0B	May 4	0	CT	Y
5	2000	161	166	5	68	23-15-0B	May 26	0	CT	N
6	2000	117	117	0	304	13-17-0S	May 3	3	CT	N
7	2000	155	164	9	41	12-40-0Zn	May 23	3	CT	Y
8	2000	125	135	10	232	10-32-0	May 10	0	NT	N
9	2000	177	191	14	112	18-36-18	May 15	3	CT	Y
10	2000	137	146	9	119	9-22-4SZn	May 15	5	CT	N
11	2001	148	151	3	115	30-0-0SZn	May 8	3	NT	Y
12	2001	125	126	1	56	54-0-0	May 2	0	CT	N
13	2001	152	147	-5	205	33-0-0	May 29	3	CT	Y
14	2001	154	153	-1	282	13-17-0S	April 4	3	NT	N
15	2001	106	113	7	56	40-48-0S	May 2	0	CT	N
16	2001	216	221	5	246	13-17-0S	April 18	0	CT	Y
17	2001	149	162	13	235	35-25-0	April 27	4	CT	N
18	2001	135	144	9	228	13-17-0S	April 26	3	NT	N
19	2001	108	121	13	138	14-45-14	May 31	0	NT	N
20	2002	218	223	5	207	11-28-0	April 9	0	CT	Y
21	2002	181	182	1	244	13-17-0S	April 15	3	CT	Y
22	2002	159	179	20	407	65-0-0 & 2 gal P-up	April 24	0	CT	Y
23	2002	154	172	18	244	40-25-0S	April 18	3	CT	Y
24	2002	161	168	8	164	30-28-0	May 16	0	CT	Y
25	2002	195	201	6	324	3 gal P-up	May 21	4	CT	Y
26	2002	199	207	8	147	38-68-0Zn	April 17	0	CT	Y
27	2002	182	196	14	181	33-0-0	May 8	4	NT	Y
28	2002	185	187	2	401	2 gal P-up	May 6	4	CT	Y
29	2002	208	202	-6	137	25-17-17	April 13	0	CT	Y
30	2002	207	208	1	137	25-0-0	April 13	0	CT	Y

[a] Yield Resp = yield response to starter; P FIV = soil test P (FIV is equal to ppm of Mehlich 3P); Till = Tillage, where CT is conventional tillage and NT is No-Till; Irr = irrigation (Y=yes and N=no); poultry litter was applied in early spring.

[b] Fertilizer was applied in a two-by-two placement at all sites, except sites 25 (Riser) and 28 (NA-CHURS) where only a pop-up fertilizer was placed directly into the seed furrow and site 22 where N was added in a 2x2 placement and 2 gal/A of pop-up (Riser) was placed into the seed furrow. Some sites also had a small amount of other nutrients and are identified as follows: Zn=zinc, S=sulfur, B=boron.

Table 4. Plant populations at growth stage V2 for small plot studies, 2001.					
Treatment / Placement	Rate	(unit)	Site 1	Site 2	Site 3
			Plant Population (plants/A)		
Control	0		28314	19892	30840
0-46-0 / 2x2	100	lb	26862	20038	28750
0-46-0 / 2x2	180	lb	28924	20328	27007
30-0-0 / 2x2	2	gal	27878	19312	28314
8-0-0-9 / 2x2	8.1	gal	26484	19892	27588
10-34-0 / 2x2	5.5	gal	26310	19457	28895
30-0-0 / 2x2	4.1	gal	26136	21344	29795
8-0-0-9 / 2x2	16.7	gal	27878	20038	26833
10-34-0 / 2x2	11.4	gal	26572	19021	27298
30-0-0 / 2x2	7.4	gal	24539	20183	27152
10-34-0 / 2x2	20.5	gal	27704	19166	28459
8-0-0-9 / 2x2	30.2	gal	24568	19457	26717
30-0-0 / pop-up	2	gal	27298	19457	27733
8-0-0-9 / pop-up	8.1	gal	25613	18730	26426
10-34-0 / pop-up	5.5	gal	27356	18730	26862
30-0-0 / pop-up	4.1	gal	26354	21054	27878
8-0-0-9 / pop-up	16.7	gal	24394	19892	28227
10-34-0 / pop-up	11.4	gal	25962	19312	27298
30-0-0 / pop-up	7.4	gal	25410	19312	29766
$LSD_{0.05}$			2289	2320	2449

A common assumption among some corn growers is that the application of starter fertilizers containing P will result in more rapid early growth and faster maturity of corn. The application of starter fertilizer did result in visual early growth responses compared to the control plots at all three locations in 2001. These early growth responses were most noticeable on plots containing P in the fertilizer. By the time the corn reached the silking stage, there were significant differences among treatments in the number of days required to reach a given silking percentage (Table 5); however, there was no consistent trend among the treatments when analyzed as individual sites or when all three sites were pooled together. This lack of consistent trends suggests that the responses were random and that there were no clear differences among any treatments.

There were statistically significant differences observed in grain yields (Table 6) and harvest grain moisture (Table 7) at all three sites in 2001. There were, however, no consistent trends in grain yields among the different treatments at any of the locations when analyzed individually or pooled together. It does appear, however, that harvest grain moisture was influenced by having P in the starter fertilizer at Site 1 in 2001. All seven treatments at Site 1 that had P in the starter fertilizer had the lowest grain moisture. This was not observed at Sites 2 and 3.

Table 5. Percentage of plants silked for small plot studies, 2001.					
Treatment / Placement	Rate	(unit)	Site 1	Site 2	Site 3
			Plants Silked (%) [a]		
Control	0		48	41	62
0-46-0 / 2x2	100	lb	84	44	79
0-46-0 / 2x2	180	lb	43	40	89
30-0-0 / 2x2	2	gal	30	54	80
8-0-0-9 / 2x2	8.1	gal	60	31	74
10-34-0 / 2x2	5.5	gal	71	37	80
30-0-0 / 2x2	4.1	gal	55	57	67
8-0-0-9 / 2x2	16.7	gal	50	44	70
10-34-0 / 2x2	11.4	gal	77	63	85
30-0-0 / 2x2	7.4	gal	60	50	74
10-34-0 / 2x2	20.5	gal	54	57	91
8-0-0-9 / 2x2	30.2	gal	51	35	80
30-0-0 / pop-up	2	gal	25	38	86
8-0-0-9 / pop-up	8.1	gal	50	50	72
10-34-0 / pop-up	5.5	gal	65	21	69
30-0-0 / pop-up	4.1	gal	23	35	66
8-0-0-9 / pop-up	16.7	gal	56	55	71
10-34-0 / pop-up	11.4	gal	94	29	80
30-0-0 / pop-up	7.4	gal	52	27	75
$LSD_{0.05}$			40	36	27

[a] Silking counts collected on July 3 at Site 1, July 11 at Site 2, and July 19 at Site 3.

Table 6. Grain yields for small plot starter studies, 2001.

Treatment / Placement	Rate	(unit)	Site 1	Site 2	Site 3
			Grain Yield (bu/A)		
Control	0		173	115	153
0-46-0 / 2x2	100	lb	167	115	170
0-46-0 / 2x2	180	lb	148	107	167
30-0-0 / 2x2	2	gal	176	117	168
8-0-0-9 / 2x2	8.1	gal	171	124	164
10-34-0 / 2x2	5.5	gal	161	103	160
30-0-0 / 2x2	4.1	gal	151	111	167
8-0-0-9 / 2x2	16.7	gal	157	112	172
10-34-0 / 2x2	11.4	gal	176	108	164
30-0-0 / 2x2	7.4	gal	162	118	158
10-34-0 / 2x2	20.5	gal	183	122	156
8-0-0-9 / 2x2	30.2	gal	175	115	150
30-0-0 / pop-up	2	gal	154	118	160
8-0-0-9 / pop-up	8.1	gal	167	110	167
10-34-0 / pop-up	5.5	gal	158	111	161
30-0-0 / pop-up	4.1	gal	155	126	167
8-0-0-9 / pop-up	16.7	gal	171	108	166
10-34-0 / pop-up	11.4	gal	164	108	157
30-0-0 / pop-up	7.4	gal	173	109	174
$LSD_{0.05}$			23	19	24

Table 7. Harvest grain moisture for small plot studies, 2001.					
Treatment / Placement	Rate	(unit)	Site 1	Site 2	Site 3
			Grain Moisture (%)		
Control	0		20.1	12.5	16.4
0-46-0 / 2x2	100	lb	18.1	12.6	16.2
0-46-0 / 2x2	180	lb	18.8	12.6	16.6
30-0-0 / 2x2	2	gal	19.7	12.5	16.5
8-0-0-9 / 2x2	8.1	gal	19.2	12.8	16.1
10-34-0 / 2x2	5.5	gal	18.6	12.1	16.2
30-0-0 / 2x2	4.1	gal	20.1	12.4	16.7
8-0-0-9 / 2x2	16.7	gal	19.5	12.3	16.4
10-34-0 / 2x2	11.4	gal	18.1	12.4	16.3
30-0-0 / 2x2	7.4	gal	18.9	12.6	16.5
10-34-0 / 2x2	20.5	gal	18.1	13.0	15.9
8-0-0-9 / 2x2	30.2	gal	19.7	12.4	16.9
30-0-0 / pop-up	2	gal	20.5	12.9	16.4
8-0-0-9 / pop-up	8.1	gal	19.9	12.7	16.6
10-34-0 / pop-up	5.5	gal	18.9	12.7	16.2
30-0-0 / pop-up	4.1	gal	19.8	12.8	16.6
8-0-0-9 / pop-up	16.7	gal	19.4	12.5	16.3
10-34-0 / pop-up	11.4	gal	18.2	12.4	16.6
30-0-0 / pop-up	7.4	gal	19.3	12.7	16.3
$LSD_{0.05}$			0.5	0.6	0.7

Small Plots: 2002

There were no visual differences observed in emergence among any treatments in 2002 at any of the five locations. Established plant populations were similar across all five sites and all treatments (Table 8). There were some statistically significant differences observed in plant populations, however, these differences did not follow distinct patterns among treatments and appear to be of little practical importance. The only site that showed obvious visual early growth differences among treatments was Site 4.

Comparing the days-to-silking data among treatments (Table 9) would suggest that the two-by-two treatments that contained P in the starter generally tended to silk slightly sooner than the other treatments, although this trend was not dramatic and only statistically significant in some situations. The grain moisture data showed only slight differences among treatments, and again, no consistent trend among the treatments (Table 10). Research by Blackmer and Schepers (1995) showed that LCM readings that are different by more than 5% represent significant differences in N status of corn. The LCM readings from this study indicate that overall there were no treatments that appeared to be lacking in N status (Table 11), with the possible exception of the control treatment at Site 2.

Grain yields were excellent at most sites in 2002 (Table 11). The yield data were similar to the other data collected in 2002, which showed no significant trends among treatments. In general, these small-plot studies would indicate no need to use starter fertilizers when planting corn. In fact, at Site 4 (the only no-till site) the yield of the control was the highest among all treatments. When the yield data were averaged across all five sites based on the percentage of the control treatments within each site, it shows that there was only a four percent range (97 to 101) in average yield among all treatments (see far right column of Table 11); these yield differences were not statistically significant. This observation explains why there were no consistent trends among any treatments in measured variables. A study in Kansas (Gordon et al., 1997) showed that corn hybrids can differ in their response to starter fertilizers; some hybrids showed consistent responses to starter fertilizer while other hybrids never responded. Because the same hybrid was planted at all five sites in 2002, it is possible that this hybrid does not respond to starter fertilizer.

Table 8. Plant populations for small plot starter studies, 2002.

Treatment	Trt # [a]	Site 1	Site 2	Site 3	Site 4	Site 5
		Plant Population (plants/A)				
No starter	1	26659	26310	25904	26020	27094
3 gal Riser	2	26078	26368	25729	26310	26484
3 gal Germinator	3	26136	25497	25091	26543	26397
3 gal 10-34-0	4	26194	25265	24336	25671	25526
3 gal 8-0-0-9	5	26775	25846	25729	26136	26049
11.4 gal 10-34-0	6	26310	25729	24916	26368	26136
4.1 gal 30-0-0	7	26600	26775	26484	27414	26049
16.7 gal 8-0-0-9	8	25904	25091	25497	25555	26833
100 lb 0-46-0	9	26717	26426	26601	27240	27007
180 lb 7.5-25-7.5	10	26252	26717	25729	26659	26746
11.4 gal 10-34-0	11	26020	25962	24568	26020	25788
11.4 gal 10-34-0	12	26368	27936	25788	27240	27181
21-0-0 +Riser	13	26136	26426	25904	26891	26920
21-0-0 +8-0-0-9	14	26252	26252	26136	26426	26223
$LSD_{0.05}$		NS	1562	1085	1219	1292

[a] Trts 2-5 were all applied as pop-up; Trts 6-10 were applied as 2x2; Trt 11 was applied as 3 gal of 10-34-0 as pop-up and 8.4 gal of 10-34-0 as 2x2; Trt 12 was applied on the soil surface behind the press wheels of the planter; Trt 13 was applied as 64 lb of 21-0-0 as 2x2 and 3 gal of Riser as a pop-up; Trt 14 was applied as 64 lb of 21-0-0 as 2x2 and 18.5 gal of 8-0-0-9 on the soil surface behind the press wheels of the planter.

Table 9. Percentage of silked plants for small plot studies, 2002.

Treatment	Trt # [a]	Site 1 (July 12)	Site 2 (July 9)	Site 3 (July 11)	Site 4 (July 2)	Site 5 (July 10)
		Silking Data (%)				
No starter	1	22	62	37	50	35
3 gal Riser	2	18	66	46	52	21
3 gal Germinator	3	19	73	49	60	43
3 gal 10-34-0	4	16	89	52	49	44
3 gal 8-0-0-9	5	14	56	44	46	27
11.4 gal 10-34-0	6	38	75	75	59	52
4.1 gal 30-0-0	7	12	53	32	39	27
16.7 gal 8-0-0-9	8	23	54	50	53	26
100 lb 0-46-0	9	27	74	40	55	61
180 lb 7.5-25-7.5	10	22	82	32	67	49
11.4 gal 10-34-0	11	20	83	60	53	57
11.4 gal 10-34-0	12	36	72	66	70	56
21-0-0 +Riser	13	18	72	53	66	24
21-0-0 +8-0-0-9	14	26	52	49	46	23
$LSD_{0.05}$		15	19	21	15	23

[a] Trts 2-5 were all applied as pop-up; Trts 6-10 were applied as 2x2; Trt 11 was applied as 3 gal of 10-34-0 as pop-up and 8.4 gal of 10-34-0 as 2x2; Trt 12 was applied on the soil surface behind the press wheels of the planter; Trt 13 was applied as 64 lb of 21-0-0 as 2x2 and 3 gal of Riser as a pop-up; Trt 14 was applied as 64 lb of 21-0-0 as 2x2 and 18.5 gal of 8-0-0-9 on the soil surface behind the press wheels of the planter.

Table 10. Harvest grain moisture for small plot starter studies, 2002.

Treatment	Trt # [a]	Site 1	Site 2	Site 3	Site 4	Site 5
		Grain Moisture at Harvest (%)				
No starter	1	15.5	21.0	20.5	20.1	21.4
3 gal Riser	2	15.5	21.0	20.4	19.5	21.5
3 gal Germinator	3	15.4	21.2	20.4	20.1	21.5
3 gal 10-34-0	4	15.6	20.9	20.2	20.2	21.5
3 gal 8-0-0-9	5	15.7	21.0	20.5	19.7	21.5
11.4 gal 10-34-0	6	15.6	20.9	20.5	19.7	21.2
4.1 gal 30-0-0	7	15.6	21.0	20.4	20.1	21.4
16.7 gal 8-0-0-9	8	15.6	21.0	20.4	20.1	21.2
100 lb 0-46-0	9	15.8	20.9	20.4	20.3	21.1
180 lb 7.5-25-7.5	10	15.6	20.9	20.6	19.8	21.3
11.4 gal 10-34-0	11	15.2	20.4	20.4	20.1	21.4
11.4 gal 10-34-0	12	15.7	20.9	20.3	19.8	21.2
21-0-0 +Riser	13	15.7	21.0	20.5	20.0	21.2
21-0-0 +8-0-0-9	14	15.7	20.8	20.5	19.7	21.3
$LSD_{0.05}$		0.4	0.3	0.2	0.5	NS

[a] Trts 2-5 were all applied as pop-up; Trts 6-10 were applied as 2x2; Trt 11 was applied as 3 gal of 10-34-0 as pop-up and 8.4 gal of 10-34-0 as 2x2; Trt 12 was applied on the soil surface behind the press wheels of the planter; Trt 13 was applied as 64 lb of 21-0-0 as 2x2 and 3 gal of Riser as a pop-up; Trt 14 was applied as 64 lb of 21-0-0 as 2x2 and 18.5 gal of 8-0-0-9 on the soil surface behind the press wheels of the planter.

Table 11. Leaf chlorophyll meter (LCM) readings for small plot studies, 2002.

Treatment	Trt # [a]	Site 1	Site 2	Site 3	Site 4	Site 5
		LCM Reading				
No starter	1	58.2	56.8	58.5	60.1	62.0
3 gal Riser	2	58.8	60.3	58.5	60.2	59.9
3 gal Germinator	3	59.3	59.8	59.7	60.1	60.8
3 gal 10-34-0	4	58.6	60.6	58.9	60.8	61.3
3 gal 8-0-0-9	5	59.0	60.1	59.2	60.0	62.2
11.4 gal 10-34-0	6	58.9	61.3	60.8	60.5	60.1
4.1 gal 30-0-0	7	59.2	60.4	59.3	60.0	60.7
16.7 gal 8-0-0-9	8	58.8	59.8	59.2	61.4	60.9
100 lb 0-46-0	9	58.9	59.4	58.2	59.8	60.3
180 lb 7.5-25-7.5	10	56.7	58.7	57.4	60.0	60.3
11.4 gal 10-34-0	11	59.0	59.6	57.8	60.6	60.3
11.4 gal 10-34-0	12	57.8	60.7	58.4	59.3	61.0
21-0-0 +Riser	13	58.3	60.0	57.6	60.5	60.8
21-0-0 +8-0-0-9	14	58.2	61.0	58.7	60.4	60.8
$LSD_{0.05}$		2.4	1.5	2.7	1.8	2.0

[a] Trts 2-5 were all applied as pop-up; Trts 6-10 were applied as 2x2; Trt 11 was applied as 3 gal of 10-34-0 as pop-up and 8.4 gal of 10-34-0 as 2x2; Trt 12 was applied on the soil surface behind the press wheels of the planter; Trt 13 was applied as 64 lb of 21-0-0 as 2x2 and 3 gal of Riser as a pop-up; Trt 14 was applied as 64 lb of 21-0-0 as 2x2 and 18.5 gal of 8-0-0-9 on the soil surface behind the press wheels of the planter.

Table 12. Grain yields for small plot starter studies, 2002.

Treatment	Trt # [a]	Site 1	Site 2	Site 3	Site 4	Site 5	Average [b] (%)
		Grain Yield (bu/A)					
No starter	1	142	227	194	188	198	100
3 gal Riser	2	134	224	193	176	202	98
3 gal Germinator	3	137	220	185	180	200	97
3 gal 10-34-0	4	132	229	185	175	188	95
3 gal 8-0-0-9	5	134	229	190	183	206	99
11.4 gal 10-34-0	6	143	227	187	181	194	98
4.1 gal 30-0-0	7	138	238	198	179	195	100
16.7 gal 8-0-0-9	8	142	227	197	180	199	100
100 lb 0-46-0	9	141	232	194	185	205	101
180 lb 7.5-25-7.5	10	141	238	194	176	201	100
11.4 gal 10-34-0	11	137	230	187	172	199	97
11.4 gal 10-34-0	12	146	221	195	179	202	100
21-0-0 +Riser	13	140	229	199	176	199	99
21-0-0 +8-0-0-9	14	139	231	192	179	196	99
$LSD_{0.05}$		12	10	NS	13	NS	--

[a] Trts 2-5 were all applied as pop-up; Trts 6-10 were applied as 2x2; Trt 11 was applied as 3 gal of 10-34-0 as pop-up and 8.4 gal of 10-34-0 as 2x2; Trt 12 was applied on the soil surface behind the press wheels of the planter; Trt 13 was applied as 64 lb of 21-0-0 as 2x2 and 3 gal of Riser as a pop-up; Trt 14 was applied as 64 lb of 21-0-0 as 2x2 and 18.5 gal of 8-0-0-9 on the soil surface behind the press wheels of the planter.

[b] This is the average treatment yield across all five sites calculated as a percentage of the control (i.e., no starter treatment; trt 1) within each location. A pooled analysis of variance showed that these differences in average yields were not statistically significant.

Conclusions

It is somewhat difficult to make final conclusions from these studies. The strip-trials showed numerous responses to starter fertilizer, however, it was not possible to determine if these responses were from N, P, or a combination of both nutrients. The main goal of the small plot studies was to determine what was causing the yield responses, however, the small plot studies showed no consistent responses to starter fertilizers.

Another possibility for the discrepancy in these results is the methodology used with the studies. A study by Shapiro et al. (1989) showed that long strip trials offered greater sensitivity for detecting differences among treatments than more traditional small-plot studies. Therefore, our goal for future research on starter fertilizers is to use a strip-trial design with a relatively small number of treatments.

References

Blackmer, T.M., and J.S. Schepers. 1995. Use of a chlorophyll meter to monitor nitrogen status and schedule fertigation for corn. J. Prod. Agric. 8:56–60.

Gordon, W.B., D.L. Fjell, and D.A. Whitney. 1997. Corn hybrid response to starter fertilizer in a no-tillage, dryland experiment. J. Prod. Agric. 10:401-404.

Jokela, W.E. 1992. Effect of starter fertilizer on corn silage yields on medium and high fertility soils. J. Prod. Ag. 5:233-237.

Mehlich, A. 1984. Mehlich 3 soil test extractant: A modification of Mehlich 2 extractant. Commun. Soil Sci. Plant Anal. 15:1409–1416.

Mitchell, W.H. 1984. Planter Fertilizer. Extension Bulletin 131. University of Delaware, Newark, DE.

Ritchie, S.W., and J.J. Hanway. 1984. How a corn plant develops. Special Report No. 48 Iowa Agric. Exp. Sta., Ames, IA.

SAS Institute. 1998. SAS user's guide: Statistics. Version 8.0 ed. SAS Inst., Cary, NC.

Scharf, P.C. 1999. On-farm starter fertilizer response in no-till corn. J. Prod. Ag. 12:692-695.

Shapiro, C.A., W.L. Kranz, and A.M. Parkhurst. 1989. Comparison of harvest techniques for corn field demonstrations. Amer. J. Altern. Agric. 4:59-64.

Sims, J.T., and S.E. Heckendorn. 1991. Methods of analysis of the University of Delaware soil testing laboratory. Coop. Bull. 10. Univ. Delaware, Newark, DE.

Foliar Applied Boron for High Yield Corn: Research Update

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Research Question

When corn is grown in very dense populations in high yield environments, ears often fail to fill to the ear tip. Boron nutrition at the critical reproductive growth stage may be a factor if B uptake is limiting pollination and seed set even in soils well supplied with B. The objective of this research was to determine corn grain yield response to B foliarly applied during pollination in a high yield environment.

Literature Summary

The factors limiting complete ear fill are not clear. One possibility is that available sunlight for photosynthesis may be limiting when corn is grown at high populations (Ottman and Welch, 1988). Unfortunately, if sunlight is a yield-limiting factor, there is no practical way to increase its supply. Boron (B) nutrition is known to have an influence on pollination and seed set in many crops. The supply of boron to crops is especially critical during reproduction. Boron is essential to the growth of pollen tubes, which are necessary for flower fertilization to occur (Blevins and Lukaszewski, 1998). If B nutrition is a yield-limiting factor, it can be added as a foliar application.

Study Description

To evaluate the effect of foliar applied B on corn ear fill, experiments were conducted from 1997 to 2000 at the Rutgers Plant Science Research Station near Adelphia, NJ. Maximum corn yield research methods were used similar to those developed by Dr. Roy Flannery during the 1980s (Flannery, 1982; Heckman, 1995). The experiment attempted to achieve a minimum stress field environment by use of irrigation and effective control of insects, diseases and weeds. A plant (Pioneer brand hybrid 33Y09-BT) population of 43,560 plants per acre was established using an equidistant 12 by 12 inch spacing pattern. Planting dates were May 2, 1997, April 23, 1998, and April 27, 1999, and May 2, 2000. Applications of N, P, and K fertilizer were made at planting. N and K were also sidedressed during the growing season. The total, N, P, and K applications were 400, 100 and 400 lbs/acre, respectively. Manganese and zinc were applied at planting at 10 lbs Mn/acre and 5 lbs Zn/acre to ensure that these micronutrients were not limiting. Boron was broadcast to all plots at 1.5 lbs B/acre at planting and also sidedressed at 1.5 lbs B/acre when corn was one foot tall.

Boron as a foliar treatment (total foliar B rate of 0.5 lbs/acre) was applied to only half of all plots that had previously received B applications to the soil. The foliar B treatment was sprayed twice over the same set of plots. The first application of 0.25 lbs. B/acre was sprayed when the corn plants were just about to begin silking (less than 10% silk emerged). The second application of 0.25 lbs B/A was sprayed when silking was nearly complete (about 90% silk emerged). The B sprays were made holding the spray boom over the top of the corn canopy.

Grain yield was determined by harvesting 36 plants per plot from an area 36 square feet from the center of each plot. The control and the foliar B treatment were replicated five times in a completely randomized experimental design.

Applied Questions *Did boron applications increase grain yield?*

Grain yield was not significantly increased with foliar applied B in any of the four experimental years (Table 1). The average yield over the four experiment years was 262.3 bu/acre for the control treatment and 263.5 bu/A for the foliar B treatment.

Table 1. Corn grain yield responses to foliar applied boron in maximum yield experiments conducted from 1997 to 2000.

Treatment	Grain yield(bu/A)				
	1997	1998	1999	2000	Mean
Control	249.1	277.7	281.2	239.7	262.3
Foliar Boron	255.5	289.8	282.9	231.8	263.5
	P>F				
Statistics	0.29	0.12	0.72	0.22	0.31
CV, %	2.8	3.4	2.9	4.5	3.5

Was boron uptake a yield limiting factor in this study?

The results do not clearly show that boron uptake during the critical growth stage of ear silking was a major yield limiting factor for high yield environment corn production. The entire area in the experiment had received 3 lbs B per acre applied to the soil. This is a heavy application rate of B for corn production in most field environments. In this particular high yield corn production study, a foliar B treatment was investigated to determine if supplemental B applied at a critical growth stage would improve corn grain yield. Boron when applied as foliar sprays during early and late silking did not significantly increase grain yield.

Recommendations The cost of B fertilizer is about $5.00 per pound. An average yield difference of 1.2 bu/acre, would be barely sufficient to pay for the cost of one half pound of B even if the cost of application was minimal such as when it is applied with irrigation water.

References

Blevins, D.G. and M. Lukaszewski. 1998. Boron in Plant Structure and Function. Ann. Rev. Plant Physiol. Plant Mol. Biol. 49:481-500.

Flannery, R. 1982. High-yield corn nutrient uptake. Better Crops Plant Food 66 (Spring):6-7.

Heckman, J.R. 1995. Corn responses to Chloride in Maximum Yield Research. Agron. J. 87:425-419.

Ottman M.J. and L.F. Welch. 1988. Supplemental radiation effects on senescence, plant nutrients, and yield of field-grown corn. Agron. J. 80:619-626.

Utilizing Edible Corn Cultivars in an Organic Production System in New Jersey

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Research Question

Large scale, conventional corn production continues to decrease in profitability. Farm size also continues to decrease in New Jersey and throughout the Northeast. This study sought to determine what edible corn cultivars work well in an organic rotational program for agronomic growers transitioning from animal feed production operations to smaller, more profitable and sustainable human food systems.

Literature Summary

Specialty corn types include yellow, blue and red cultivars suited for popcorn production, baby corn consumption, processed food corn, and ornamental use. Production practices for specialty corn are similar to those used for yellow dent corn. The Rodale Institute in Kutztown, Pennsylvania states that it may be difficult to produce specialty crops during the transition period from conventional production to organic production (Organic Grain Cropping System and Marketing, 2002). Two particular objectives for growers to meet in order to transition successfully are to supply sufficient nitrogen for the crop and to focus upon an entire crop rotation sequence instead of just the current crop. Additionally, weed control is a key factor in sustaining organic production. Results at Rutgers have shown that timely cultivation can result in acceptable levels of control in New Jersey (Kluchinski, 2002).

Study Description

This study was conducted in 2002 at the Rutgers Research Farm in Pittstown, NJ (Hunterdon County) as part of a larger study entitled "Edible Agronomics." The objective of this larger project is to develop information to assist conventional agronomic crop producers of animal feed grains and foster a transition into multiple year rotations of human food crops within an organic production system.

The seedbed was prepared by plowing down a wheat cover crop in early April and disking twice in May to help control weeds before planting. Four specialty corn cultivars were planted on May 30, 2002. When the soil reached 67° F at 2 inch depth, the red and blue cultivars were hand planted into plasticulture at the rate of two seeds per row foot on 60-inch centers. The yellow corn cultivar was planted with a John Deere unit planter placing two seeds per foot of row, again on 30-inch centers. A plasticulture system with two staggered crop rows on 36 inch plastic beds on 5 foot centers was used for a small ornamental cultivar "Cutie Blues", a crimson colored strawberry type "Ornamental Popcorn" and a blue colored popcorn cultivar "Shaman's Blue." Conventional tillage production was used for the yellow cultivar "Robust" with multiple uses as a sweet corn, a popcorn and an ornamental.

A later planting date for these cultivars was used to minimize weed pressure by incorporating timely pre-plant cultivations and to accelerate corn seed germination in warmer soils. The soil pH was 6.3. Based on soil tests, all plots were fertilized with 200 pounds of dehydrated chicken manure (3-4-3 NPK) before planting. Fifty pounds fish-based nitrogen per acre was supplied to the crop six weeks after planting. Soil moisture was good throughout the germination period. The plasticulture system had mounded beds with trickle irrigation tube underneath the plastic to stop weed growth and to maintain consistent soil moisture.

Applied Questions

How did these specialty corns grow in organic systems?

Among the cultivars tested, there were no differences in germination percentage (all over 95%), rate of emergence (over 95% within ten days of planting) and growth vigor. Lodging percentage of these specialty corn cultivars was less than 5%. The grower should be aware that there is considerable difference in size. The height of cultivar "Robust" ranged from 72-78 inches; cultivar "Shaman's Blue" was 66-74 inches, "Ornamental Popcorn" was 32-38 inches and "Cutie Blues" was 74-80 inches.

What pest management practices were used for these specialty corn cultivars?

The early spring period had ample moisture that supported growth of significant germination of broadleaf weeds and annual grasses by mid-June. Two cultivations two weeks apart with a Buffalo wide sweep cultivator were sufficient to control 95% of the redroot pigweed, common lambsquarters, common ragweed and foxtail species; the primary weed problems in the study. Japanese beetles were managed effectively with applications of pyrethrum and rotenone. Boom sprayer applications of Dipel (*Bacillus thuringiensis*) controlled European corn borer and corn earworms. Due in part to the hot, dry mid-summer season, very few diseases were noted on the foliage and practically no infections were found on the ears at harvest.

What were the maturity and yield of these specialty corns?

On September 12, approximately 100 days after planting, three cultivars were ready for harvest. The fourth cultivar "Cutie Blues" was ready on September 30. The yellow popcorn cultivar "Robust" from Stokes Seeds had extensive tillering and produced 143,000 ears per acre. Ear weight averaged 162 grams. Ear length ranged in size from 6.5-7 inches. Seed weight was 3,240 seeds per pound. This cultivar's potential utility as a baby corn that can be used for Oriental dishes was excellent when harvested six weeks earlier during the first weeks of August. These ears were easy to harvest, succulent in texture and somewhat uniform in size. After drying and conditioning, the cultivar "Robust" corn popped quite well on the cob under microwave processing and tasted good. The percentage of the kernels popped was generally over 80%. As a sweet corn, the cultivar was not acceptable in taste, shape and size.

The blue cultivar "Shaman's Blue" from Johnny's Selected Seeds produced 57,164 ears per acre. Ear weight averaged 226 grams each and ranged in cob length from 7.5-8.5 inches. Seed weight was 3,780 seeds per pound. This cultivar produced a pale-purplish blue popcorn that did not pop well in our trials but could possibly be used to make blue corn chips.

The red cultivar "Ornamental Popcorn" from Stokes Seed produced 127,629 ears per acre. It had very small ears that weighed 53 grams each and ranged in cob length from 2-3 inches. Seed weight was 5,675 seeds per pound.

The dark blue cultivar "Cutie Blues" from Stokes Seeds had an average ear weight of 42 grams and an ear size that ranged from 2.5-3.5 inches. 27,032 ears per acre were harvested. It was the latest maturing of the four specialty corn cultivars tested. This characteristic made it well-suited for the Halloween market. Early picking of this cultivar resulted in an excellent tasting baby corn.

Recommendations This study was the first year of a three-year rotational system involving multiple crops. High-value human, food grade crops are emphasized. The first year's results are considered promising for some of these cultivars. Using sustainable production methods for specialty crops needs more testing in the Mid-Atlantic region. The first and most important consideration for any grower who converts to specialty corn crop production, is to identify and connect with a potential market. Additionally they should begin with very small on-farm trials, ensure that their weed pressure is minimal and check with an organic certifying agency with regards to the latest USDA organic regulations and procedures.

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Evaluating Organic Food Grade Soybean Production in New Jersey

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Research Question Soybeans produced principally for oil extraction and soybean meal used for animal feed has shown decreased profitability during the past decade. Concurrently, demand for soybean varieties earmarked for tofu, soymilk and other soyfood products have increased. This study investigated cultural practices needed to produce food grade soybean and compared two food grade varieties for yield and other performance characteristics.

Literature Summary Commercial trials conducted by Moyer of the Rodale Institute Experimental Farm in Kutzstown, Pennsylvania have produced organically grown food grade soybeans that yielded approximately 50 bushels per acre. Northeastern markets have paid $10 - $16 per bushel for clean, large-seeded organically produced soybeans (Moyer, 2002). A key production practice for successful organic production is weed control. Results from Rutgers have shown that timely cultivation can result in acceptable levels of control (Kluchinski, 2002).

Study Description The study was conducted in 2002 at the Rutgers Research Farm in Pittstown, NJ (Hunterdon County). This organic research project is part of a larger program entitled “Edible Agronomics” that seeks to transition conventional agronomic producers of animal feed grains into multiple year rotations of agronomic human foods.

Two new food grade varieties (early group II maturity types numbered 2F11 from Iowa and HP204 from Minnesota) were obtained from NC Plus Organics in Lincoln, Nebraska and were planted on May 30, 2002. The soil pH was 6.3 and all plots were fertilized with 200 pounds of 3-4-3 NPK dehydrated chicken manure before planting. Soil moisture was good. All varieties were pre-treated with *Bradyrhizobium* seed inoculant before planting. Five replicates of each variety were planted in two row plots with 30 inch row spacing. Each plot was 80 feet in length. Crop growth measurements were date of first seedling emergence, percent plant population, plant height at 30 days post-plant, number of days from planting until maturity, plant height at maturity, plant population at harvest, lodging and total grain yield. Harvest samples of soybean were collected from each plot at total leaf drop and pod dryness which were used for analysis of seed composition and nutraceutical value.

Applied Questions *How were these soybeans planted?*

The seedbed was prepared by moldboard plowing a barley cover crop in early April. This green manure was disked in twice before planting. Planting occurred when the soil temperature reached 67° F at 2 inches depth. A John Deere four row planter was used to plant the plots at a seeding rate of 104,544 seeds per acre at a depth no deeper than 1.5 inches.

How did these food grade soybeans grow?

There was no difference in percent germination which was over 90% for both varieties. Seedling emergence was over 90% for both varieties within ten days after planting. Growth vigor compared favorably to standard group II beans in the area. Lodging percentage was minimal. Average height at harvest of 2F11 was 23 inches and HP204 was taller at 27 inches.

W*hat pest management practices were needed?*

The early spring period had ample moisture that allowed significant germination of broadleaf and annual grass weeds by mid June. Two cultivations, two weeks apart, were sufficient to control 95% of the redroot pigweed, common lambsquarters, common ragweed and foxtail species. In mid-July, an invasion of Japanese beetles reached the threshold level of damage and were managed effectively with applications of pyrethrum and rotenone. Due to the hot, dry mid-summer season very few diseases were noted on the foliage and practically no infections were found on the pods or in the shelled beans at harvest.

What were the maturity and yield of these "tofu" beans?

By early October, or about 120 days after planting, both varieties began to senesce before frost and were ready for harvest at the end of the month. However, due to frequent rains, muddy field conditions and high seed moisture levels, the actual harvest date was delayed until December 18. Nonetheless, little lodging or seed shatter was observed in either variety. The variety, 2F11, had an average yield of 50.2 bushels per acre and produced more than HP204 which averaged 42.1 bushels per acre at 13% moisture.

What was the quality of these food grade soybeans?

The variety 2F11 achieved 92.6% harvested whole beans and 7.4% splits, which was better than HP204 that had 82.6% whole beans and 17.4% splits. Both had good seed coat color, a clear hilum and produced approximately 40% protein. Seed size for 2F11 and HP204 was 2064 and 1681 beans per pound, respectively, – acceptable size for food grade beans. These quality parameters compared favorably with the much older, Vinton 81 variety, considered to be the food grade standard. Vinton 81 is a late maturity group I variety compared to these early maturity group II varieties that are rated at 2.1 for 2F11 and 2.0 for HP204. Thus, maturity differences between Vinton 81 and these two varieties were relatively small.

Recommendations

This was the first year of a three-year rotational system study involving multiple crops. The first year's results are considered promising for these two food soybean varieties. Using sustainable production methods for specialty crops in the Mid-Atlantic region needs more testing. The first and most important consideration for any grower who converts to food soybean production is to identify and connect with a potential market. Additionally, they should begin with very small on-farm trials, ensure that their weed pressure is minimal and check with NOFA-NJ in regards to the latest USDA organic regulations and procedures.

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Comparing Tillage vs. No-Till for Tofu-Type Soybean Production in New Jersey

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Research Question

This applied research is part of a larger program entitled "Human Food Soybean Systems" which seeks to transition conventional agronomic producers of animal feed grains into cropping food grade soybean varieties earmarked for tofu, soymilk and other soyfood products.

Tofu type soybeans can differ from conventional soybean varieties in terms of seed size, seed composition and plant growth. In transitioning from animal feed type varieties to human food grade varieties, the grower requires information about the adaptability of the food grade types to tillage practices. This study compared no-till seeding into a rye stubble of three tofu-type varieties and one conventional type soybean variety vs. seeding into a conventionally tilled field to determine which tillage method is best suited to food soybean production.

Literature Summary

In the Rodale publication "1998 On-Farm Evaluation of Food Grade Soybean Varieties," (Moyer, 1998) no significant differences in yield were found in Pennsylvania between farms using modified no-till, cover crop management and conventional tillage. Yields among food grade soybean varieties were approximately 50 bu/A. Higher plant populations on the no-till farm contributed to smaller individual seed sizes. Weed control is a key factor for sustaining either organic or conventional production. Results from Rutgers have shown that timely cultivation in organic systems can result in acceptable levels of control (Kluchinski, 2002).

Study Description

This study was conducted in 2003 at the Rutgers Research Farm in Cream Ridge, NJ (Monmouth County). Three food grade varieties were obtained from NC Plus Organics in Lincoln, Nebraska. The three varieties were Iowa 1007, HP-204 from Minnesota, and Vinton 81; all are early Maturity Group II type beans. Vinton 81 is considered the standard for food soybean varieties because of its taste, protein content, light colored hilum, and large seed size. HP204 is widely used in the food industry as well because of these same characteristics and because it has a few days longer maturity. Iowa 1007, from the Iowa Seed Foundation, was specifically developed for tofu production. A standard Round-Up Ready (RR) variety, Asgrow 2703, was planted for comparative purposes.

All varieties were planted on June 10, 2003 into a winter rye stubble; the field was harvested for straw the week before. Half of the two acre study site was cultivated with two passes in late May and early June. The other half of the field was left un-tilled in 6" stubble. The soil pH was 6.2. Soil moisture was ample. Planting was conducted with a John Deere 7240 Vacuum Seeder Max Emerge 2, delivering 181,000 seeds per acre.

Eight replicates of each variety were systematically planted (four replicates planted in no-till conditions and four replicates planted with conventional tillage) in strip plots 450 feet in length that consisted of five rows each spaced 15 inches apart. Post-emergence applications of sethoxydim (Poast) at 1.5 pt/A and bentazon (Basagran) at 2 pt/A were made on July 8 when the soybeans were between the second and third trifoliate stage. Weed control was assessed as percentage coverage within the plot for each species.

Agronomic growth characteristics measured were time of first plant emergence, percent stand at 30 days post-planting, plant height, number of days until maturity, plant height at maturity, percent stand at harvest, lodging and yield. Yield data was collected by harvesting 150 linear row feet per replicate using a Hege small plot combine equipped with a 5 foot grain table.

Applied Questions

How did these food grade soybeans grow compared to conventional beans?

There was no difference measured either in percent germination that was over 95% for all varieties or rate of emergence that was over 90% within seven days after planting. Growth vigor (visual observation) of food grade soybeans compared favorably to the conventional bean. Lodging percentage was minimal throughout the season and at harvest.

What pest management practices were needed?

The post-emergence herbicide treatment in the early summer provided effective control of over 90% for broadleaf and annual grass weeds. Weed control was considered comparable in both tillage treatments. Few insects or diseases were noted in the crop during monthly inspections.

What was the maturity, harvest date and condition of these "tofu" beans at harvest?

By mid-October or about 125 days after planting, all three tofu type soybeans were senesced and ready for harvest. The conventional, late maturity Group II soybeans were still green at this time and needed another six weeks until harvest maturity was reached. Due to frequent rains and muddy field conditions, the actual harvest date in 2003 was delayed until December 4. Nonetheless, the soybean stems of all varieties did not show much lodging and relatively few pods had shattered.

What was the comparative yield of the soybean varieties?

There was a trend for the three food grade soybeans to yield a few bushels per acre more in the tilled ground treatment (Table 1). One possible explanation for this is the better warming of the cool spring soil when tilled. The Round-Up Ready soybean Asgrow 2703, was observed to produce better under no-till conditions. This is believed to be because Roundup-Ready varieties have been bred to be utilized in no-till conditions. The highest yielder was the new release from Iowa 1007 at an average of 57 bu/A.

What was the quality of these food grade soybeans?

All four varieties had over 95% whole beans and less than 5% splits (Table 2). There were few shattered seeds seen on the ground after harvest. The three food grade soybeans would generally be considered very large sized with about three beans equaling a gram or approximately 1,500 seeds per pound. The standard animal feed variety was considerably and typically smaller at approximately five seeds per gram or about 2,200 seeds per pound. Larger seed size has been positively correlated with higher protein. Smaller seed size varieties can plant less pounds per acre for a given plant population.

Table 1. Varietal Yields (bu/A) at 13% Moisture, 2003.					
Tillage System	Soybean Cultivar				
	Vinton 81	HP204	Iowa 1007	Asgrow RR 2307	Average
Tillage	43.1	42.5	58.1	39.9	45.9
No-Till	40.3	39.5	56.2	43.6	44.9
Average	41.7	41.0	57.2	41.9	45.5

Table 2. Bean Splits, Protein, Size and Weight Comparisons, 2003.				
Soybean Characteristic	Soybean Cultivar			
	Vinton 81	HP204	Iowa 1007	Asgrow RR 2307
% whole beans	95.3	96.6	95.9	98.5
% split	4.7	3.4	4.1	1.5
% protein	38.8	38.6	39.3	37.6
Weight/seed (g)	0.29	0.34	0.31	0.21
# seeds/lb.	1566	1336	1465	2162

Recommendations

This applied research showed that yield of food grade soybean varieties differed little in regards to tillage practices based upon the results at one study site. In addition, the food varieties were found to yield as much or more than a commonly grown Roundup Ready soybean variety. Earlier maturity allows timely harvest and subsequent timely planting of winter grains and accommodates better small grain crop establishment than late Group II or Group III. Planting a Maturity Group II soybean is a recommended practice for New Jersey when a small grain crop is planned after the soybeans are harvested.

It is recommended that a grower who is transitioning to tofu- type soybeans first establish a market connection. And, a new producer should start with limited acreage and do on- farm comparisons with the specific standard varieties that they have produced previously. A small on-farm evaluation is recommended because these MG II food varieties have a tendency to set pods low on the plant which effects harvest efficiency. This study was conducted on level ground which may produce different yield results than a grower using a different combine equipped with a 10-20 foot grain table operating upon more uneven ground. Additional tillage comparisons and some grower demonstration activities are also recommended in order to confirm these promising results regarding food soybean production.

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Protein Levels of Tofu-Type Soybean Varieties in New Jersey

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Research Question

This applied research project is part of a larger program entitled "Human Food Soybean Systems" which seeks to provide information for farmers who are transitioning from conventional agronomic production of animal feed grains into production of food grade soybeans destined for tofu, soymilk and other soyfood markets. In switching from traditional soybean varieties used for animal feed to human food, the grower has little information regarding the expected levels of protein and oil content for choosing varieties under New Jersey growing conditions. This statewide study compared three varieties of food grade soybeans to a standard soybean variety at seven sites in New Jersey to determine if there are variations in protein and oil content.

Literature Summary

In 1996, Ilnicki reported that food soybean variety, Iowa 3001, produced 43.9 Bu/A with 39% protein and 15.7% oil content. In 1997, Majek and Ayeni in NJ reported that Iowa 3001 yielded 51.6 Bu/A, 39.8% protein and 17.0% oil content. And, in 1998 and 1999, Singer attained yields for Iowa 3001 harvested in NJ of 49.0 and 25.6 Bu/A with protein levels of 36.9 and 36.3% and oil contents of 19.0% and 19.6%, respectively. In 1995, the Illinois Crop Improvement Association published information obtained from seven sites in Illinois about tofu quality and percent protein for food soybean varieties. The average protein content for this Illinois study was 37.4% ± a standard deviation of 2.6%.

Study Description

This study was conducted in three different growing zones in 2003. The southern portion included the Rutgers Research Farm in Deerfield, NJ, the central zone included the Rutgers Research Farm in Cream Ridge, NJ and the northern zone included the Rutgers Research Farm in Pittstown, NJ, among several local farms. The varieties tested were Vinton 81, HP-204 and Iowa 1007. They were planted from mid to late June in replicated strip trials. Harvest samples for each variety were randomly collected and sent to the IPG Laboratory in Champaign, Illinois for food grade analysis.

Applied Questions

What were the protein levels in New Jersey and how did they compare to other states?

The average protein for the three varieties across the seven NJ sites (13% moisture basis) ranged from 38.1% to 39.1%, with a low of 35% and a high of 41.1% (Table 1). Except for the Snyder 02 test site, there was little difference between these three varieties and the standard used at each farm site. All varieties at the majority of sites were eligible for the premium price of high protein beans (generally 38%). Protein content can be influenced by the environment which is signified by the performance of these varieties at different locations.

Variety HP-204 had the highest percent protein and was the only variety to exceed 38% protein at all sites.

Table 1. Percent Protein (at 13% Moisture), 2003				
Farm Name	Soybean Cultivar			
	Vinton-81	HP-204	Iowa 1007	Standard
Bullock	37.6	38.1	38.4	38.6
Cream Ridge	38.8	38.6	39.3	37.6
RAREC	39.7	39.2	39.0	37.3
Snyder	38.8	39.3	37.8	37.7
Snyder 02	35.6	39.3	35.0	39.5
Wickoff	41.1	40.9	39.8	37.5
Zeng	37.9	38.1	37.6	38.8
NJ Average, 2003	38.5	39.1	38.1	38.1
IL Average, 1995	37.4	---	---	---

*What were the oil and fiber levels in New Jerse*y?

Oil content ranged from 20.2 to 20.9%. Fiber content ranged from 5.04 to 5.28%. There were no significant differences between the three varieties and the standard for either of these characteristics (Table 2).

Table 2. Average Percent Oil and Percent Fiber, 2003.					
Compositon	Soybean Cultivar				
	Vinton 81	HP204	IA 1007	Standard	Average
Oil	20.2	20.2	20.5	20.9	20.5
Fiber	5.14	5.04	5.17	5.28	5.16

Recommendations

The results observed in this applied research project showed that food grade soybean varieties produced in NJ can attain high quality in terms of protein, oil and fiber that are comparable to food grade soybeans grown in other states.

It is recommended that a grower transitioning to tofu type soybeans first establish a market connection that, among other things, details the level of protein desired and if protein premiums are attached. This information will assist a grower when selecting the variety best suited for the processor. Additional years of testing are recommended to confirm the promising results indicated by this study.

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