OPTIMUM PLANTING DATES AND POPULATIONS OF THREE SOYBEAN MATURITY GROUPS FOR OKLAHOMA PRODUCTION

By

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OPTIMUM PLANTING DATES AND POPULATIONS

OF THREE SOYBEAN MATURITY GROUPS FOR

OKLAHOMA PRODUCTION

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PREFACE

This study was conducted to explore the planting date and seeding rate options for soybean producers in Oklahoma. Although research of this nature has been conducted in the past, the use of new soybean cultivars and expansion of soybean production into new areas within Oklahoma has prompted the need for additional research of this nature. This research consisted of two independent experiments, a maturity group and planting date experiment presented in chapter one, and a maturity group and plant population experiment presented in chapter two. These studies were presented as two chapters for journal publication. Although the data were limited to the cultivars used in the study, the research could be used to predict overall maturity group behavior in Oklahoma and aid producers in the selection of maturity group, planting date, and population combinations.

I wish to express my appreciation to my major advisor, Dr. J. Ron Sholar, and my other committee members, Dr. Lewis H. Edwards and Dr. Jonathan M. Shaver, for their support and guidance in the completion of this research. I also wish to thank Bob Heister, Jerald Nickles, and Otis Bales for their time and assistance in this research, and Tom Pickard, Ray Sidwell, and Rick Kochenower for sharing their time and space to conduct the research. In addition, I would like to thank the Oklahoma Soybean Board for providing funding and support of this research.

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OPTIMUM PLANTING DATES OF THREE SOYBEAN MATURITY GROUPS FOR OKLAHOMA PRODUCTION

OPTIMUM PLANTING DATES OF THREE SOYBEAN MATURITY GROUPS FOR OKLAHOMA PRODUCTION

ABSTRACT

Soybean [*Glycine max* (L.) Merr.] production in Oklahoma has traditionally been limited to eastern Oklahoma due to high temperatures and low rainfall in the north central, northwestern, and southwestern portions of the state. Three practices essential for successful soybean production and the successful expansion of soybean production areas are selecting an appropriate maturity group for the region, planting at the optimum date, and selecting the optimum target population. The objective of this study was to determine the optimum planting date for cultivars of three soybean maturity groups.

The study was performed over two years at three locations: Eastern Research Station, Haskell, OK; North Central Research Station, Lahoma, OK, and Oklahoma Panhandle Research and Extension Center, Goodwell, OK. Cultivars representing maturity groups III, IV, and V were chosen for this study based on their adaptability to the region and performance in variety trials. The cultivars chosen were representative of those cultivars best adapted to Oklahoma environmental conditions, and all were glyphosate resistant.

The cultivars were planted every two weeks from mid-April through early July. The interaction of maturity group and planting date was studied to determine the maximum yield potential for all three maturity groups. Significant yield differences were found among years and among locations, therefore each location-year was considered independently. Cultivars in maturity groups III and IV produced the greatest yield over a

wide range of planting dates, while maturity group V cultivar yields were highly variable due to poor weather conditions at time of flowering and grain fill. These data will provide the Oklahoma soybean producer additional information that can be used when selecting the appropriate maturity group for a planned planting date.

INTRODUCTION

In Oklahoma, soybean [*Glycine max* (L.) Merr.] production has traditionally been limited to the eastern portion of the state and has not been explored extensively in the north central and northwestern regions due to high temperatures and low rainfall during the growing season in those locations. Three practices that are essential in successful soybean production are selection of appropriate maturity groups (MG) for the region, planting at the optimum date for each maturity group, and selecting optimal target populations.

Planting date is a critical factor in determining soybean yield. Soybean development is influenced by temperature, water availability, day length, and variety selection (Sholar, 1997). Theoretically, by choosing an optimum planting date, heat and drought stresses during the most sensitive growth stages, could be avoided. Researchers in Louisiana found that soybeans planted at an optimal date, such as late April, rather than late date in May or June, have more time to outgrow stresses that are imposed during the reproductive stages (Board and Harville, 1996). In the Midwest, studies in Indiana showed that planting date affects flowering date, maturity date, and the length of the reproductive period (Robinson and Wilcox, 1998). In Ohio studies evaluating planting dates, row widths, and cultivars, planting date was shown to have the greatest impact on yield (Beuerlein, 1988). However, some research has shown that planting date does not consistently affect yield (Egli and Zhen-wen, 1991). Other studies have consistently shown a decrease in yield as planting date is delayed (Lueschen et al., 1992).

Numerous planting date studies have compared determinate and indeterminate cultivars. Determinate soybean plants terminate stem growth when flowering begins or shortly thereafter, while indeterminate soybeans continue growth for a considerable time after flowering begins (Bernard, 1972; Robinson and Wilcox, 1998). Generally, cultivars in early maturity groups (0 to IV) are indeterminate while full season groups (V to XII) are determinate. Researchers in Indiana showed that yield of indeterminate cultivars decreased progressively at planting dates occurring after early May, whereas the yield of determinate cultivars decreased only if the planting date was delayed past early June. Determinate cultivars yielded more when planted in late May or early June, while the indeterminate cultivars produced maximum yields when planted from early to late May (Robinson and Wilcox, 1998). In earlier Indiana research, across all planting dates (mid-May through late June) the number of days for the entire reproductive period was essentially the same for determinate and indeterminate isolines, but the number of days to specific reproduction stages was different (Wilcox and Frankenberger, 1987). Cober et al. (1996) observed that under natural day length in the field in Ontario, Canada, determinate lines generally had a reduced reproductive period compared with indeterminate lines.

Wilcox and Frankenberger (1987) also observed that indeterminate cultivars did not respond to planting date in Ohio, while determinate strains increased in seed yield with progressively later planting dates. They also found that cultivars do not respond consistently to similar planting dates in successive years. Using indeterminate and determinate cultivars from MG III, researchers in Nebraska found that yields of determinate cultivars were not reduced until planting date was delayed past early June, but yields of indeterminate cultivars decreased linearly from May 13 through July 6 (Elmore, 1990).

MG III and IV are considered "early maturing varieties." Recent studies have focused on the performance of these maturity groups with planting dates ranging from early April to mid July. In Ohio, research with MG III soybeans showed that yield loss averaged 0.33 bu/acre for each day planting was delayed past May 1 (Beuerlein, 1988). Nebraska research with MG III showed that the highest yields were obtained from early to mid-May plantings (Elmore, 1990). In Kentucky, yield response to planting date of MG III and IV showed the best results for mid-June plantings, in contrast to Arkansas, Kansas, and South Central Texas studies that favored April planting systems for their respective regions (Steele and Grabau, 1997). High temperature periods during seed-fill resulted in reduced yields of the early-maturing cultivars planted in late April in Kentucky (Kane et al., 1997).

In the mid-southern US in the past, conventional soybean production has consisted of planting MG V and later cultivars in May and later months (Heatherly and Elmore, 1983). These cultivars when planted in May or later, typically flower, sets pods, and fill seeds during the hottest and driest portion of the growing season (Reicosky and Heatherly, 1990). Mississippi research showed that May and June plantings of these cultivars were high-risk enterprises (Heatherly, 1988).

Recent research in the lower Mississippi River valley revealed that planting early maturing cultivars (MG III and IV) in April vs. May and later allows critical reproductive development to coincide with periods of adequate soil moisture and greater rainfall, thus partially avoiding drought stress and above-optimum temperatures (Heatherly and Spurlock, 2001). This planting system has also produced higher, more consistent yields. Louisiana research also with early maturing cultivars, consistently produced high yields using a MG IV cultivar in a short-season system (planting an early-maturing cultivar late in the season) (Boquet, 1998). May et al. (1989) working in Arkansas, observed a yield advantage using MG III and IV over later cultivars across both early and normal planting dates. Bruce et al. (1985) explained the cause of the yield advantage by observations that MG IV cultivars planted in April go through the drought-sensitive development stages of pod formation and fill before the occurrence of typical August droughts. Kane et al. (1997) reported that in Kentucky, early-planted, early-maturing cultivars were more likely to encounter pod-set and seed-fill temperature regimes that inhibited production. At more northerly latitudes, the advantages of earlier-than-normal plantings are not realized probably due to low temperatures in April that hinder germination and early vegetative growth and lack of severe summer drought (Heatherly and Spurlock, 2001).

In a 37-year study in eastern Oklahoma, Keim et al. (1999) found that optimum yields were obtained by planting MG IV, V, and VI between mid-May and early July. Planting maturity groups III and IV in April in eastern Oklahoma reduces the probability that the crop will be flowering or maturing in hot, dry conditions (Sholar and Edwards, 1997), while full season groups V and VI should be planted between May 10 and June 15 (Sholar, 1997) to reduce the probability of flowering in hot, dry conditions. Generally in eastern Oklahoma, significant yield reductions begin when planting date is delayed beyond late June (Sholar and Edwards, 1997). This information provides general planting date concepts for eastern Oklahoma, but these same principals may not be successful in north central or western Oklahoma due to lower precipitation and high growing season temperatures. Oklahoma experiences similar late summer drought and high temperatures that occur in the mid-southern region of the United States. Therefore, it is hypothesized that similar benefits of early planting of early-maturing cultivars will be realized.

As soybean acreage continues to expand beyond the traditional soybean production regions of the United States, further research must be completed in these regions to determine the optimum planting date for adapted maturity groups and cultivars. North central and northwestern Oklahoma, relatively new soybean production areas that have not been extensively researched, will be among the locations utilized in this research.

MATERIALS AND METHODS

The experimental design for this study was a randomized complete block design with three replications. The six treatments were arranged in a split plot with main plots date of planting and sub-plots of maturity groups. The experiment was conducted over a two-year period at three locations in Oklahoma: the Eastern Research Station (ERS) near Haskell, the North Central Research Station (NCRS) near Lahoma, and the Oklahoma Panhandle Research and Extension Center (OPREC) in Goodwell. The plots were 3.05 m x 6.71 m. A 0.9 m alley was left unplanted and was tilled between each replication. A 3.05 m border was planted on both sides of each replication. A .762 m x 6.71 m section was harvested from each plot to obtain grain yield. The seed was weighed and expressed as yield in kg/ha.

The cultivars were chosen based on availability, adaptability, proven yield potential in Oklahoma, herbicide tolerance traits, and to represent common cultivars and maturity groups used for Oklahoma soybean production. Asgrow 3301(AG3301) was chosen to represent maturity group III (MG III) in 2000. In 2001, Asgrow 3302 (AG3302) replaced the AG3301 cultivar, which was unavailable to Oklahoma seed suppliers. AG3301 possesses glyphosate tolerant traits while AG3302 possesses glyphosate tolerant traits and sulfonylurea resistance. Asgrow 4602 (AG4602) was chosen as a representative of maturity group IV (MG IV), and Asgrow 5602 (AG5602) was chosen as a representative of maturity group V (MG V). All cultivars were glyphosate tolerant and sulfonylurea herbicide tolerant except AG3301 which was glyphosate resistant only.

Field management followed customary agronomic procedures for the region. The fields were initially tilled approximately one week prior to the first planting date, then again at each planting date, including the first planting date. Tillage implements used were a Do-all at the ERS, and a field cultivator at both the NCRS and OPREC. Additional tillage was used to control weeds in blocks that were not yet planted. At the ERS, tillage operations were conducted to hasten soil drying after heavy rains to improve field conditions and facilitate planting. The ERS and NCRS locations were completely rain-fed. The OPREC location was fully irrigated in 2001, but irrigation was only partially available in 2000 due to equipment malfunctions. Glyphosate was applied at a rate of 1.75 to 2.34 L per hectare as needed for post emergence weed control. In general, two applications were required for full season weed control.

All cultivars were planted on 76.2 cm rows at a seeding depth of approximately 2.54 cm and at a rate of 374,351 seeds/ha with a cone planter. Planting dates were selected to represent typical planting times in Oklahoma. Planting at all three locations began in mid April and was repeated approximately every two weeks through early July. This time period included six planting dates. Some plantings were unavoidably delayed beyond the scheduled two-week interval due to weather conditions that created unfavorable field conditions at planting time.

An analysis of variance (ANOVA) test was conducted using yield values. Least significant differences (LSDs) were determined at the 0.05 level. Locations and years were found to be significant, therefore, all location-year combinations were considered independently.

RESULTS AND DISCUSSION

The effects of environmental conditions on plant development are numerous. In this experiment, rainfall amounts and temperatures (Fig. 1-6) during reproductive phases varied greatly among locations, years, and cultivars. Using an analysis of variance, significant location-year interaction was found. Therefore, each location-year must be considered independently. Data are presented in tables (Tables 1-6) with each table encompassing one year of the experiment at each location. Least significant differences (LSD) were used to determine differences within each cultivar among the six planting dates. LSD were also used to determine differences among the three cultivars within each planting date. Each cultivar will be discussed separately, followed by a discussion of the planting dates.

EASTERN RESEARCH STATION (ERS)

In 2000, AG3301/3302, representing MG III, had significant yield reductions when planted after mid-May (Table 1). In 2001, there was no significant difference in yield observed for soybeans planted in the middle of the season (Table 2), but significant yield reduction when planted after late April. In both years, there was a significant yield increase in the final planting relative to the previous planting. This somewhat unexpected late season yield increase may be attributed to increased precipitation and cooler temperatures that occurred in September (Fig. 1, 2) when these plants had reached reproductive growth phases.

In 2000, AG4602, representing MG IV, had significant yield reductions when planted after mid-May (Table 1). Yields declined with each two-week delay in planting due to deteriorating weather conditions during reproductive phases. In 2001, AG4602 yields were highly variable, with the greatest yield produced in the final planting date in late June (Table 2). An early season drought was experienced at the ERS in 2001, contributing to the variable and low yields. The yield increases from the later plantings are most likely attributed to the cooler temperature and increased precipitation in early fall (Fig. 3,4).

Yields of AG5602 were low at all planting dates in 2000 and there were no significant differences found in the yields (Table 1). These poor yields were due to unfavorable weather conditions throughout the growing season and hot, dry weather during the reproductive phases for all planting dates (Fig. 1). In 2001, yields steadily increased from the April planting through the final planting date, with significant yield increases occurring from early May through late June plantings (Table 2).

Significant differences in yield were found among the three cultivars in most of the planting dates (Tables 1, 2). AG3301/3302 had highest yields in April plantings. In 2000, AG3301/3302 had the best yields when planted through mid-May, while AG4602 yielded best in early June and early July plantings (Table 1). In 2001, AG3301/3302 yielded best through April plantings while AG5602 had the greatest yields in all remaining planting dates (Table 2). Overall, AG3301/3302 appeared to be the best choice for plantings from April through mid-May and AG4602 performed best in later plantings.

NORTH CENTRAL RESEARCH STATION (NCRS)

In 2000, AG3301/3302 representing MG III, responded well to early plantings with only slight yield decreases through late May. Subsequent planting dates showed significant reductions in yield (Table 3). In 2001, yield significantly increased with each two-week delay in planting up to the early June planting, and then decreased with subsequent plantings (Table 4). In both years, AG3301/3302 performed well when planted from mid-April through early June.

AG4602 representing MG IV, performed similarly to AG3301/3302. In both years, AG4602 performed well when planted from mid-April through early June. In 2000, yields steadily decreased with each two-week delay in planting after the first planting (Table 3). In 2001, yields were greatest from late April to early June plantings, while subsequent planting dates had significantly reduced yields (Table 4).

In 2000, yields of AG5602, a representative of MG V, were low at all planting dates due to unfavorable weather conditions during the growing season and deteriorating conditions during the reproductive phases (Fig. 3). There were no significant yield differences due to planting date found in the yields of AG5602 in 2000 except for the May 12 planting which had a significantly greater yield than all other planting dates (Table 3). In 2001, there was no significant difference in yields from plantings through the mid-June planting (Table 4). However, there was a slight yield increase in each planting up to mid-May. Plantings that occurred after early June had significant reductions in yield.

Significant differences in yield were found among the cultivars in nearly all the planting dates (Tables 3, 4). AG3301/3302 produced greatest yields when planted from mid-April through late May and early June, although AG4602 yielded as well or slightly better than AG3301/3302 in the late April planting. In 2001, AG3301/3302 also yielded well in the mid-June planting (Table 4). Generally, AG5602 did not perform as well as AG3301/3302 and AG4602 in most of the planting dates. Overall, AG3301/3302 had the highest yields when planted through early June while AG4602 produced better yields in subsequent plantings.

OKLAHOMA PANHANDLE RESEARCH AND EXTENSION CENTER (OPREC)

AG3301/3302 representing MG III, produced the highest yields when planted in late April or early May (Table 5,6). In 2000, there was no significant yield difference in plantings through mid May (Table 5). The significant increase in yield in the early July planting can be attributed to cooling temperatures (Fig. 5) and resumed irrigation capabilities during the soybean reproductive phases that occurred in late summer and early fall. In 2001, the early May planting resulted in the greatest yield (Table 6). All other planting dates produced no significant differences in yield. With adequate irrigation, AG3301/3302 performed well across all planting dates.

In 2000, AG4602, a representative of MG IV, yielded well when planted in April, while plantings from late May through early June resulted in significant yield reductions. As was the case with AG3301/3302 yields, a steady increase in yields was shown through the last planting date after the initial decrease in yield from mid-season plantings (Table 5). This yield decrease (May 30 planting) and subsequent increase (June 14 planting) was associated with the loss and then reestablishment of irrigation capabilities during the reproductive phases. In 2001, there were no significant differences in the yields of AG4602 through the mid-June planting (Table 6).

In 2000, yields of AG5602, a representative of MG V, were low at all planting dates due to unfavorable weather conditions during the growing season and deteriorating conditions during the reproductive phases (Fig. 5) and there were no significant differences found in the yields due to planting date (Table 5). In 2001, there was no significant yield difference in the planting dates through the early June planting (Table 6). However, there was a slight yield decrease in each planting up to mid-May. Plantings that occurred after early June had significant reductions in yield.

There were significant differences in the performance of the cultivars among the planting dates between 2000 and 2001. In 2000, AG3301/3302 and AG4602 performed equally well in planting dates in mid-April and early May with AG4602 having a slight yield advantage (Table 5). The cause of this advantage was most likely due to a severe hailstorm that occurred in the first week of August, prior to the first harvest of AG3301 plantings. At the time of this storm, AG3301 was closer to maturity than AG4602, therefore AG 3301 pods shattered and were removed from the plant with greater ease. Although AG5602 performed well among all planting dates, AG3301/3302 and AG4602 generally produced the best yields (Table 6).

CONCLUSION

Genetic potential of later maturity groups and cultivars should produce greater yields than earlier maturity groups and cultivars when planted at the same date. However, high temperatures and late summer drought (Fig. 1-6) compounded with the shorter length of flowering time for the later, determinate MG V cultivar reduced the later cultivar yield in this study. The increased length of flowering time of earlier, indeterminate MG III and IV cultivars provides these soybeans greater opportunity to encounter cooler temperatures and greater precipitation during the reproductive growth phases. Generally, AG3301/3302 had the greatest yields when planted from April through early June while AG4602 had greater yields in subsequent plantings.

Results were somewhat variable due to erratic weather patterns, but it can be concluded that soybean yields in the three locations studied tended to decrease when planting was delayed beyond June 1. Similar to the results of Wilcox and Frankenberger (1987), the cultivars did not always respond to planting date in the same manner from one year to the next. However, these data provide ample evidence to recommend an optimum planting date for a MG III cultivar in Oklahoma of mid-April through mid-May. This agrees with research in the lower Mississippi River valley that showed plantings of MG III and IV cultivars in April allows critical reproductive development to coincide with periods of greater rainfall (Heatherly and Spurlock, 2001). These data also suggest that an optimum planting date for a MG IV cultivar is from late April through early June. The early June plantings are similar to the short-season system used by Boquet (1998) in Louisiana in which MG IV cultivars consistently produced high yields in the short-season system. Although AG5602 yields increased through the late planting date at the ERS in

2001 as was expected from a full season maturity group, during the two years of the experiment there appeared to be little benefit to planting a MG V cultivar in these regions of study. However, these data and conclusions are limited to one cultivar as a representative of maturity group V. Further research with cultivars of MG V is needed to determine the role of a determinate maturity group V cultivar in Oklahoma soybean production.

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APPENDIXES

Appendix Page

Appendix A

Eastern Research Station 2000 Planting and Harvest Dates

Planting Date	*Maturity Group*	*Date of First Flower*	*Harvest Date*
April 13	III	June 8*	September 7
	IV	June 8	September 7
	V	July 6	September 22
April 27	III	June 8	September 7
	IV	June 8	September 7
	V	July 6	September 22
May 18	III	June 20	September 7
	IV	June 20	September 22
	V	July 6	November 22
June 1	III		September 7
	IV		November 22
	V	July 6	November 22
June 20	III		November 22
	IV		November 22
	V		November 22
July 6	III		November 22
	IV		November 22
	V		November 22

*Date of first flower indicates first observation of flower or flowers within a plot; data is incomplete

Appendix B

Eastern Research Station 2001 Planting and Harvest Dates

Planting Date	*Maturity Group*	*Date of First Flower*	*Harvest Date*
April 13	III		August 15
	IV		October 8
	V	July 13*	October 29
April 26	III		August 15
	IV		October 8
	V	July 13	October 29
May 9	III		October 8
	IV		October 29
	V	July 13	October 8
May 24	III	July 13	October 8
	IV	July 13	October 29
	V	July 13	October 8
June 7	III	July 13	October 8
	IV	July 13	October 8
	V	August 8	October 29
June 22	III	July 25	October 29
	IV	July 25	October 29
	V	August 8	October 29

*Date of first flower indicates first observation of flower or flowers within a plot; data is incomplete

Appendix C

North Central Research Station 2000 Planting and Harvest Dates

Planting Date	*Maturity Group*	*Date of First Flower*	*Harvest Date*
April 14	III	June 9*	September 20
	IV	June 9	September 20
	V	July 7	November 20
April 28	III	June 9	September 20
	IV	June 9	September 20
	V	July 7	November 20
May 12	III	June 23	September 20
	IV	June 23	September 20
	V	July 7	November 20
May 30	III		September 20
	IV		November 20
	V	July 7	November 20
June 23	III	August 5	November 20
	IV	August 5	November 20
	V		November 20
July 7	III		November 20
	IV		November 20
	V	August 23	November 20

*Date of first flower indicates first observation of flower or flowers within a plot; data is incomplete

Appendix D

North Central Research Station 2001 Planting and Harvest Dates

Planting Date	*Maturity Group*	*Date of First Flower*	*Harvest Date*
April 12	III		October 22
	IV		October 22
	V	July 10*	October 22
April 27	III		September 22
	IV		October 22
	V	July 10	November 25
May 11	III		October 22
	IV		October 22
	V	July 10	November 25
June 8	III	July 10	October 22
	IV	July 10	October 22
	V	July 10	November 25
June 20	III		October 22
	IV		October 22
	V	August 9	November 25
July 5	III		October 22
	IV		October 22
	V	August 9	November 25

*Date of first flower indicates first observation of flower or flowers within a plot; data is incomplete

Appendix E

Oklahoma Panhandle Research and Extension Center 2000 Planting and Harvest Dates

Planting Date	*Maturity Group*	*Date of First Flower*	*Harvest Date*
April 15	III		October 2
	IV		October 2
	V		October 2
May 5	III		October 2
	IV		October 2
	V		October 2
May 15	III		October 2
	IV		October 2
	V		October 2
June 1	III	July 20*	October 2
	IV	July 20	October 2
	V		October 2
June 15	III	July 20	October 2
	IV	July 20	October 2
	V		October 2
July 1	III		October 2
	IV		October 2
	V	August 23	October 2

*Date of first flower indicates first observation of flower or flowers within a plot; data is incomplete

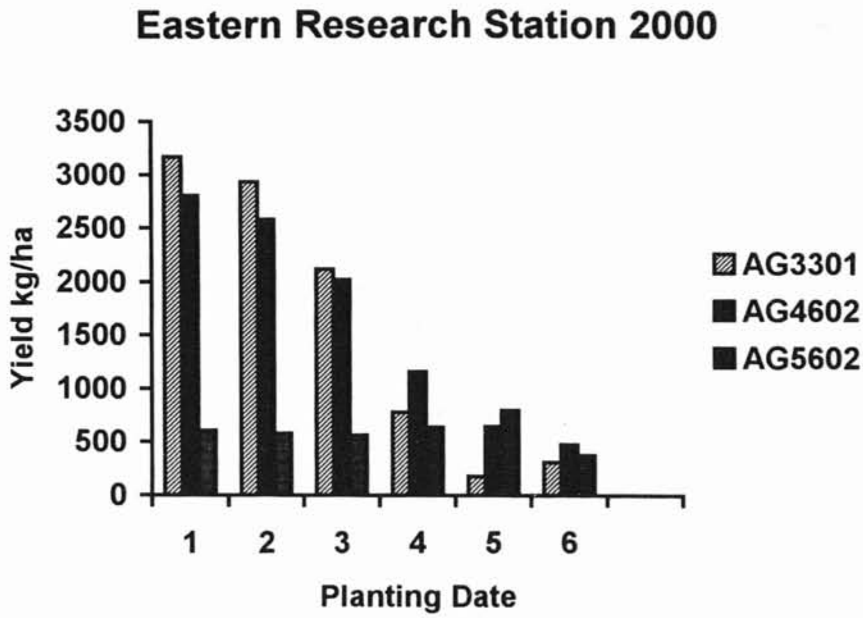
Appendix F

Oklahoma Panhandle Research and Extension Center 2001 Planting and Harvest Dates

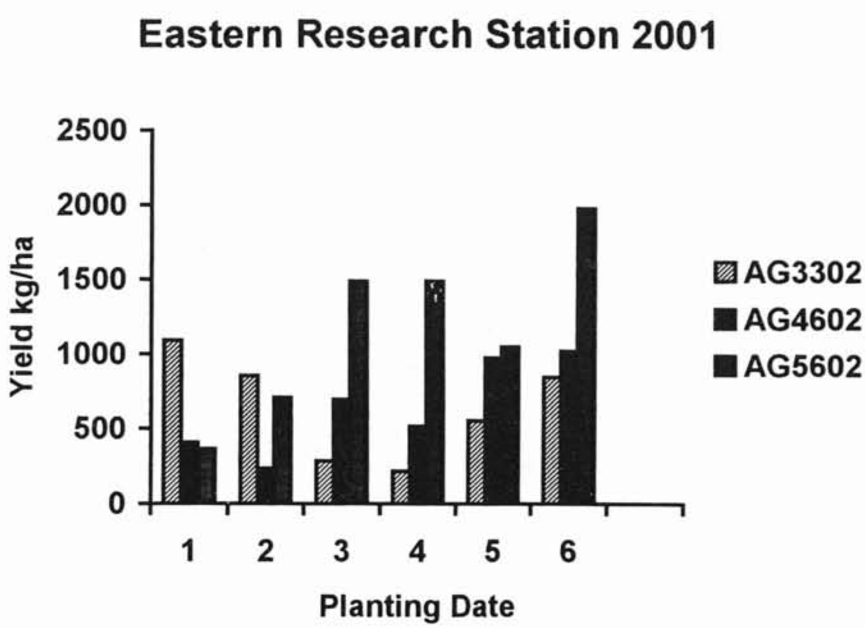
Planting Date	*Maturity Group*	*Date of First Flower*	*Harvest Date*
April 17	III		October 16
	IV		September 21
	V		October 3
April 30	III		September 21
	IV		October 3
	V		October 16
May 14	III		September 21
	IV		October 16
	V		October 16
May 30	III		October 3
	IV		October 16
	V		September 21
June 14	III		October 3
	IV		October 3
	V		October 25
July 1	III		October 3
	IV		October 16
	V		October 25

*Date of first flower indicates first observation of flower or flowers within a plot; data is incomplete

Appendix G

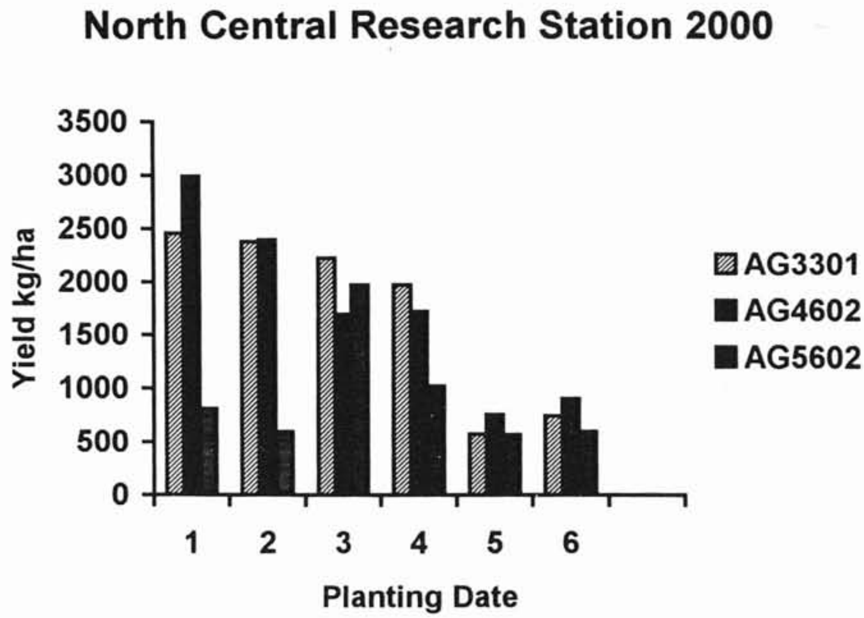


Eastern Research Station 2000
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
1
2
3
4
5
6
Planting Date
AG3301
AG4602
AG5602

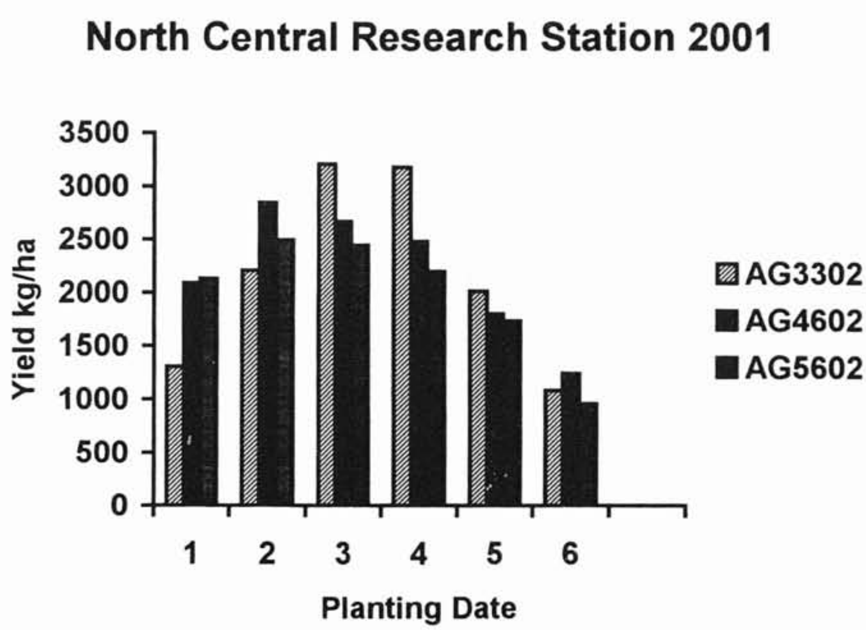


Eastern Research Station 2001
2500
2000
1500
1000
500
0
Yield kg/ha
1
2
3
4
5
6
Planting Date
AG3302
AG4602
AG5602

Appendix H

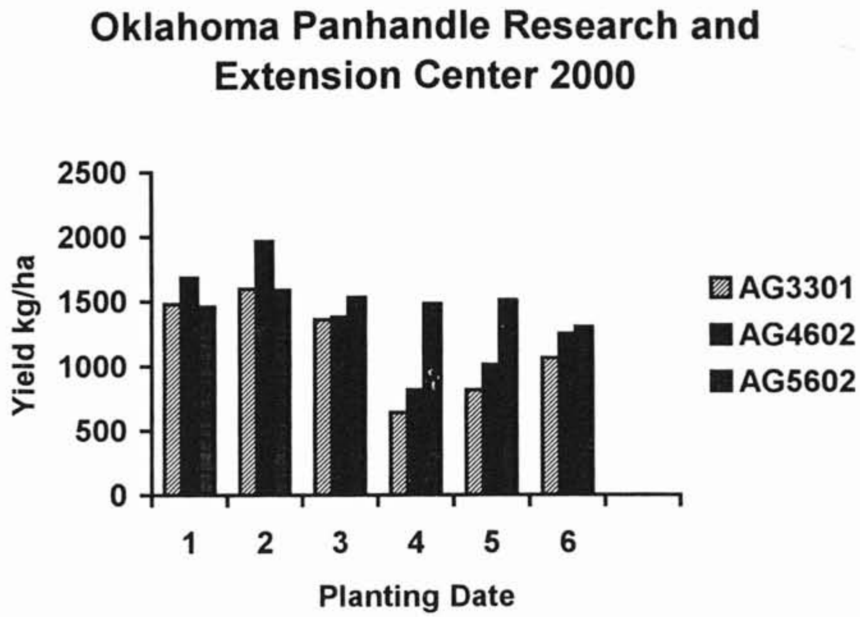


North Central Research Station 2000
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
1
2
3
4
5
6
Planting Date
AG3301
AG4602
AG5602

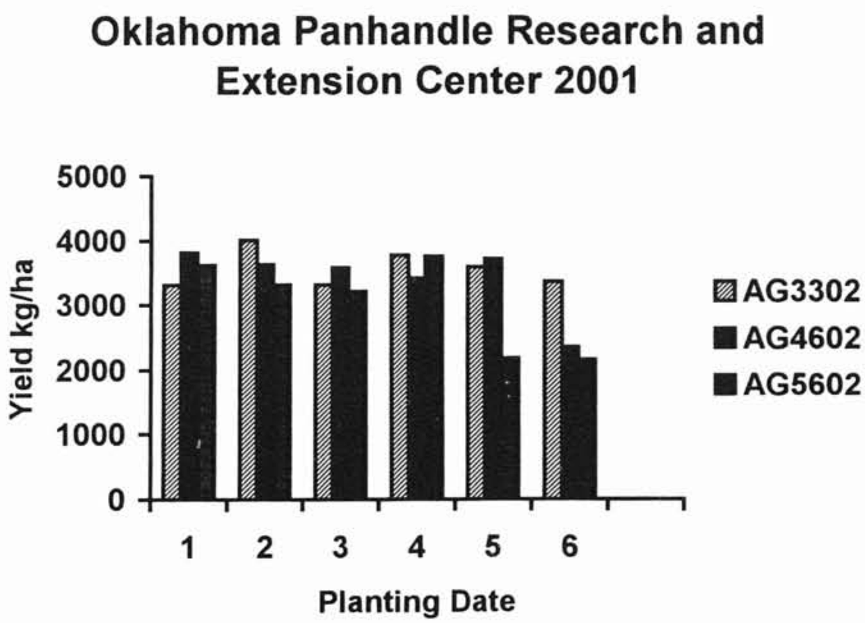


North Central Research Station 2001
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
1
2
3
4
5
6
Planting Date
AG3302
AG4602
AG5602

Appendix I



Oklahoma Panhandle Research and Extension Center 2000
2500
2000
1500
1000
500
0
Yield kg/ha
1
2
3
4
5
6
Planting Date
AG3301
AG4602
AG5602



Oklahoma Panhandle Research and Extension Center 2001
5000
4000
3000
2000
1000
0
Yield kg/ha
1
2
3
4
5
6
Planting Date
AG3302
AG4602
AG5602

LIST OF TABLES

Table 1

Eastern Research Station 2000 Yield Data

	Planting Date					
	April 13	*April 27*	*May 18*	*June 1*	*June 20*	*July 6*
	Yield kg/ha					
AG3301	3168.79^{a*,a**} ±336.39	2934.07^{a,d} ±288.14	2122.31^{a,g} ±282.95	779.16^{b,j} ±129.33	176.04^{b,n} ±9.78	303.19^{b,p} ±76.39
AG4602	2803.66^{c,b} ±214.57	2581.98^{c,e} ±136.92	2021.25^{cd,g} ±316.36	1157.33^{de,i} ±194.21	638.97^{e,m} ±100.38	469.45^{e,o} ±51.75
AG5602	603.11^{f,c} ±235.81	577.03^{f,f} ±50.82	560.73^{f,h} ±48.24	632.45^{f,k} ±206.62	795.46^{f,l} ±111.23	371.65^{f,op} ±111.08

LSD (0.05) between cultivars 127.68 LSD (0.05) between dates 1277.1

*values with the same letter indicate no significant difference within cultivar between planting dates

**values with the same letter indicate no significant difference between cultivars within planting date

Table 2

Eastern Research Station 2001 Yield Data

	Planting Date					
	April 13	*April26*	*May 9*	*May 24*	*June 7*	*June 22*
	Yield kg/ha					
AG3302	1093.15^{a*,a**} ±223.66	853.57^{ab,c} ±81.56	284.76^{b,h} ±60.65	217.34^{b,k} ±22.77	556.62^{ab,m} ±170.10	844.25^{ab,p} ±229.85
AG4602	408.85^{cd,b} ±66.92	234.55^{d,e} ±50.33	695.05^{cd,g} ±59.21	518.60^{cd,j} ±165.69	974.79^{cd,l} ±198.53	1020.70^{c,o} ±156.78
AG5602	366.53^{g,b} ±126.14	707.25^{g,d} ±125.66	1486.22^{ef,f} ±239.04	1486.22^{ef,i} ±149.35	1050.83^{fg,l} ±23.99	1977.56^{e,n} ±108.62

LSD (0.05) between cultivars 96.68 LSD (0.05) between dates 759.53

*values with the same letter indicate no significant difference within cultivar between planting dates

**values with the same letter indicate no significant difference between cultivars within planting date

Table 3

North Central Research Station 2000 Yield Data

	Planting Date					
	April 14	*April 28*	*May 12*	*May 30*	*June 23*	*July 7*
	Yield kg/ha					
AG3301	$2458.10^{a*,b**}$ ±741.32	$2383.11^{a,d}$ ±235.81	$2229.89^{a,f}$ ±285.64	$1978.86^{a,h}$ ±354.30	$577.03^{b,j}$ ±190.40	$749.82^{b,k}$ ±158.41
AG4602	$2996.01^{c,a}$ ±1284.71	$2399.41^{cd,d}$ ±161.40	$1701.76^{de,g}$ ±515.42	$1724.60^{de,h}$ ±528.25	$756.34^{f,j}$ ±269.68	$903.04^{ef,k}$ ±124.23
AG5602	$811.76^{h,c}$ ±599.15	$599.85^{h,e}$ ±480.10	$1978.86^{g,fg}$ ±1120.64	$1023.66^{h,i}$ ±328.20	$570.51^{h,j}$ ±294.76	$599.85^{h,k}$ ±39.53

LSD (0.05) between cultivars 364.16 LSD (0.05) between dates 853.4

*values with the same letter indicate no significant difference within cultivar between planting dates

**values with the same letter indicate no significant difference between cultivars within planting date

Table 4

North Central Research Station 2001 Yield Data

	Planting Date					
	April 12	*April 27*	*May 11*	*June 8*	*June 20*	*July 5*
	Yield kg/ha					
AG3302	$1308.63^{cd*,b**}$ ±112.07	$2204.23^{b,e}$ ±250.40	$3204.84^{a,f}$ ±852.95	$3176.15^{a,h}$ ±412.47	$2031.36^{bc,k}$ ±272.22	$1082.39^{d,mn}$ ±187.11
AG4602	$2090.89^{ef,a}$ ±135.59	$2849.79^{e,c}$ ±197.37	$2667.59^{e,g}$ ±688.24	$2478.95^{ef,i}$ ±189.47	$1797.52^{fg,kl}$ ±521.34	$1239.49^{g,m}$ ±426.13
AG5602	$2129.63^{h,a}$ ±369.66	$2494.73^{h,d}$ ±424.45	$2441.65^{h,g}$ ±416.47	$2194.18^{h,j}$ ±399.06	$1732.97^{h,l}$ ±286.14	$956.14^{i,n}$ ±215.29

LSD (0.05) between cultivars 270.54 LSD (0.05) between dates 763.95

*values with the same letter indicate no significant difference within cultivar between planting dates

**values with the same letter indicate no significant difference between cultivars within planting date

Table 5

Oklahoma Panhandle Research and Extension Center 2000 Yield Data

	Planting Date					
	April 15	*April 30*	*May 14*	*May 30*	*June 14*	*July 1*
	Yield kg/ha					
AG3301	1484.64[a*,b**] ±248.77	1596.52[a,d] ±22.67	1363.07[ab,f] ±81.16	637.96[d,i] ±90.96	812.25[cd,l] ±451.73	1061.84[bc,] ±654.25
AG4602	1686.89[ef,a] ±178.14	1966.61[e,c] ±46.81	1380.28[fg,f] ±120.17	812.25[h,h] ±111.82	1008.05[gh,k] ±107.35	1252.26[g,n] ±96.23
AG5602	1462.05[i,b] ±59.24	1586.84[i,d] ±40.10	1529.82[i,e] ±142.78	1484.64[i,g] ±63.57	1509.38[i,j] ±19.72	1301.75[i,m] ±42.03

LSD (0.05) between cultivars 144.57 LSD (0.05) between dates 415.25

*values with the same letter indicate no significant difference within cultivar between planting dates

**values with the same letter indicate no significant difference between cultivars within planting date

Table 6

Oklahoma Panhandle Research and Extension Center 2001 Yield Data

	Planting Date					
	April 15	*May 5*	*May 15*	*June 1*	*June 15*	*July 1*
	Yield kg/ha					
AG3302	3315.50[a*,b**] ±430.66	4008.26[a,c] ±542.58	3313.87[a,fg] ±876.10	3770.28[a,h] ±211.30	3587.71[a,j] ±331.68	3364.40[a,l] ±54.45
AG4602	3820.81[b,a] ±297.02	3630.09[b,d] ±140.23	3573.04[b,f] ±241.42	3413.30[b,i] ±893.66	3708.33[b,j] ±299.09	2357.03[c,mn] ±555.60
AG5602	3628.46[d,a] ±502.68	3313.87[d,e] ±319.26	3206.28[d,g] ±190.17	3749.09[d,h] ±428.00	2179.36[e,k] ±131.79	2156.54[e,n] ±153.71

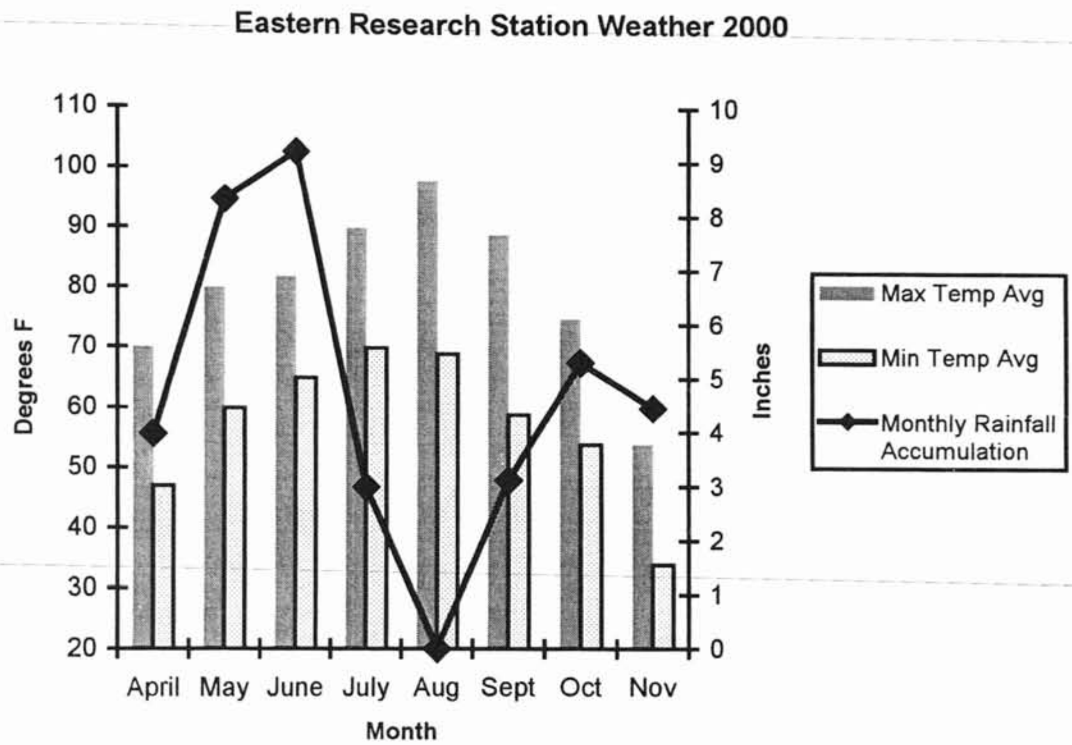
LSD (0.05) between cultivars 292.76 LSD (0.05) between dates 794.33

*values with the same letter indicate no significant difference within cultivar between planting dates

**values with the same letter indicate no significant difference between cultivars within planting date

LIST OF FIGURES

Figure 1



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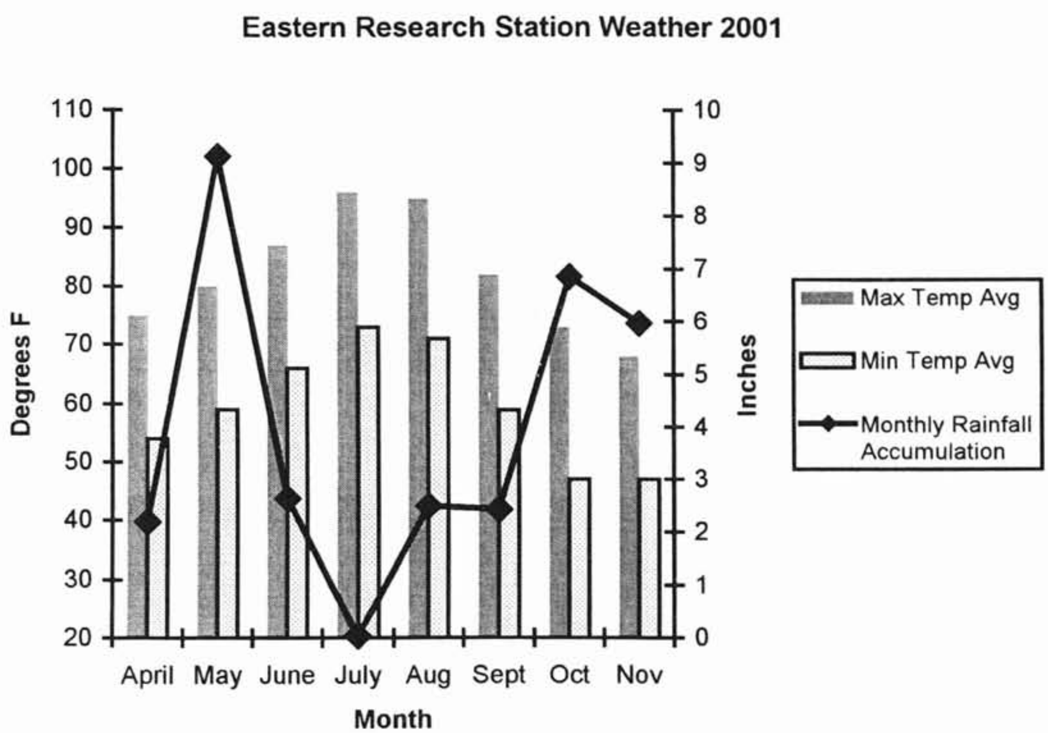
110
100
90
80
70
60
50
40
30
20
Degrees F
10
9
8
7
6
5
4
3
2
1
0
Inches
April
May
June
July
Aug
Sept
Oct
Nov
Month
Max Temp Avg
Min Temp Avg
Monthly Rainfall Accumulation

Figure 2



Eastern Research Station Weather 2001
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100
90
80
70
60
50
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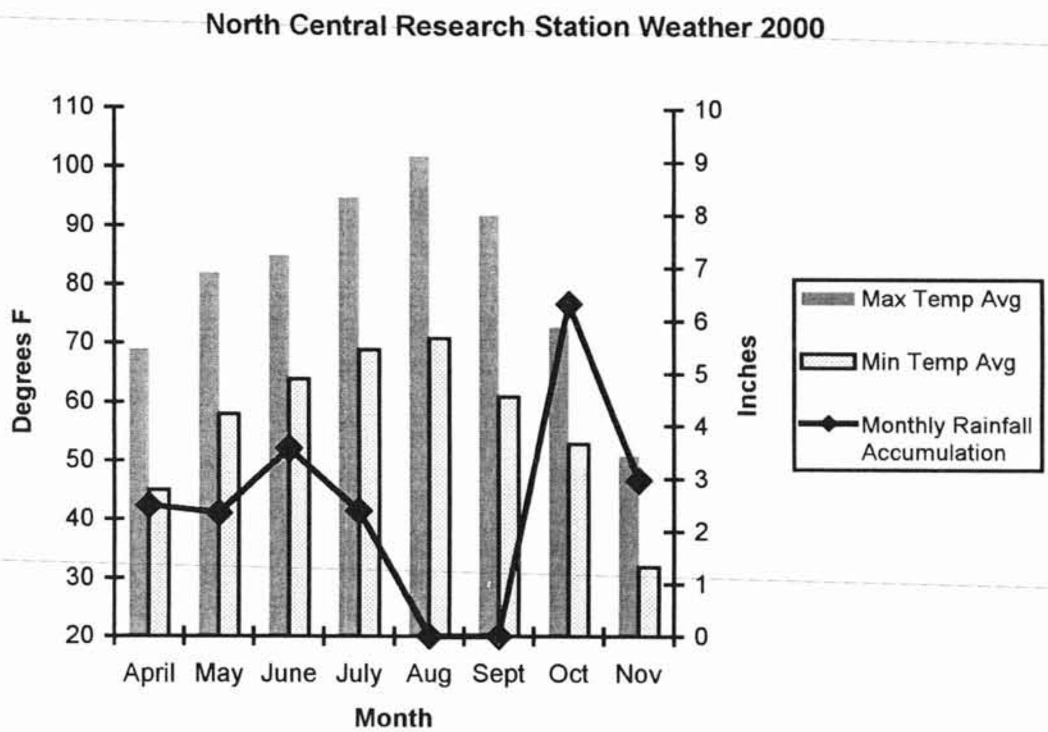
30
20
Degrees F
10
9
8
7
6
5
4
3
2
1
0
Inches
April
May
June
July
Aug
Sept
Oct
Nov
Month
Max Temp Avg
Min Temp Avg
Monthly Rainfall Accumulation

Figure 3



North Central Research Station Weather 2000
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100
90
80
70
60
50
40
30
20
Degrees F
10
9
8
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4
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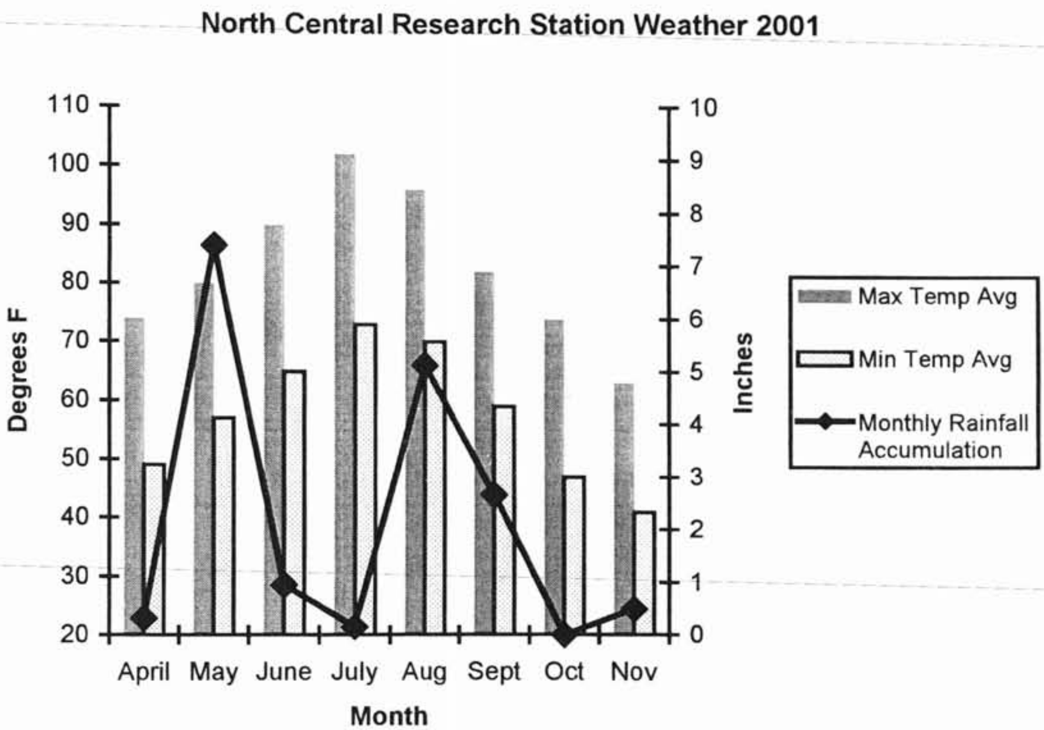
2
1
0
Inches
April
May
June
July
Aug
Sept
Oct
Nov
Month
Max Temp Avg
Min Temp Avg
Monthly Rainfall Accumulation

Figure 4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90
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70
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Degrees F
10
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2
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Inches
April
May
June
July
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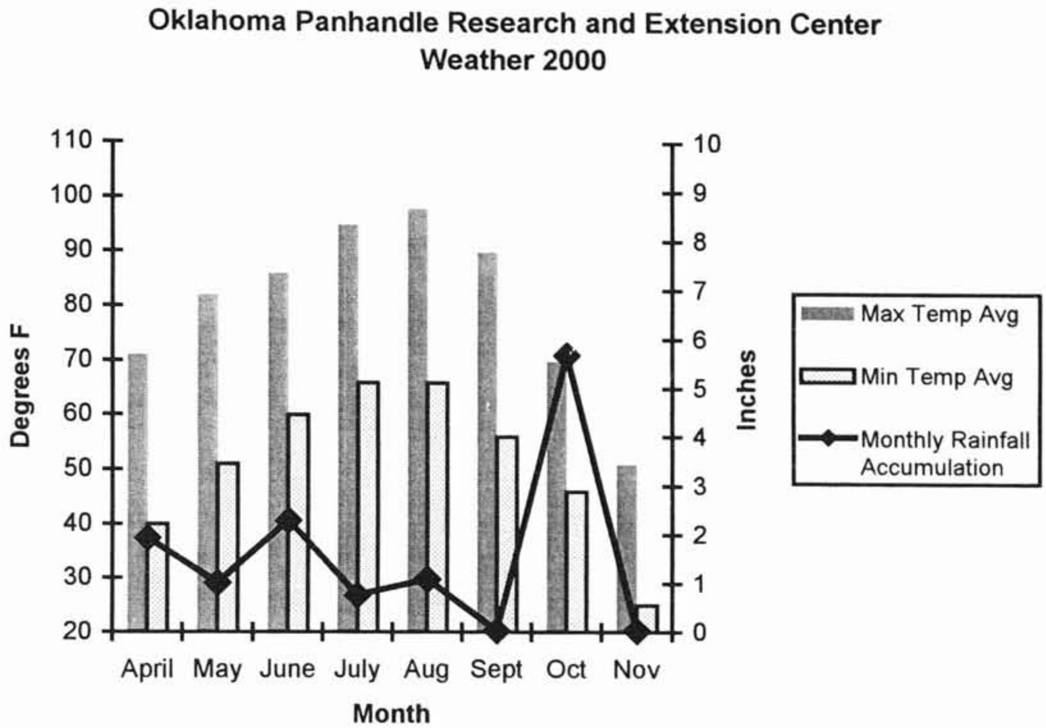
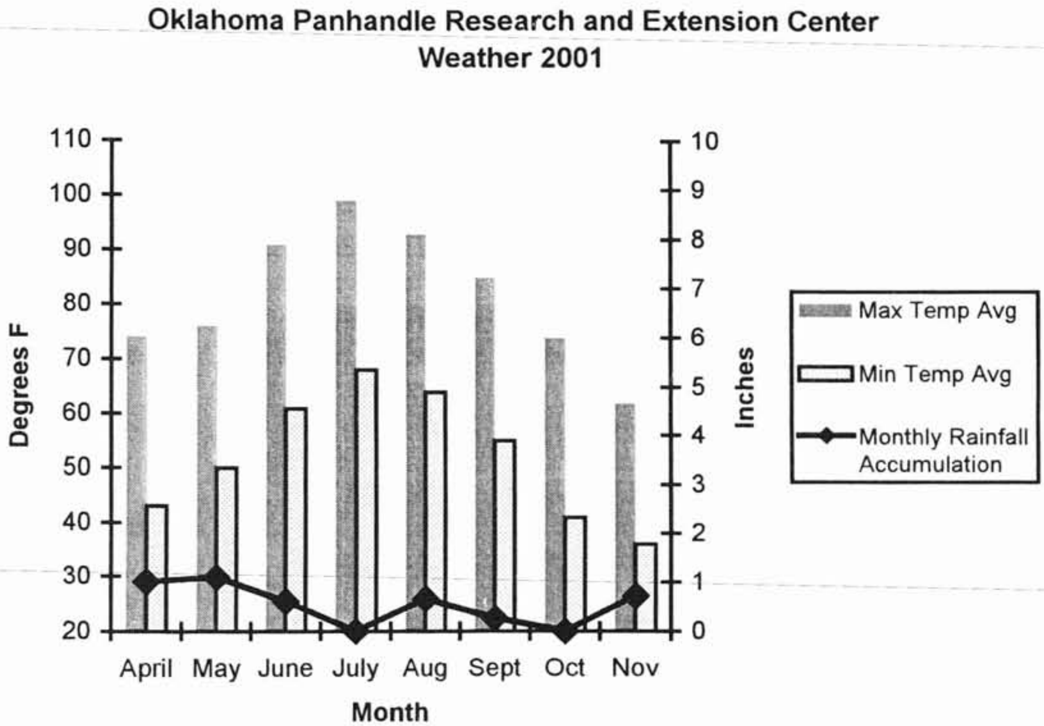
Oct
Nov
Month
Max Temp Avg
Min Temp Avg
Monthly Rainfall Accumulation

Figure 5



*rainfall does not include irrigation

Figure 6



*rainfall does not include irrigation

CHAPTER TWO

OPTIMUM POPULATIONS OF THREE SOYBEAN MATURITY GROUPS FOR OKLAHOMA PRODUCTION

OPTIMUM POPULATIONS OF THREE SOYBEAN MATURITY GROUPS FOR OKLAHOMA PRODUCTION

ABSTRACT

Soybean [*Glycine max* (L.) Merr.] production in Oklahoma has traditionally been limited to eastern Oklahoma due to high temperatures and low rainfall in the north central, northwestern, and southwestern portions of the state. Three practices essential for successful soybean production and the successful expansion of soybean production areas are selecting an appropriate maturity group for the region, planting at the optimum date, and selecting the optimum target populations. The objective of this study was to determine the optimum plant population for cultivars of three soybean maturity groups.

The study was performed over two years at three locations: Eastern Research Station, Haskell, OK; North Central Research Station, Lahoma, OK, and Oklahoma Panhandle Research and Extension Center, Goodwell, OK. Cultivars representing maturity groups III, IV, and V were chosen for this study based on their adaptability to the region and performance in variety trials. The cultivars chosen were representative of cultivars best adapted to Oklahoma environmental conditions, and all were glyphosate resistant.

The cultivars were planted at the regional optimum planting date based upon Oklahoma Cooperative Extension Service recommendations. Target populations were chosen to represent a range of seeding rates from 247,000 to 618,000 viable seeds per hectare. The interaction of cultivar and seeding rate was studied to determine the maximum yield potential for all three maturity groups. There were no significant

differences found in cultivar-seeding rate combinations. Therefore, it is of no benefit in Oklahoma soybean production to plant at higher populations than are recommended for the maturity group, cultivar, planting date, and field conditions.

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INTRODUCTION

Soybeans [*Glycine max* (L.) Merr.] can compensate in yield for a wide range in seeding rates (Wilcox, 1974) and over a broad range of plant densities, providing the stands do not fall below 124,000 to 173,000 plants/hectare (Beuerlein, 1988; Oplinger and Philbrook, 1992). Compensation is achieved through adjustment in pods per plant, seeds per pod, seed weight, and branching (Wilcox, 1974; Oplinger and Philbrook, 1992). Additionally, natural thinning of stands generally occurs when plants are above optimum densities (Beuerlein, 1980; Oplinger and Philbrook, 1992).

Soybean grain yield is determined more by harvested plant populations than by seeding rates (Oplinger and Philbrook, 1992). Researchers in Wisconsin found that maximum yields occurred at a 618,000 viable seeds/ha planting rate, resulting in a harvest population of 388,000 plants/ha (Oplinger and Philbrook, 1992). Oplinger and Philbrook (1992) also observed no yield differences at seeding rates of 494,000 and 741,000 viable seeds/ha seeding rates. In Nebraska, researchers found that soybean yield was highest at populations of greater than or equal to 129,000 plants/ha (Ennin and Clegg, 2001).

Additional research has been conducted comparing indeterminate and determinate cultivars. Determinate soybean plants terminate stem growth when flowering begins or shortly thereafter, while indeterminate soybeans continue growth in stem length and leaf production for considerable time after flowering begins (Bernard, 1972; Robinson and Wilcox, 1998). Indeterminate soybean cultivars are commonly grown in the northern US, while determinate cultivars are commonly grown in the South (Beuerlein, 1988).

High seeding rates (618,000 seed/ha) for indeterminate cultivars usually produce tall plants with small, weak stems. Severe lodging is likely to occur with the high seeding rates, resulting in excessive harvest loss and poor grain quality (Beuerlein, 1985, 1988). If seeding rates are too low (148,000 seeds/ha), the plants will be short, have many branches, and pods will be close to the soil surface, making harvest losses excessive (Beuerlein, 1985, 1988). Beuerlein found that for both indeterminate and determinate cultivars, as seeding rates increase, plant height, height of the lowest pod, and lodging tend to increase. He also determined that when planted in Ohio, determinate cultivars should be planted at seeding rates 25 to 50% greater than indeterminate cultivars.

In the mid-Atlantic US, researchers in Virginia tested indeterminate cultivars from maturity groups III and IV and found no response in soybean yield to plant population (103,000 to 880,000 plants/ha) when no drought stress was experienced (Holshouser and Whittaker, 2001). With only brief drought stress, 208,000 plants/ha were adequate for maximum yields. When drought stress limited leaf area production, populations over 600,000 plants/ha were required to maximize yields (Holshouser and Whittaker, 2001).

In the mid-Southern US, researchers in Arkansas found that short-season soybean production systems (use of early-maturing cultivars planted late in the season) require high populations to optimize yield (Ball et al., 2000b). Production systems that utilize short season cultivars for double-cropping and late sowing often have insufficient time to establish a complete canopy prior to reproductive development. Therefore, higher populations than are traditionally recommended provide a way to optimize grain yield in

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In other research, planting date has been shown to affect optimal plant population. Research in Louisiana revealed that yields of determinate soybeans were increased at late planting dates (July 3) by using a plant population density approximately twice that which would be used at optimal planting dates (Boquet, 1990). These results were similar to those of the indeterminate cultivars studied in the short-season production systems in Arkansas. However, the determinate soybean cultivars exhibited large reductions in branch stem vegetative and reproductive development resulting from the late planting and from the increased plant population density (Boquet, 1990).

Research in eastern Oklahoma showed an increase in planting rate was desirable when planting was delayed until July (Sholar, 1997). The short stature of late planted soybeans results in pod set close to the soil surface, excessive harvest loss, and poor grain quality, similar to those characteristics of short stature soybeans described by Beuerlein (1985, 1988). In addition to seeding rate increased due to late planting, Sholar and Edwards (1997) recommended increasing seeding rates 10% for a poor seedbed, 10% for early-maturing (indeterminate) cultivars, and 10% when planting late or after wheat in eastern Oklahoma.

Eastern Oklahoma soybean production utilizes both indeterminate and determinate cultivars. Research in the Midwest, mid-south, and mid-Atlantic has generally shown little benefit to varying population beyond a traditional optimal plant population of population density for the region. However, impacts of environmental conditions such as drought have been shown to affect the optimal plant population, and therefore affect the optimal seeding rate. Although drought cannot be accurately predicted, it can be safely expected in the north central and northwestern portions of Oklahoma. Higher plant populations may enable a maintained soybean yield under drought conditions in Oklahoma as it has in other regions.

MATERIALS AND METHODS

The experimental design for this study was a randomized complete block with a factorial arrangement of three cultivars and seven population treatments with three replications. The experiment was conducted over a two-year period at three locations in Oklahoma: the Eastern Research Station (ERS) near Haskell, the North Central Research Station (NCRS) near Lahoma, and the Oklahoma Panhandle Research and Extension Center (OPREC) in Goodwell. The plots were 3.05 m x 6.71 m. A 0.9 m alley was left unplanted and was tilled between each replication. A 3.05 m border was planted on both sides of each replication. A .762 m x 6.71 m section was harvested from each plot to obtain grain yield. The seed was weighed and expressed as yield in kg/ha.

The cultivars were chosen based on availability, adaptability, proven yield potential in Oklahoma, herbicide tolerance traits, and to represent common cultivars and maturity groups used for Oklahoma soybean production. Asgrow 3301(AG3301) was chosen to represent maturity group III (MG III) in 2000. In 2001, Asgrow 3302 (AG3302) replaced the AG3301 cultivar, which was unavailable to Oklahoma seed suppliers. AG3301 possesses glyphosate tolerant traits while AG3302 possesses glyphosate tolerant traits and sulfonylurea herbicide resistance. Asgrow 4602 (AG4602) was chosen as a representative of maturity group IV (MG IV), and Asgrow 5602 (AG5602) was chosen as a representative of maturity group V (MG V). All cultivars were glyphosate tolerant and sulfonylurea tolerant except AG3301 which was glyphosate resistant only.

Field management followed customary agronomic procedures for the region. The fields were initially tilled with a Do-all at the ERS and a field cultivator at the NCRS and the OPREC in mid-April and then again before planting. The ERS and NCRS were completely rain-fed. The OPREC test was fully irrigated in 2001, but irrigation was only partially available in 2000 due to equipment malfunctions. Glyphosate was applied at a rate of 1.75 to 2.34 L per hectare as needed for post emergence weed control. In general, two applications were required for full season weed control.

All cultivars were planted on 76.2 cm rows at a seeding depth of approximately 2.54 cm. Seeding rates began at 250,000 viable seeds per hectare and increased in 62,000 seeds per hectare increments up to 620,000 viable seeds per hectare. Planting dates were selected for each region based on traditional optimum dates: mid-May at the NCRS and OPREC, and the first week of June at the ERS. Initial and harvest populations were sampled from the center rows of each plot. The number of plants in a 1.22m section of row was recorded.

An analysis of variance (ANOVA) test was conducted using yield values. Least significant differences (LSDs) were determined at the 0.05 level. Locations, maturity groups, and years were found to be significant, therefore, all location-year-maturity group combinations were considered independently.

RESULTS AND DISCUSSION

The effects of environmental conditions on plant development are numerous. In this experiment, rainfall amounts and temperatures varied greatly between years and among locations. Using an analysis of variance, significant location-year-cultivar interaction was found. Therefore, each location-year-cultivar must be considered independently. Data are presented in tables (Tables 7-12) with each table encompassing one year of the experiment at each location. Least significant differences (LSD) were used to determine differences within each cultivar among the seven seeding rates.

EASTERN RESEARCH STATION

For AG3301 in 2000 at the ERS, yields ranged from 1121.47 (520,000 plants/ha) to 1431.17 kg/ha (500,000plants/ha) (Table 13) across all populations. The lowest yield was obtained from a harvest population of 520,000 plants/ha (1121.47 kg/ha) while the highest yield was obtained from a harvest population of 500,000 plants/ha (1431.17 kg/ha) (Table 13). A harvest population difference of only 20,000 plants/ha (500,000 and 520,000 plants/ha) produced a significant yield difference, while a difference of 190,000 plants/ha (330,000 and 520,000 plants/ha) did not produce a significant difference. In 2001, the lowest yield (620.45 kg/ha) was produced by the highest plant population (520,000 plants/ha) (Table 14). The highest yield, 933.19 kg/ha, was obtained from a harvest population of 340,000 plants/ha. However, a harvest population of only slightly less, 340,000 plants/ha produced only 766.06 kg/ha. These data provide evidence that plant population, limited to the extent of those harvest populations in this study, was not a significant yield determining factor at high and low

A harvest population of 110,000 plants/ha produced the only significant yield difference in the AG5602 cultivar in 2001. These data provide evidence that harvest population was not a significant yield-determining factor for AG5602 planted in western Oklahoma in the 2000 and 2001 growing seasons.

CONCLUSION

Very few significant differences in yield were obtained in either year of the study or at any of the three locations. The yield differences that were obtained were inconsistent and appeared to be dependent on factors other than harvest population. Differences in yield were possibly masked by the poor weather conditions in both years at all locations. Holshouser and Whittaker (2001) found that plant populations did not significantly affect yield when no drought stress was experienced and that increased populations were required to maintain yield during drought. However, the data presented here do not adhere to their findings. Even under drought conditions, significant differences in yield were not observed by altering seeding rates. Failure to achieve significant differences in harvested plant populations may have contributed to these results. However, differences of 250,000 plants per hectare produced no significant yield differences, supporting the conclusion that no yield benefit is obtained by increasing plants per hectare beyond the recommended rates for maturity group, cultivar, planting date, and field conditions.

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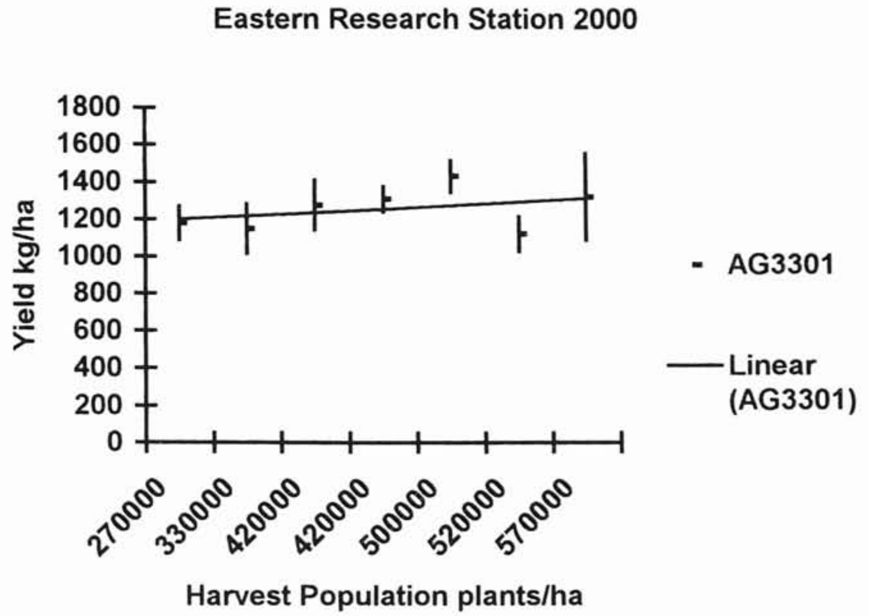
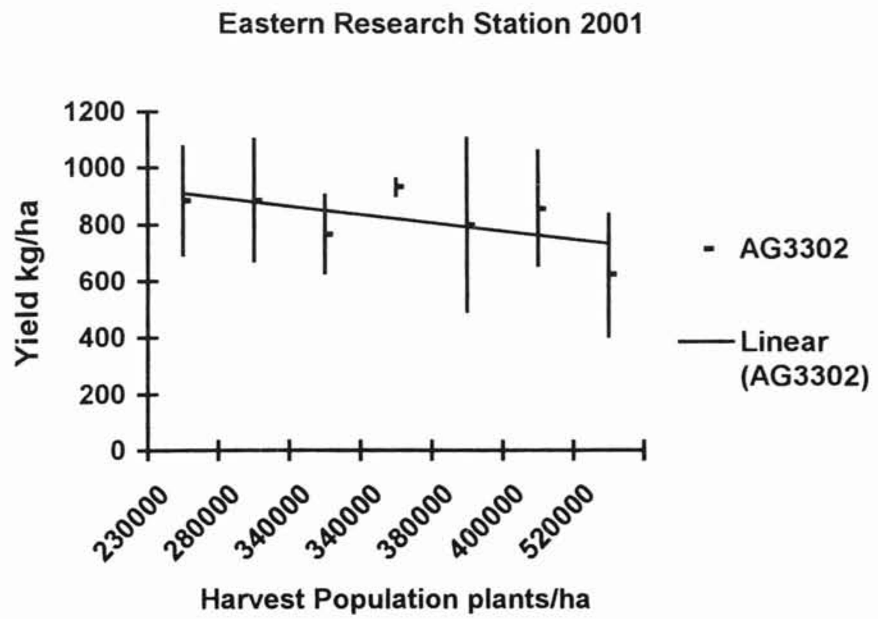
APPENDIXES

Appendix | Page

Appendix J



Eastern Research Station 2000
1800
1600
1400
1200
1000
800
600
400
200
0
Yield kg/ha
270000
330000
420000
420000
500000
520000
570000
Harvest Population plants/ha
AG3301
Linear (AG3301)



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1000
800
600
400
200
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Yield kg/ha
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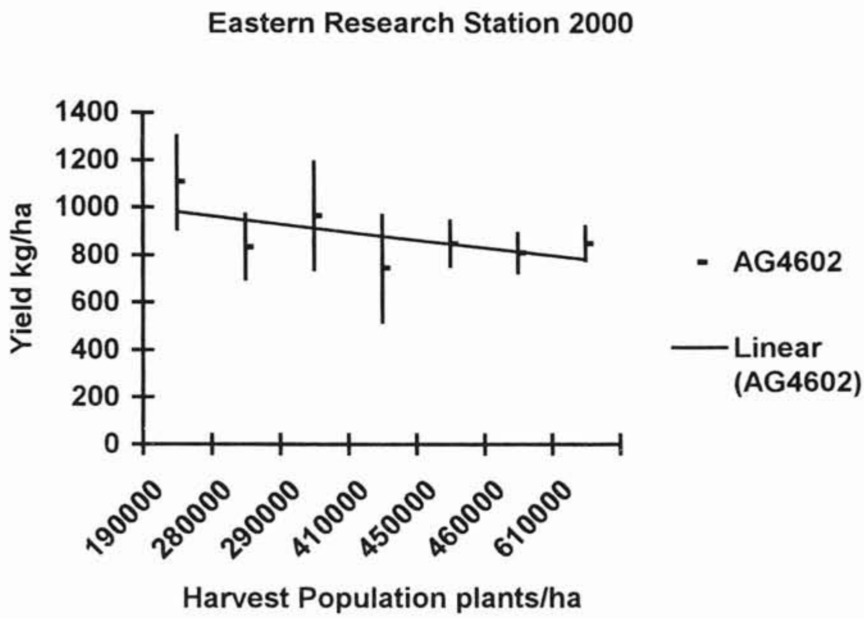
340000
340000
380000
400000
520000
Harvest Population plants/ha
AG3302
Linear (AG3302)

Appendix K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1200
1000
800
600
400
200
0
Yield kg/ha
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280000
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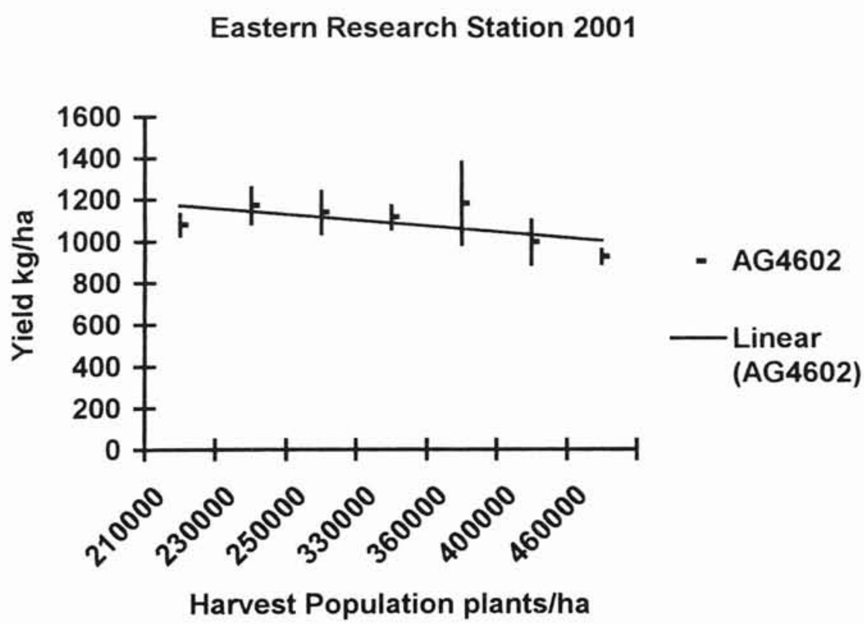
410000
450000
460000
610000
Harvest Population plants/ha
AG4602
Linear (AG4602)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200
0
Yield kg/ha
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230000
250000
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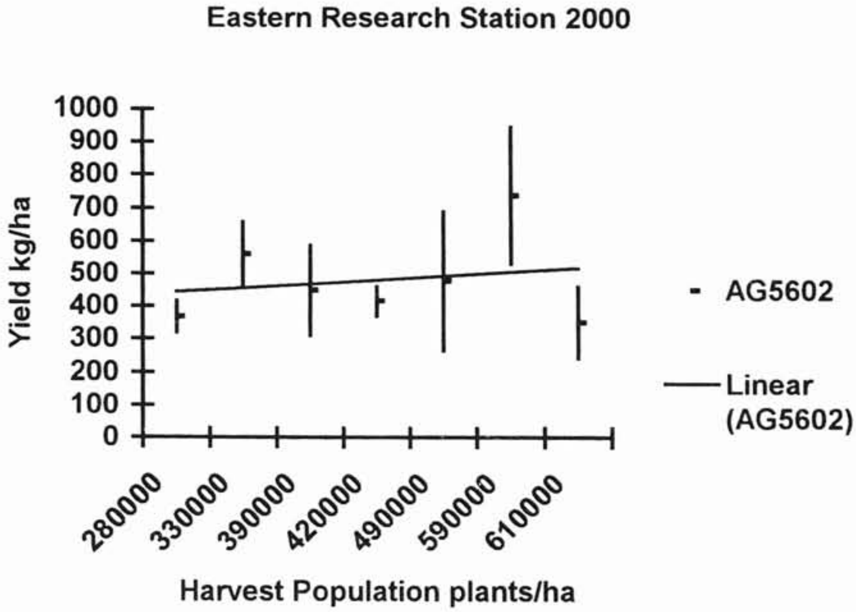
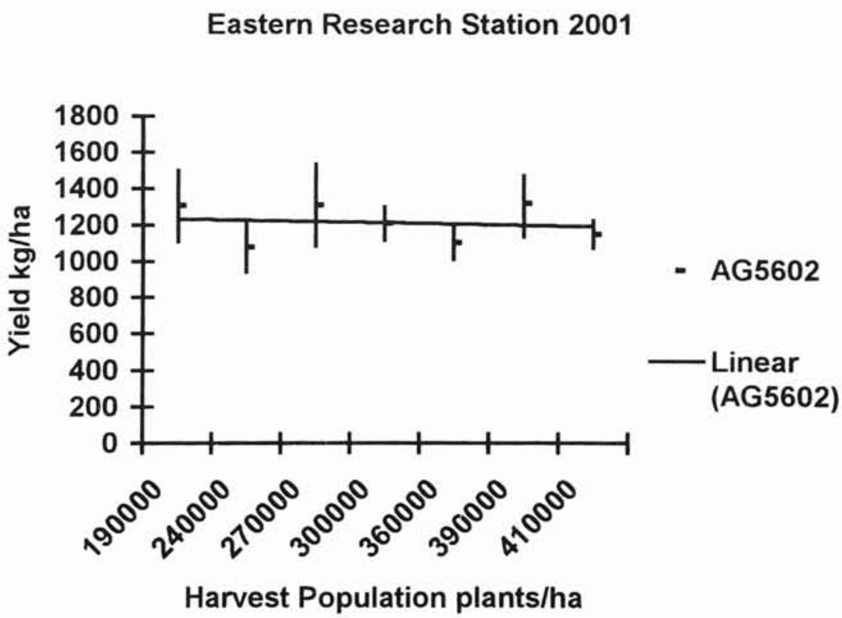
360000
400000
460000
Harvest Population plants/ha
AG4602
Linear (AG4602)

Appendix L

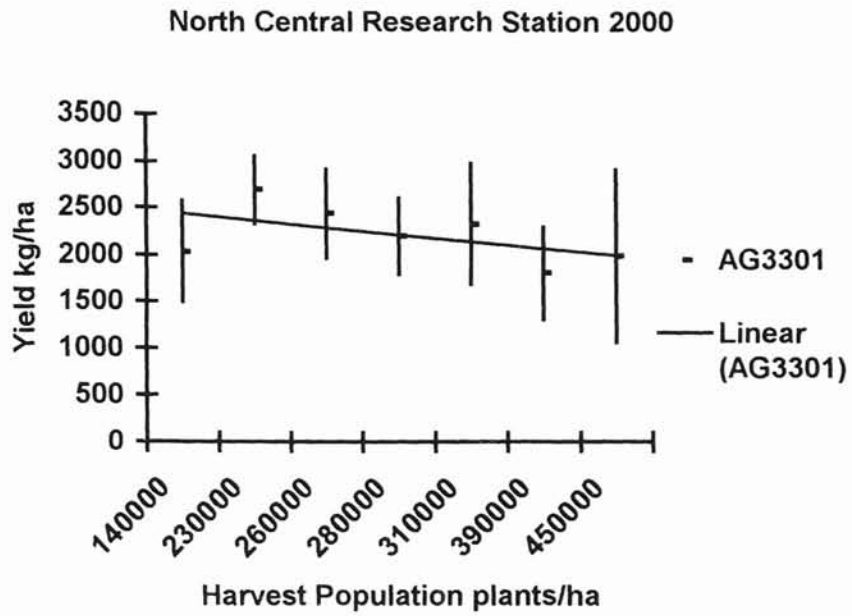


Eastern Research Station 2000
Yield kg/ha
1000
900
800
700
600
500
400
300
200
100
0
280000
330000
390000
420000
490000
590000
610000
Harvest Population plants/ha
AG5602
Linear (AG5602)



Eastern Research Station 2001
Yield kg/ha
1800
1600
1400
1200
1000
800
600
400
200
0
190000
240000
270000
300000
360000
390000
410000
Harvest Population plants/ha
AG5602
Linear (AG5602)

Appendix M



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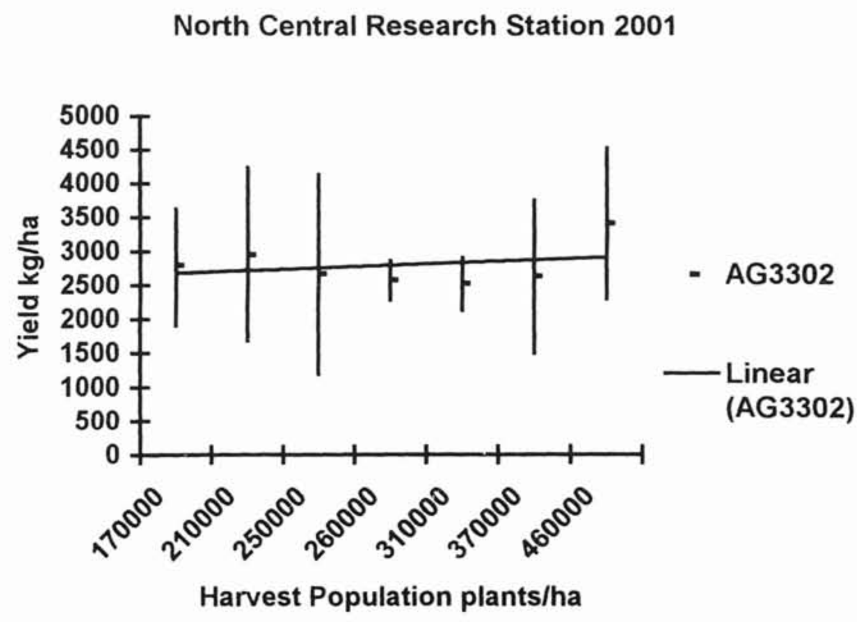
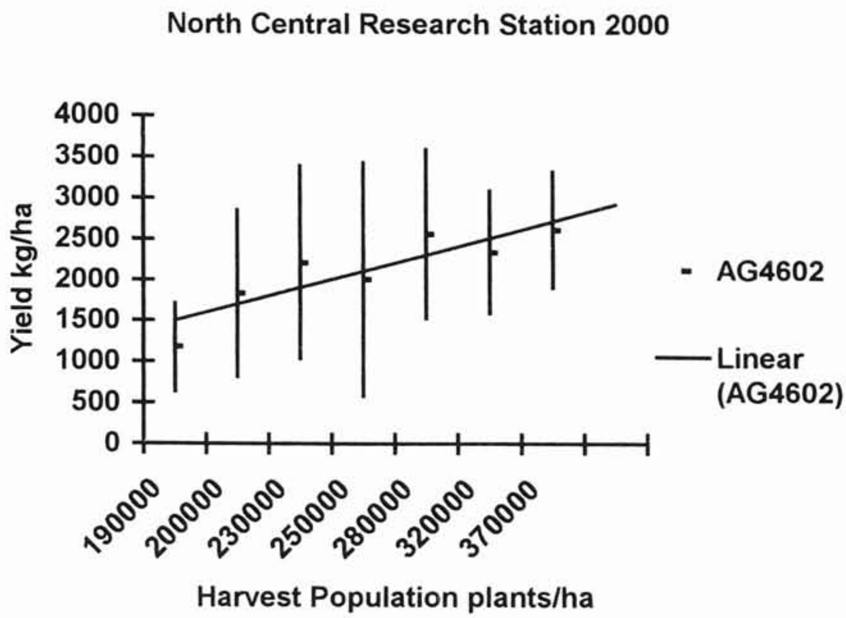
Yield kg/ha
3500
3000
2500
2000
1500
1000
500
0
140000
230000
260000
280000
310000
390000
450000
Harvest Population plants/ha
AG3301
Linear (AG3301)



North Central Research Station 2001
Yield kg/ha
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
170000
210000
250000
260000
310000
370000
460000
Harvest Population plants/ha
AG3302
Linear (AG3302)

Appendix N



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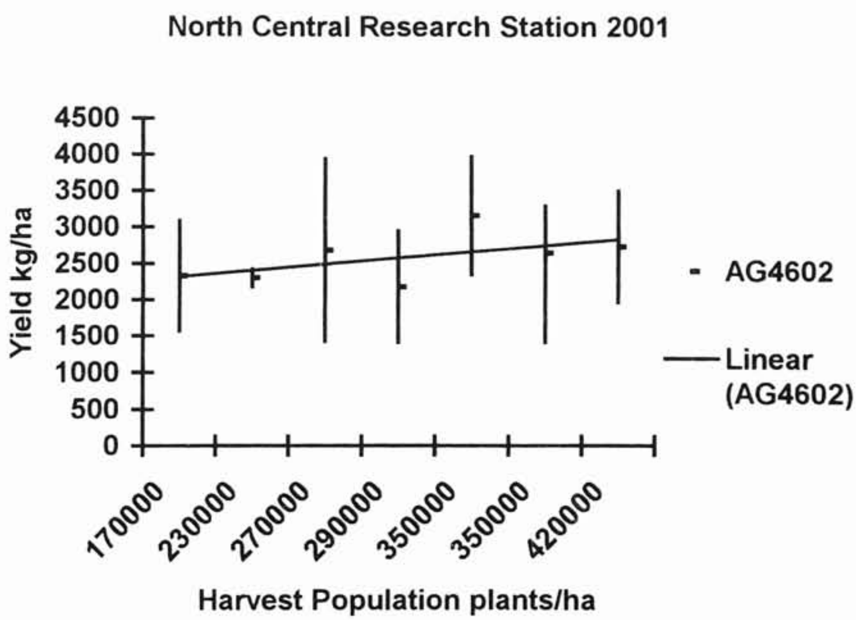
4000
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
190000
200000
230000
250000
280000
320000
370000
Harvest Population plants/ha
AG4602
Linear (AG4602)



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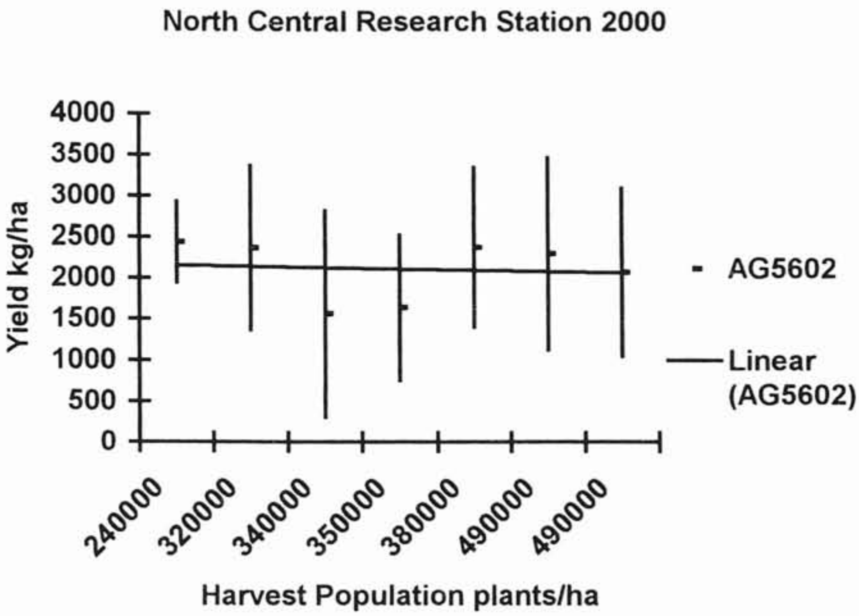
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
170000
230000
270000
290000
350000
350000
420000
Harvest Population plants/ha
AG4602
Linear (AG4602)

Appendix O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Yield kg/ha
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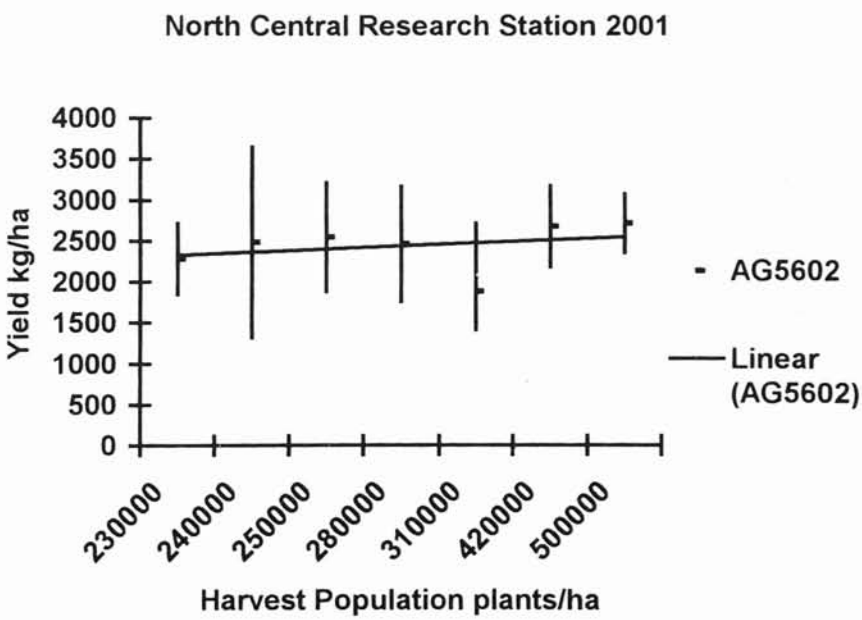
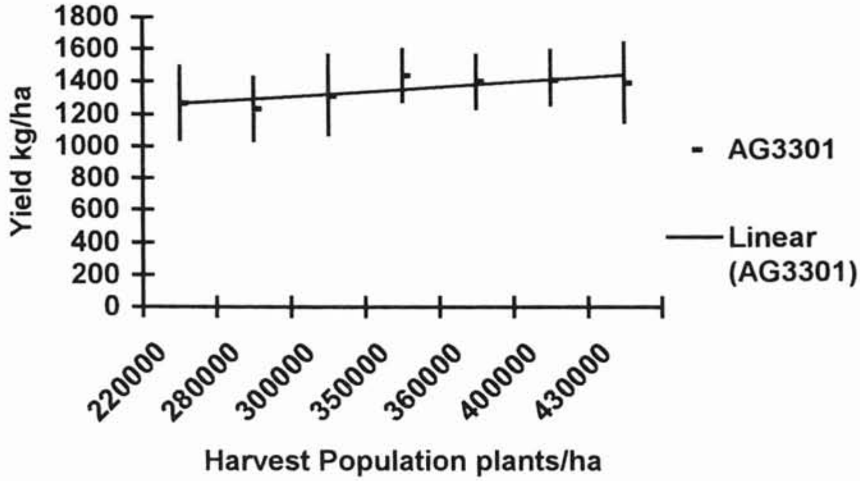
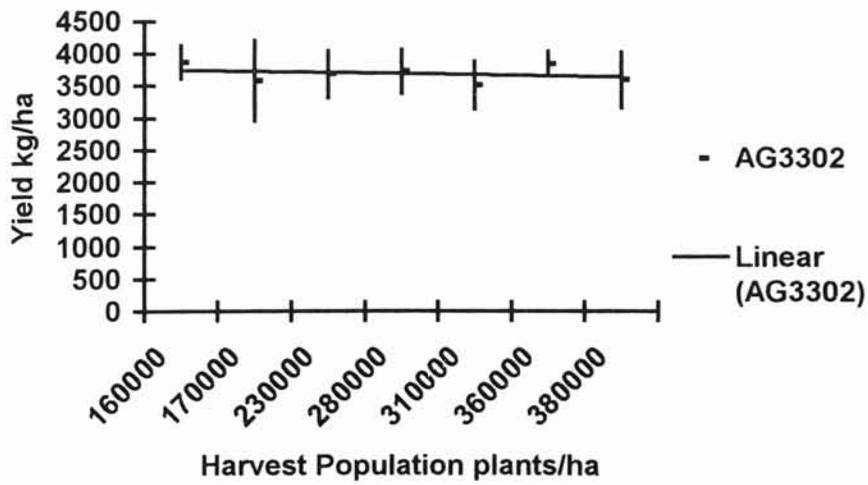
3500
3000
2500
2000
1500
1000
500
0
240000
320000
340000
350000
380000
490000
490000
Harvest Population plants/ha
AG5602
Linear (AG5602)


North Central Research Station 2001
Yield kg/ha
4000
3500
3000
2500
2000
1500
1000
500
0
230000
240000
250000
280000
310000
420000
500000
Harvest Population plants/ha
AG5602
Linear (AG5602)

Oklahoma Panhandle Research and Extension Center 2000



Oklahoma Panhandle Research and Extension Center 2001



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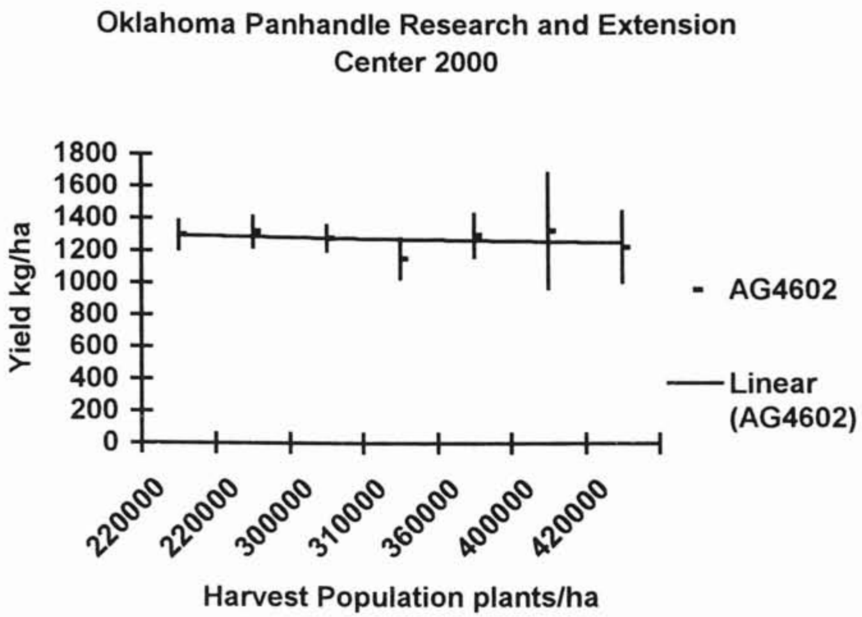
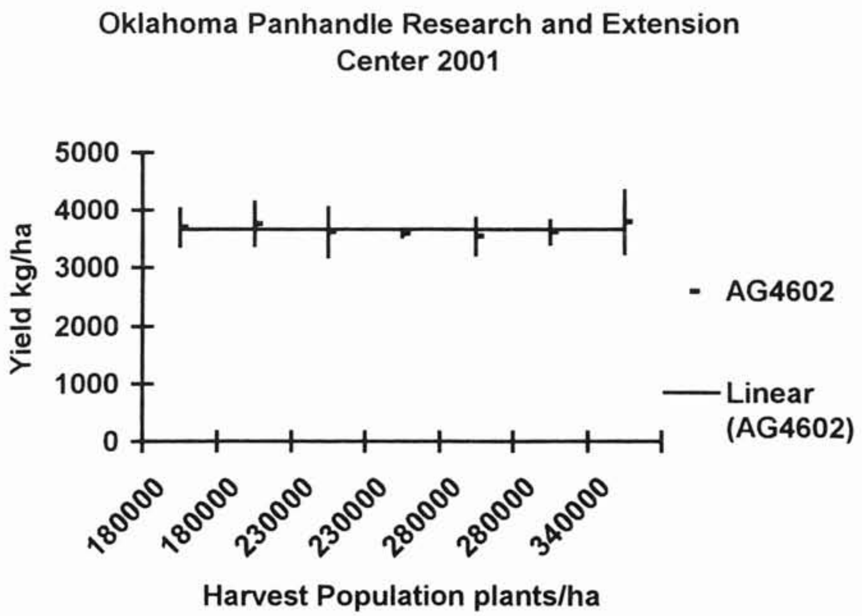
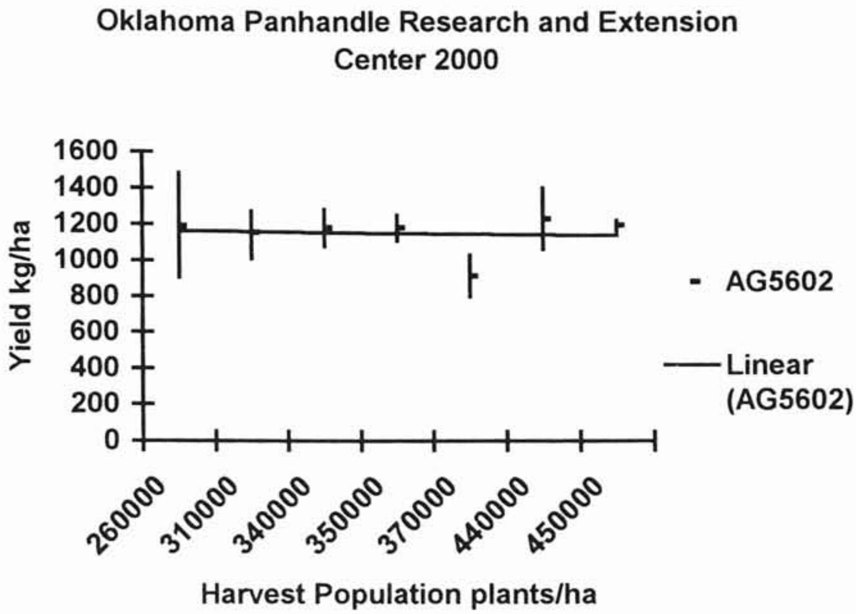

Oklahoma Panhandle Research and Extension Center 2000
1800
1600
1400
1200
1000
800
600
400
200
0
Yield kg/ha
220000
220000
300000
310000
360000
400000
420000
Harvest Population plants/ha
AG4602
Linear (AG4602)


Oklahoma Panhandle Research and Extension Center 2001
5000
4000
3000
2000
1000
0
Yield kg/ha
180000
180000
230000
230000
280000
280000
340000
Harvest Population plants/ha
AG4602
Linear (AG4602)

Appendix R



Oklahoma Panhandle Research and Extension Center 2000
Yield kg/ha
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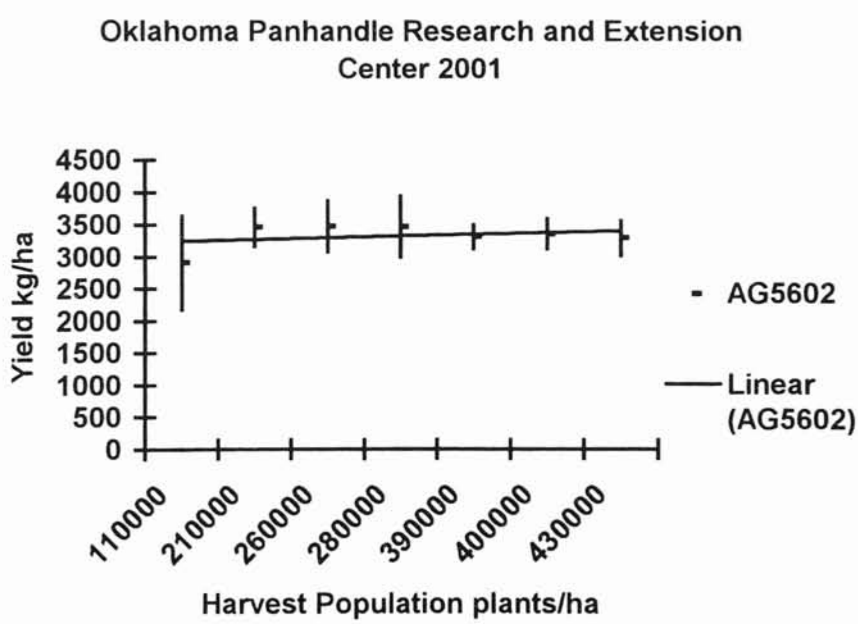
1400
1200
1000
800
600
400
200
0
260000
310000
340000
350000
370000
440000
450000
Harvest Population plants/ha
AG5602
Linear (AG5602)



Oklahoma Panhandle Research and Extension Center 2001
Yield kg/ha
4500
4000
3500
3000
2500
2000
1500
1000
500
0
110000
210000
260000
280000
390000
400000
430000
Harvest Population plants/ha
AG5602
Linear (AG5602)

LIST OF TABLES

Table 7

Eastern Research Station Agronomic Data 2000

	Seeding rate seeds/ha	*Initial Population plant/ha*	*Harvest Population plant/ha*	*% of Initial Population (Harvest/Initial x 100)*	*Yield kg/ha*	*Standard Deviation ±*	
AG3301	250000	340000	270000	79	1180.15	90.87	c*d
	310000	360000	330000	92	1150.81	133.5	d
	370000	470000	420000	89	1310.55	67.76	abc
	430000	580000	420000	72	1277.95	132.79	bc
	500000	620000	500000	81	1431.17	84.32	a
	560000	680000	570000	84	1320.33	232.88	ab
	620000	720000	520000	72	1121.47	94.99	d
AG4602	250000	330000	190000	58	1105.17	196.34	a
	310000	420000	300000	69	964.98	226.5	b
	370000	470000	280000	60	834.58	137.04	bc
	430000	530000	410000	77	743.3	224.09	c
	500000	610000	460000	75	808.5	83.18	c
	560000	700000	450000	64	847.62	96.49	bc
	620000	790000	610000	77	847.62	73.41	bc
AG5602	250000	300000	280000	93	368.39	48.24	c
	310000	420000	390000	93	449.89	137.97	b
	370000	480000	330000	69	560.73	88.2	b
	430000	560000	420000	75	417.29	45.17	c
	500000	580000	490000	85	479.23	212.26	bc
	560000	710000	590000	83	740.04	207.56	a
	620000	860000	610000	71	352.09	108.91	c

LSD (0.05) between seeding rates within cultivar 136.18

*values with the same letter indicate no significant difference in yield within cultivar between seeding rates

Table 8

Eastern Research Station Agronomic Data 2001

	Seeding rate seeds/ha	*Initial Population plant/ha*	*Harvest Population plant/ha*	*% of Initial Population (Harvest/Initial x 100)*	*Yield kg/ha*	*Standard Deviation ±*	
AG3302	250000	320000	410000	128	856.44	200.99	a*b
	310000	280000	280000	100	885.85	213.94	ab
	370000	240000	230000	96	884.42	189.84	ab
	430000	450000	380000	84	797.62	305.02	ab
	500000	460000	340000	74	933.19	28.08	a
	560000	560000	340000	61	766.06	138.00	bc
	620000	580000	520000	90	620.45	215.77	c
AG4602	250000	280000	230000	82	1172.05	85.38	a
	310000	320000	210000	66	1079.52	49.88	a
	370000	420000	360000	86	1180.66	198.23	a
	430000	310000	250000	81	1139.05	100.29	ab
	500000	420000	330000	79	1114.67	56.44	ab
	560000	590000	400000	68	994.88	106.30	bc
	620000	460000	460000	100	923.87	32.94	c
AG5602	250000	230000	190000	83	1306.18	195.52	a
	310000	280000	240000	86	1079.52	139.2	b
	370000	360000	270000	75	1310.49	222.58	a
	430000	380000	390000	103	1319.81	152.5	a
	500000	420000	410000	98	1151.96	76.27	b
	560000	380000	300000	79	1210.06	91.56	ab
	620000	420000	360000	86	1103.91	92.0	b

LSD (0.05) between seeding rates within cultivar 148.17

*values with the same letter indicate no significant difference in yield within cultivar between seeding rates

Table 9

North Central Research Station Agronomic Data 2000

	Seeding rate seeds/ha	*Initial Population plant/ha*	*Harvest Population plant/ha*	*% of Initial Population (Harvest/Initial x 100)*	*Yield kg/ha*	*Standard Deviation ±*	
AG3301	250000	190000	140000	74	2034.29	542.43	a*b
	310000	250000	260000	104	2445.06	473.21	ab
	370000	270000	230000	85	2692.82	361.91	a
	430000	310000	310000	100	2334.21	642.10	ab
	500000	320000	280000	88	2203.81	405.18	ab
	560000	360000	450000	125	1988.65	920.40	ab
	620000	460000	390000	85	1809.34	499.46	b
AG4602	250000	190000	200000	105	1828.90	1018.08	ab
	310000	280000	280000	100	2565.68	1033.48	a
	370000	200000	190000	95	1173.63	536.31	b
	430000	250000	230000	92	2213.59	1181.60	a
	500000	270000	250000	93	2008.21	1423.50	ab
	560000	360000	320000	89	2343.99	746.78	a
	620000	450000	370000	82	2617.84	706.37	a
AG5602	250000	230000	240000	104	2438.54	491.09	a
	310000	340000	320000	94	2370.07	1003.14	ab
	370000	390000	350000	90	1643.08	887.42	ab
	430000	410000	340000	83	1564.58	1255.39	b
	500000	470000	380000	81	2376.59	974.94	ab
	560000	600000	490000	82	2298.35	1170.08	ab
	620000	660000	490000	74	2070.15	1022.22	ab

LSD (0.05) between seeding rates within cultivar 834.77

*values with the same letter indicate no significant difference in yield within cultivar between seeding rates

Table 10

North Central Research Station Agronomic Data 2001

	Seeding rate seeds/ha	*Initial Population plant/ha*	*Harvest Population plant/ha*	*% of Initial Population (Harvest/Initial x 100)*	*Yield kg/ha*	*Standard Deviation ±*	
AG3302	250000	180000	170000	94	2796.71	836.66	a*b
	310000	270000	260000	96	2570.04	295.34	b
	370000	210000	210000	100	2958.09	1278.71	ab
	430000	330000	310000	94	2515.53	388.95	b
	500000	280000	250000	89	2664.72	1471.76	ab
	560000	400000	370000	93	2628.86	1128.94	ab
	620000	470000	460000	98	3415.00	1116.15	a
AG4602	250000	180000	170000	94	2329.03	758.40	b
	310000	260000	230000	89	2302.49	120.73	b
	370000	290000	270000	93	2680.51	1256.14	ab
	430000	320000	290000	91	2176.25	769.15	b
	500000	370000	350000	95	3155.35	812.30	a
	560000	430000	420000	98	2735.02	766.56	ab
	620000	360000	350000	97	2643.92	943.67	ab
AG5602	250000	250000	240000	96	2481.82	1163.90	ab
	310000	240000	230000	96	2276.67	462.25	ab
	370000	330000	310000	94	1877.86	831.11	b
	430000	270000	250000	93	2543.50	664.40	ab
	500000	310000	280000	90	2458.15	704.90	ab
	560000	450000	420000	93	2676.20	497.18	ab
	620000	510000	500000	98	2712.07	360.40	a

LSD (0.05) between seeding rates within cultivar 823.40

*values with the same letter indicate no significant difference in yield within cultivar between seeding rates

Table 11

Oklahoma Panhandle Research and Extension Center Agronomic Data 2000

	Seeding rate seeds/ha	*Initial Population plant/ha*	*Harvest Population plant/ha*	*% of Initial Population (Harvest/Initial x 100)*	*Yield kg/ha*	*Standard Deviation ±*	
AG3301	250000	210000	220000	105	1266.25	225.15	b*c
	310000	290000	280000	97	1233.97	195.50	c
	370000	330000	300000	91	1316.81	239.55	abc
	430000	370000	360000	97	1405.03	161.90	abc
	500000	360000	350000	97	1442.68	159.03	a
	560000	490000	430000	88	1399.65	245.32	ab
	620000	440000	400000	91	1412.56	185.97	ab
AG4602	250000	210000	220000	105	1297.44	90.54	ab
	310000	240000	220000	92	1318.96	95.76	ab
	370000	340000	310000	91	1155.44	126.04	b
	430000	370000	300000	81	1279.16	78.08	ab
	500000	420000	360000	86	1299.60	133.48	ab
	560000	480000	420000	88	1226.44	220.86	ab
	620000	490000	400000	82	1327.57	359.69	a
AG5602	250000	270000	260000	96	1192.01	290.28	a
	310000	320000	310000	97	1156.51	116.65	a
	370000	460000	350000	76	1182.33	71.76	a
	430000	400000	340000	85	1182.33	103.35	a
	500000	430000	370000	86	913.37	116.19	b
	560000	500000	440000	88	1231.82	171.31	a
	620000	530000	450000	85	1196.32	29.99	a

LSD (0.05) between seeding rates within cultivar 171.86

*values with the same letter indicate no significant difference in yield within cultivar between seeding rates

VITA 2

Sarah Elizabeth Haymaker

Candidate for the Degree of

Master of Science

Thesis: OPTIMUM PLANTING DATES AND POPULATIONS OF THREE SOYBEAN MATURITY GROUPS FOR OKLAHOMA PRODUCTION

Major Field: Plant and Soil Sciences

Biographical:

Education: Graduated with honors from Enid High School, Enid, Oklahoma, in May, 1996; received Bachelor of Science degree in Agricultural Sciences and Natural Resources with a major in Agronomy, from Oklahoma State University in December of 1999. Completed the requirements for the Master of Science degree with a major in Plant and Soil Sciences at Oklahoma State University in August, 2002.

Experience: Began working on a farm in Lahoma, Oklahoma, in 1992; employed by Collingwood Grain, Inc., as a crop consulting intern during the summers of 1998 and 1999; earned Certified Crop Advisor license in 2000; employed by Oklahoma State University Department of Plant and Soil Sciences as an undergraduate and as a graduate research assistant, 1996 to present.

Professional Membership: American Society of Agronomy