

SOLID-SEEDED SOYBEANS IN EASTERN OKLAHOMA

By

MBOLDA
"

Agriculture Engineer Degree

National Advanced School of Agriculture

Dschang, Cameroon

1978

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
December, 1988

Thesis
1988
M478A
cop. 2

SOLID-SEEDED SOYBEANS IN EASTERN OKLAHOMA

Thesis Approved:

R. Jewell Crooktree

Thesis Adviser

James S. Kirby

U. M. Ward

Norman R. Danham

Dean of the Graduate College

PREFACE

In September 1973 the Government of Cameroon started a national seed development and food production program with an initial creation of the Mission for the Development of Food Crops and Seed Production Around Metropolitan Areas (MIDEVIV). The responsibilities of this important organization have grown and specialized so that more emphasis was assigned to its seed development component by presidential decree in August 1984. Beginning in 1976 with the opening of the Seed Project (ProSem), the actual northern branch of MIDEVIV, special emphasis has been given to that area of Cameroon where the agricultural production presents problems inherent to soil erosion caused both by water and wind.

As part of the governmental training program for agricultural scientists the MIDEVIV training opportunities cover various aspects involved in seed production and development. The MIDEVIV training plan includes management of seed agencies, seed production and field control, seed technology, soil and water management, machinery for seed production and processing, and extension programs. As part of this effort I was sent to Oklahoma State University for a degree in agronomy with emphasis in soil science.

I am deeply indebted to the United States Agency for International Development-Cameroon (USAID-Cameroon), to the Cameroon Government, particularly to Mr. Jean Bernard Abong (Director of

MIDEVIV), Elias Awa (Assistant Director of MIDEVIV), Mr. Joseph Elang (ProSem Manager), and P. Noel Leumassi (Chief of the Department of Production and Development), for having selected me, for the financial assistance, and for their strong moral support and valuable counsel. Gratitude is also expressed to Mr. Arnet W. Jones and Development Assistance Corporation (DAC) team Cameroon for their constant encouragement. Appreciation is also extended to Dr. Ron Gaddis for his friendship, motivation, and encouragement to do graduate study.

The most prominent assistance during the course of studies and research culminating in this thesis was rendered by my major adviser, Dr. R. Jewell Crabtree. Both his permanent multidisciplinary guidance and friendly patience are appreciated and need to be sincerely acknowledged. For their valuable suggestions and comments gratitude is expressed to Dr. James Kirby and to Dr. William Warde, members of my advisory committee.

Cordial gratitude goes to Mr. Jay Prater, senior agriculturalist, for his useful and constructive suggestions and constant assistance in conducting experiments and collecting the necessary data. Appreciation is expressed to those professors and fellow graduate students whose discussions have been of great help to me in pursuit of knowledge in the areas related to soil and plant sciences. Thanks is also extended to Mr. Conrad Evans and to many other people that are not individually named, for their understanding and assistance in various aspects during my stay in the United States.

I am also grateful to my parents-in-law Satienkoue and to my parents Somotcham back in Cameroon whose support and patience developed a self confidence in me and my wife. Special gratitude goes

to my wife Adelaide and my lovely children Pernelle, Ghislaine, Frank, Yancey, and Reginald for their company and their daily attention to what I have been doing. Special gratitude also needs to be extended to colleagues, friends, and all my relatives in Cameroon for their immense support.

Finally, I would like to express my gratitude to USAID, DAC, and MIDEVIV for arranging the administrative and financial assistance without which these studies and consequently the expected improvement in my career would not have been possible.

TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION	1
II. LITERATURE REVIEW	3
Water and Soybean Production	3
Soybean Cultivar Selection	4
Soybean Responses to Narrow Row Spacing and Planting Dates	6
Soybean Production and Weed Control	9
III. MATERIALS AND METHODS	13
IV. RESULTS AND DISCUSSION	15
Precipitation Amounts and Distribution	15
1987 Yields	15
1988 Yields	19
Weed Control	25
V. CONCLUSIONS	27
REFERENCES	28

LIST OF TABLES

Table	Page
I. Rainfall from 1 Jan. 1987 to 31 Oct. 1988 and the 30-yr. Monthly Average (1958-1987) at the Vegetable Research Station near Bixby, Oklahoma	17
II. Soybean Mean Yields and ANOVA for the 1987 Environment . .	18
III. Soybean Mean Yields and ANOVA for the 1988 Environment . .	20
IV. Soybean Mean Yields and Pooled ANOVA of the Two Planting Dates for the 1988 Environment	23
V. Soybean Mean Yields and Pooled ANOVA for the 1987-1988 Environments	24

Figure	Page
1. Rainfall from 1 Jan. 1987 to 30 Sept. 1988 at the Vegetable Research Station near Bixby, Oklahoma	16

CHAPTER I

INTRODUCTION

Much progress has been made in breeding new cultivars and developing new cultural practices for soybean [*Glycine max* (L.) Merr.] production during the last three decades. However, due to today's narrow price-cost squeeze, growers need further decreases in production costs. One promising way to decrease these costs is to narrow the row spacing, "solid-seed", in an effort to reduce the cost of post emergence herbicide applications and mechanical cultivations.

Previous research, under different soil and climatic conditions, has shown that soybeans grown in narrow rows (20-30 cm) often out yield those grown in the more conventional 76 to 102 cm row spacings. Higher yields are often attributed to taking advantage of a quick canopy formation that results in decreased water loss to evaporation, and the shading out of weeds.

In eastern Oklahoma the potential exists for growers to monocrop solid-seeded soybean cultivars that range in maturity groups I through VI. Although early maturing cultivars have the potential to complete both the vegetative and reproductive stages of growth by mid to late August, when rainfall amounts become more limiting, they also tend to yield less compared to soybean cultivars in maturity groups V and VI. The higher yields for maturity groups V and VI can most often be

attributed to later blooming, pod set, and pod fill during a time when the area often receives mid and late September rains.

The objective of this study was to compare the yields of several soybean cultivars varying in maturity groups under monocropped, solid-seeded, and rainfed conditions in eastern Oklahoma.

CHAPTER II

LITERATURE REVIEW

Water and Soybean Production

Water conservation is a major consideration for crop production systems in the Great Plains because of the limited amount and erratic rainfall pattern in this region (Fenster, 1976; Greb, 1979). This is typically true for summer crops in the southern Great Plains since these factors have significant impact on yields and profitability (Crabtree et al., 1986). Any production system that increases water infiltration and storage in soil will help stabilize and improve crop production in the Great Plains (Smika and Wicks, 1968).

Keeping the soil surface in good tilth helps to avoid drought by increasing the amount of water that enters the soil and also helps to control erosion by reducing runoff. Good tilth also tends to avoid crust formation, which is often a serious problem for soybean seedling emergence on heavier textured soils (Scott and Aldrich, 1983). In most cases the moldboard plow is unequalled for breaking sod, turning under green manure crops, and covering heavy straw, corn-stalks, and other plant residues in order to improve soil tilth and leave the surface rough and porous. The key to raising the amount of available water storage is to manage in such a way to increase the rate at which water enters the soil surface. Good water management coupled with adequate

fertilization, proper cultivar selection, timely operations during planting and harvesting, and weed control enhance the potential for maximizing soybean yields (Scott and Aldrich, 1983).

Seasonal water use by soybeans can range from 450 to 825 mm where the growing season ranges from 100 days at low altitudes up to 190 days in the higher altitudes (Doorenbos and Pruitt, 1977). Total seasonal water use reported for soybean grown in the midwestern United States has typically ranged from 330 to 766 mm (Carter and Hartwig, 1962; Whitt and Van Bavel, 1955; Herpich, 1963; Kanemasu et al., 1976; Somerhalder and Schleusener, 1960; Musick et al., 1976).

Water use is highly affected by the length of the growing season, the rate of crop development before reaching full ground canopy cover, the amount and distribution of rainfall, the total evaporative demand, and the soil water-holding characteristics (Van Doren and Reicosky, 1987). It appears that the seasonal water requirement reaches maximum starting near canopy closure at the onset of flowering and continues through podfill. Available evidence indicates that the late flowering and podfill periods are the most sensitive to soil water deficits (Hiler et al., 1974; Doss et al., 1974).

Soybean Cultivar Selection

Improved cultivars have made substantial contributions to higher soybean yields (Luedders, 1977; Boerma, 1979; Wilcox et al., 1979; Boyer et al., 1980). According to Mangold (1987) and Caviness and Smith (1959), the days of having one cultivar for a large geographical area and many different kinds of planting situations are over. One particular cultivar can not be the best adapted to the wide variety of

cultural and management practices used by growers. As yields are pushed higher, it is hard to straddle the wide range in yields with one or two cultivars (Mangold, 1987). Cooper (1980) reported three main categories of soybean cultivars that should be available to growers. The categories are: 1) traditional, broadly adapted indeterminate and determinate cultivars; 2) semidwarf cultivars particularly suited for narrow rows; 3) and a third category developed for stress situations, particularly drought stress.

When selecting a soybean cultivar, it is important to choose one that is adapted to environmental and field conditions under which it will be grown (Scott and Aldrich, 1983). Because of their response to photoperiod, most soybean cultivars are adapted for full-season growth in a band usually no wider than 160 to 240 km from north to south latitude. North of this band the cultivar will flower later than normal and may not mature before a killing freeze. South of this band, the cultivar will mature earlier and yield less than the adapted cultivars. For the most part, maturity group II, III, and IV cultivars are best adapted to the central Corn Belt. Cultivars in Groups V and VI are used primarily on the east coast and in the upper and south central United States. Group VII and VIII cultivars are adapted to southern United States and along the Gulf (Scott and Aldrich, 1983).

Generally, cultivars that take advantage of all or most of the growing season will yield more than those that mature earlier. However, there are seasons when the early cultivar escapes the effects of some quirk in the environment, such as a late drought. A late drought may catch the mid- and full-season cultivars at the wrong stage of reproductive development while the early cultivar produces normally.

In many areas, the maturity of full-season cultivars is often delayed by cool weather or their harvest by wet weather, in which case the earlier cultivar would be better a choice for those situations (Scott and Aldrich, 1983).

Several researchers have also observed that cultivars and seeding rates differ in the degree of yield response (Cooper, 1971; Lehman and Lambert, 1960; Wiggars, 1939). Plant height is reduced when plantings are made earlier or later than the optimum 15 May to 15 June. Narrow row plantings during these periods allow canopy closure to better utilize light, water, and nutrients resulting in higher yields (Parker et al., 1981). Thus, factors that limit plant size tend to increase the yield response to narrow rows. It is partly for this reason that early and determinate semidwarf cultivars tend to respond more to narrow row systems than do either full-season or indeterminate cultivars (Cooper, 1971, 1977, 1980, 1981; Costa et al., 1980).

Soybean Responses to Narrow Row Spacing and Planting Dates

Results of numerous studies have shown that soybean yields are frequently increased by planting in narrow rows (Cooper, 1977; Donovan et al., 1963; Reiss and Sherewood, 1965; Safo-Kantanka and Lawson, 1980; Weber et al., 1966). For the midwestern United States, soybean yields are usually higher when grown in narrow rows than in the traditional 102 cm rows (Pendleton and Hartwig, 1973; Cooper, 1977).

Yield increases at corresponding plant populations result from the development of a canopy that provides complete ground cover in narrow rows by the time of optimum rate of grain filling. Full ground cover

canopies intercept more active solar radiation and have greater photosynthetic activity than do partial ground cover canopies associated with wider row spacings (Shibles and Weber, 1965, 1966). Soybean leaves near the top of a fully developed canopy intercept over 90% of the incoming radiation with less than 2% reaching the soil surface (Parks, 1983).

Water availability and water use rates as affected by row spacing have become major considerations in soybean production, particularly in drier regions (Van Doren and Reicosky, 1987). Peters and Johnson (1960) reported a higher yield in 50 compared with 100 cm rows and suggested that the root system of the soybean does not fully make use of the available water stored in the soil between the wide rows. They concluded that evaporation from the soil surface alone was responsible for most of the total water loss from the soil profile under the soybean crop when the soil surface was kept moist. Peters and Johnson (1960) also concluded that complete canopy cover earlier in the season results in additional reduction in soil evaporation losses in narrow row planted soybeans.

In most cases where soybean yields have been increased by narrow row spacings, the results have been obtained on soils with a large water-holding capacity (Alessi and Power, 1982). In a drier region, no significant effect of row spacing on soybean yields was found in years of normal or above normal precipitation (Alessi and Power, 1982). In contrast, a yield reduction was observed in narrow rows when there were severe soil water deficits during years of below normal precipitation. Data suggested that narrow rows are beneficial for soybean production when water is not restricted, ie, with irrigation (Alessi and Power,

1982). The concept of limiting factors suggests that limitations to soybean yields such as moisture stress would decrease the potential yield advantage of narrow row systems. Thus, adequate early season moisture, which permits canopy closure in both wide and narrow rows, followed by moisture deficiency during pod-filling tends to eliminate the potential yield advantage of narrow rows (Beaver and Johnson, 1981; Cooper, 1980; Parks et al., 1982; Taylor, 1980).

Optimal planting time for soybeans in the southern United States can range from early May through early June. Plantings before or after these dates have usually resulted in substantial seed yield reductions (Beatty et al., 1982; Board and Hall, 1984; Boquet et al., 1982; Cavinness and Smith, 1959; Graves et al., 1978; Griffin et al., 1983; Hensen and Carr, 1946; Hodges et al., 1983; Parker et al., 1981; Smith, 1968). The vegetative growth period (days from emergence to first flower) necessary to obtain a leaf area index (LAI) of three for optimum seed yield may vary from 42 to 58 days depending on temperature and other growing conditions (Constable, 1977). Field observations in the southern United States have shown that an optimal May-June planting date, with a minimum of 45-days from emergence to first flowering, is needed to make sufficient growth for adequate seed yield and acceptable pod height (Hartwig, 1954).

Quick canopy closure weakens the impact of falling raindrops and slows the velocity of runoff water. This helps reduce erosion and has the potential to increase available water storage in the soil profile. Combined with other soil and water conservation practices such as terracing or strip cropping, drilled solid-seeded soybeans can stabilize more soil (Taylor, 1987). By eliminating mechanical cultivation, the

chance to tear away at the soil structure units or expose fields to as much runoff and gullyng is significantly reduced (Taylor, 1987).

Increasing the plant population tends to also increase the height of the first pod (Wiggars, 1939). The height of the first pod from ground level is associated with total plant height (Hicks et al., 1969; Johnson and Harris, 1967). With a more uniform plant distribution in narrow row spacings, the harvest cutting area is spread over the entire length of the combine cutter bar, giving a more homogeneous feeding of plants into the combine. The absence of cultivation ridges allows a lower cutting height and results in improved combine efficiency and lower harvesting losses (Cooper, 1977).

Soybean Production and Weed Control

Soybean yield losses resulting from weed interference and the cost of weed control constitute some of the highest costs involved in the production of the crop (Jordan et al., 1987). Nationwide, the monetary losses due to weeds in the past few years have been estimated to average about 17% of the crop value, or approximately \$1.9 billion (Chandler et al., 1984). By adding an estimated cost of control of \$1.1 billion, the total cost of weeds in the soybean crop for the United States can be calculated at approximately \$3 billion per year and represents a cost greater than that for all other crop pest controls combined (Shaw, 1978).

The intensity and distribution of weed species in a soybean crop are functions of complex interactions among soil properties, rainfall patterns, temperature, and cultural practices (Jordan et al., 1987). Weeds compete directly with soybean plants for light, nutrients, and

moisture, and may interfere indirectly through the production and release of allelopathic chemicals that inhibit crop growth (Lolas and Coble, 1982). In addition, the efficiency of harvesting equipment is reduced by the presence of a significant number of weeds (Nave and Wax, 1971). The quality of a harvested soybean crop is directly influenced by weed infestation that can lead to higher moisture content, foreign matter, and splits (Anderson and McWhorter, 1976).

The objective of weed control for any soybean producer is to grow the crop with as few weeds as economically feasible. Herbicides and cultivation are the most successful tools for weed control early in the growing season with crop competition providing most of the control later in the year (Altieri, 1982).

Timely operations of tillage and preemergence herbicides, essential early control methods, are more effective and economical on small than on large weeds (Scott and Aldrich, 1983). Studies in Mississippi showed that 6 to 10 preplant cultivations at 4- to 6-day intervals controlled johnsongrass [*Sorghum halepense* (L.) Pers.] in soybeans while in Minnesota it was shown with several common weed species that the number of weeds that emerge after the soybeans were planted was about the same regardless of the number of preplant tillage operations (McWhorter and Hartwig, 1965; Robinson and Dunham, 1956).

The degree of interference between crops and weeds is directly proportional to the density and duration of the weed infestation in the crop. These factors have been investigated for a number of specific weeds in soybeans (Thurlow and Buchanan, 1972; Oliver et al., 1976; Eaton et al., 1973; Coble and Ritter, 1978; Coble et al., 1981). In general, this research has shown that a period of 4 to 6 weeks without

weed competition at the beginning of the growing season will allow production of maximum yields under most environmental conditions. Any weeds emerging in the crop after this initial weed-free period will not compete with soybeans and will not affect yield potential (Coble et al., 1981).

Slife (1956) and McCarty (1983) reported that cocklebur (*Xanthium pensylvanicum* Wallr.) is one of the most competitive species evaluated thus far with one weed every 10 m² resulting in over 66 kg ha⁻¹ loss in yield. Tall morningglory [*Ipomoea purpurea* (L.) Roth] was slightly less than one-third as competitive as common cocklebur but caused almost twice the yield reduction as venice mallow (*Hibiscus trionum* L.), prickly sida (*Sida spinosa* L.), and sicklepod (*Falcaria vulgaris* Bernh.).

The conclusions of weed scientists are that enough tillage is needed to prepare a weed-free seedbed in order to obtain the maximum benefit from soil-applied herbicides (Jordan et al., 1987). The early 1980's brought a move to more shallow incorporation of grass herbicides such as trifluralin (a,a,a-trifluoro-2,6-dinitro-N-N-dipropyl-p-toluidine), alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (2-chloro-N-(2,6-diethylphenyl)-N-methoxymethylacetamide)], and metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide] with one-pass incorporation by implements such as the field cultivator (Jordan et al., 1987).

Crop competition enhancement involves several cultural practices, including row spacing, seeding rate, fertilization, and cultivar selection (Walker and Buchanan, 1982). With the onset of conservation tillage and expanded production of soybeans in the late 1970's,

interest in growing soybeans in narrow rows or in solid-seeded stands increased. Narrow rows obviously produce a full canopy sooner and provide maximum shading at an earlier date, thereby requiring less weed control input to achieve maximum potential yield. Early canopy closure by narrow rows complements the weed-free seedbed preparation and pre-emergence herbicide application to constitute a good weed control program (Jordan et al., 1987).

CHAPTER III

MATERIALS AND METHODS

This field study was conducted under monocropped, solid-seeded, and rainfed conditions at the Vegetable Research Station near Bixby, Oklahoma in 1987 and 1988 on a Wynona silt loam soil (Cumulic Haplaquolls) with a 0 to 1% slope.

The seedbed was prepared each year by one tandem disking of the soybean stubble land. Trifluralin herbicide (a,a,a-trifluoro-2,6-dinitro-N-N-dipropyl-p-toluidine) was broadcast sprayed at a rate of 1.1 kg ha⁻¹ active ingredient (a.i.) in 234 L ha⁻¹ water and incorporated with a Do-all prior to planting. No fertilizer was added during the study because soil tests in the fall of 1986 and 1987 showed phosphorus (P) and potassium (K) to be at 100% sufficiency levels as determined by the Oklahoma State University's soil testing laboratory procedures and recommendations.

In 1987 20 soybean cultivars ranging in maturity groups (MG) from I through VI were planted on 12 May. In 1988, 22 soybean cultivars of the same MG were planted on 26 April and repeated in an adjacent area on the same soil type on 27 May. All plantings were made at a rate of 134 kg ha⁻¹ in 25 cm rows using an eight-row planter equipped with double-disk openers, 4-cm-depth bands and press wheels. Plot size for both years was 4.6- x 19.8-m.

A Gleaner model "A" combine was used to harvest a 3.0- x 19.8-m

strip from the center of each plot on 24 August (MG I and II), 1 September (MG III), 9 September (MG IV), and 16 October (MG V and VI) 1987. The 26 April 1988 planting was harvested on 16 August (MG I and II), 1 September (MG III), 15 September (MG IV), 11 October (MG V), and 19 October (MG VI). For the 27 May 1988 planting harvests were done on 1 September (MG I and II), 15 September (MG III), 11 October (MG IV), 19 October (MG V), and 1 November (MG VI).

Seed yield data for 1987 were analyzed using a randomized complete-block design consisting of 20 treatments with four replications. Seed yield data for 1988 were analyzed separately for each planting date (26 April; 27 May) using a randomized complete-block design consisting of 22 treatments with four replications. The 1988 seed yield data were then pooled and analyzed to measure the effect of planting date. In addition, seed yield data for the cultivars planted in both years (12 May 1987 and 26 April 1988) were pooled and analyzed as a randomized complete-block design consisting of 11 treatments to investigate the effect of year to year environments on soybean yields.

CHAPTER IV

RESULTS AND DISCUSSION

Precipitation Amounts and Distribution

Rainfall amounts and distribution from 1 Jan. 1987 to 30 Sept. 1988 are illustrated in Fig. 1. Monthly rainfall amounts from 1 Jan. 1987 to 31 Oct. 1988 are contrasted in Table I along with the 30-year (1958-1987) monthly averages. In eastern Oklahoma total annual rainfall and distribution can show significant deviation as evidenced by comparing the 1987 and 1988 environments. This erratic year to year rainfall exerts great impact on yields and profitability potentials for summer crops grown under rainfed conditions in this area (Crabtree, et al., 1986).

1987 Yields

Twenty soybean cultivars ranging in maturity groups (MG) I through VI were planted solid-seeded (25 cm rows) on 12 May. Stands were adequate for all cultivars and by 10 July no obvious gap in leaf canopy appeared between rows, thus having a potential favorable effect on decreasing surface evaporation and the shading out of weeds. Statistical analysis shows that the cultivar yields were significantly different with an "F" value of 132.2 at an observed significance level (OSL) less than 0.001 (Table II).

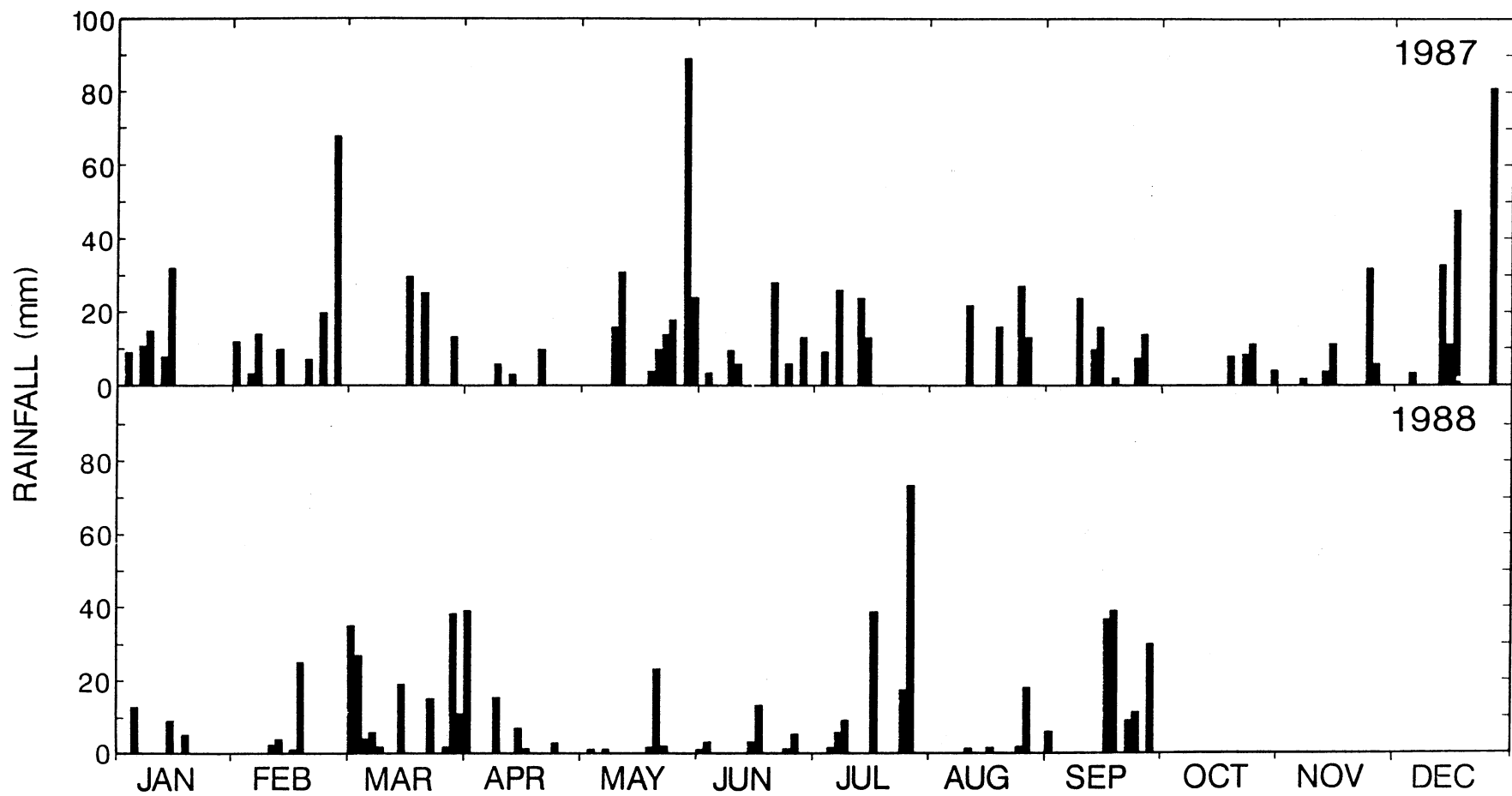


Fig. 1. Rainfall from 1 Jan. 1987 to 30 Sept. 1988 at the Vegetable Research Station near Bixby, Oklahoma.

TABLE I
 RAINFALL FROM 1 JAN. 1987 TO 31 OCT. 1988
 AND THE 30-YR MONTHLY AVERAGE (1958-
 1987) AT THE VEGETABLE RESEARCH
 STATION NEAR BIXBY, OKLAHOMA

Month	Rainfall		
	1987	1988	30-yr avg.
	-----mm-----		
Jan.	77	26	39
Feb.	136	35	44
March	56	162	63
April	17	45	97
May	210	30	129
June	67	27	117
July	72	135	85
August	65	22	68
Sept.	78	133	102
Oct.	32	30	87
Nov.	90	-	72
Dec.	177	-	47
TOTALS	1077	645	950

Based on the LSD test, among all the MG I cultivars solid-seeded in 1987 Corsoy 79 and Weber 84 significantly out yielded Sprite at the 0.01 level (Table II). The Sprite cultivar was very low in stature and podded close to the ground making harvest difficult. Yields for the three MG II cultivars ranged from 1180 to 1350 kg ha⁻¹, but with no significant differences (0.05 level) between these three cultivars (Table II). Cultivar Mead out yielded (significant at the 0.05 level) the other MG III cultivars. Cultivars Fremont, Chamberlin, and Williams 82 had yields of similar magnitude with the Logan yielding the least of the four MG III cultivars (Table II).

TABLE II
SOYBEAN MEAN YIELDS AND ANOVA
FOR THE 1987 ENVIRONMENT

Cultivar	Maturity group	Yield	
		-----kg ha ⁻¹ -----	
Weber 84	I	1250	
Corsoy 79	I	1590	
Sprite	I	834	
Plate	II	1180	
Century 84	II	1310	
Vickery	II	1350	
Logan	III	940	
Fremont	III	1030	
Chamberlin	III	1040	
Williams 82	III	1160	
Mead	III	1300	
Ripley	IV	820	
Sparks	IV	1300	
Zane	IV	1300	
Douglas	IV	1730	
Egyptian	IV	2230	
Bay	V	3180	
Forrest	V	3260	
Essex	V	3270	
Sohoma	VI	3530	
LSD (0.05)		221	
LSD (0.01)		294	

Source	df	M S	F
Block	3	328370	
Cultivar	19	3211004	132.2**
Error	57	24289	

** Significant at the 0.01 level.

Egyptian yielded significantly more (0.01 level) than the rest of the MG IV cultivars. Douglas yielded significantly more (0.01 level) than did the Zane and Sparks cultivars with Ripley yielding the least of the five MG IV cultivars (Table II). Cultivars of MG V and VI yielded much more in magnitude (significant 0.01 level) when compared

to all other MG (Table II). The magnitude in yields ranged in the order of 2 to 3 times when compared to the MG I and II cultivars (Table II). One major reason of the differences across MG cultivars comes from the environmental adaptability factors. Traditionally, most of the soybean cultivars grown in east central Oklahoma fall into MG V and VI with some cultivars of MG IV grown in the far northeastern counties. Cultivars of MG I, II, and III are primarily designed for the central and northern Corn Belt of the United States, thus are outside their normal area of production at the Bixby location.

Across all the cultivars solid-seeded in 1987, Bay (MG V), Forrest (MG V), Essex (MG V), and Sohoma (MG VI) performed the best as they yielded 3180, 3260, 3270, and 3530 kg ha⁻¹, respectively (Table II). Although, cultivars in maturity groups I, II, and III did not yield favorably when compared with the above, some of them demonstrated potential within their respective maturity groups. Corsoy 79 (MG I), Fremont, Chamberlin, Williams 82, and Mead (all MG III) were selected for further study in 1988.

1988 Yields

Based upon their 1987 yield performance certain cultivars in several maturity groups (MG) were selected for further evaluation in 1988. Corsoy 79 (MG I), Fremont, Chamberlin, Williams 82, Mead (all MG III), Douglas and Egyptian (MG IV) along with all the MG V and VI grown in 1987 were retained for further evaluation in 1988. In addition, the study was expanded to include other cultivars of MG I, II, III, and IV (Table III). Maturity group V cultivars OK-3015 and OK-7316, developed by the Oklahoma State University soybean breeding program, were

TABLE III
SOYBEAN MEAN YIELDS AND ANOVA FOR
THE 1988 ENVIRONMENT

Cultivar	Maturity group	Yields	
		26 April 1988	27 May 1988
-----kg ha ⁻¹ -----			
Hardin	I	590	2740
Corsoy 79	I	1090	2520
BSR 101	I	690	2415
Hack	II	1350	2070
Elgin	II	2410	2225
Mead	III	2510	2360
Fremont	III	1670	2484
Williams 82	III	2570	2440
Chamberlin	III	2910	2220
Pella 86	III	3030	2193
Egyptian	IV	2340	2665
Stafford	IV	2800	3083
Douglas	IV	2805	2720
Crawford	IV	2910	2415
Essex	V	2750	3150
Forrest	V	3560	3160
Narow	V	3730	3145
OK-7316 ^a	V	2550	3143
OK-3015 ^a	V	3370	3060
Bay	V	3564	3015
Sohoma	VI	3080	3400
Sharkey	VI	2755	2940
LSD (0.05)		472	321
LSD (0.01)		627	426

		26 April 1988	27 May 1988		
Source	df	MS	F	MS	F
Rep	3	276297		224289	
Cultivar	21	669110	28.7**	3192377	13.0**
Error	63	51463		111407	

^a Unreleased experimental lines, but referred to as cultivars in the text for convenience of discussion.

** Significant at the 0.01 level.

included along with Sharkey (MG VI). In all, twenty two cultivars were planted solid-seeded on 26 April and repeated in an adjacent area on the same soil type on 27 May 1988.

A wetter than usual March and first half of April allowed both surface and subsoil water to accumulate prior to planting. Stand establishments for both planting dates were good even though the months of May and June were drier in 1988 (57 mm) than in 1987 (277 mm) as shown in Table 1. As in 1987, canopy closure for the 26 April planting was obtained within approximately 60 days, however, the 27 May planting canopied in about a 50-day period. July and September were wetter than normal and most likely played a major role in the enhancement of the 1988 yields. Statistical analyses of the yield data for both the 26 April and 27 May plantings resulted in "F" values of 28.7 and 13.0, respectively and indicated statistically significant differences in yield among cultivars for each of the 1988 plantings (Table III).

For the 26 April planting, MG I cultivars ranged from 590 to 1090 kg ha⁻¹ (Table III). When these same MG were planted a month later (27 May) the magnitude in yields increased 2.3, 3.5, and 4.6 times for the Corsoy 79, BSR 101, and Hardin, respectively (Table III). This can most likely be attributed to two good rains in mid to late July (Fig. 1). For the 26 April planting responses were quite different for the MG II cultivars. Elgin yielded 2410 compared with 1350 kg ha⁻¹ for the Hack cultivar, however, little difference in yields was obtained when these cultivars were planted 27 May (Table III).

Among the MG III cultivars, Pella 86 and Chamberlin produced yields of nearly the same order of magnitude for the 26 April planting, however, for the 27 May planting yields were lower for both cultivars

(Table III). Yields of Williams 82 and Mead were very similar whether planted on 26 April or 27 May for the 1988 environment (Table III). For the 26 April planting, the Fremont cultivar yielded significantly lower when compared with Pella 86 and Chamberlin, which had yields of similar magnitude. There were no significant differences among the MG III cultivars when planted on 27 May 1988.

Yields obtained from the 26 April planting for MG IV cultivars showed Egyptian yielding somewhat lower than the other MG IV cultivars (Table III). Stafford, Douglas, and Crawford produced similar yields when planted on 26 April. When these four MG IV cultivars were planted on 27 May, Stafford produced the highest yields, 3083 compared with 2720, 2665, and 2415 kg ha⁻¹ for Douglas, Egyptian, and Crawford, respectively (Table III).

Except for Essex and OK-7316, which yielded significantly lower at the 0.05 level, the MG V entries performed about equal for the 26 April planting date (Table III). In contrast, when planted on 27 May, all entries yielded similarly (Table III). No significant yield differences were found between Sohoma and Sharkey (MG VI) when planted on 26 April, however, when planted on 27 May, Sohoma yielded significantly more (0.01 level) than Sharkey (Table III).

The soybean yield data for 1988 were pooled over planting dates and analyzed for a cultivar x planting date interaction (Table IV). Yield analysis over the planting dates showed an expected significant cultivar x planting date interaction with an "F" value of 13.7 (Table IV). This interaction prevents one from getting any valuable information out of planting date significance (F=23.0) or out of cultivar significance

TABLE IV
SOYBEAN MEAN YIELDS AND POOLED ANOVA OF THE TWO
PLANTING DATES FOR THE 1988 ENVIRONMENT

Cultivar	Maturity group	Mean yields pooled over planting dates -----kg ha ⁻¹ -----
Hardin	I	1665
Corsoy 79	I	1804
BSR 101	I	1552
Hack	II	1708
Elgin	II	2317
Mead	III	2435
Fremont	III	2078
Williams 82	III	2506
Chamberlin	III	2564
Pella 86	III	2611
Egyptian	IV	2503
Stafford	IV	2943
Douglas	IV	2761
Crawford	IV	2661
Essex	V	2948
Forrest	V	3358
Narow	V	3436
OK-7316 ^a	V	2807
OK-3015 ^a	V	3384
Bay	V	3290
Sohoma	VI	3224
Sharkey	VI	2846
LSD (0.05)		296
LSD (0.01)		391

Source	df	M S	F
Blocks	3	89826	
Planting date	1	2047041	23.0**
Cultivar	21	2639327	29.6**
Planting date x cultivar	21	1222160	13.7**
Error	129	89094	

^a Unreleased experimental lines, but referred to as cultivars in the text for convenience of discussion.

** Significant at the 0.01 level.

($F=29.6$) from the pooled analysis. For the most part, this significant interaction may be due to differences in genetic potentials within and among different maturity groups and rainfall patterns.

The high July rainfall favored flowering, pod set, and pod filling stages of MG I, II, and III cultivars while improving subsoil moisture for the benefit of the MG IV, V, and VI. Good rainfall in September benefited the pod filling stage of MG IV, V, and VI cultivars.

TABLE V
SOYBEAN MEAN YIELDS AND POOLED ANOVA
FOR THE 1987-1988 ENVIRONMENTS

Cultivar	Maturity group	Mean yields pooled over years -----kg ha ⁻¹ -----	
Corsoy 79	I	1337	
Fremont	III	1349	
Chamberlin	III	1973	
Williams 82	III	1864	
Mead	III	1902	
Douglas	IV	2268	
Egyptian	IV	2283	
Bay	V	3370	
Forrest	V	3404	
Essex	V	3011	
Sohoma	VI	3307	
LSD (0.05)		268	
LSD (0.01)		357	

Source	df	MS	F
Blocks	3	508385	
Year	1	5621079	77.9**
Cultivar	10	4894234	67.8**
Environment x cultivar	10	1345474	18.7**
Error	63	72160	

** Significant at 0.01 level.

Yield data for 11 soybean cultivars planted on 12 May 1987 and 26 April 1988 were pooled over environments and analyzed for an environment x cultivar interaction (Table V).

Yield analysis over the two year environments indicated a significant cultivar x environment interaction with an "F" value of 18.7 (Table V). Since this interaction is significant, it would be misleading to base any conclusion upon the year significance ($F=77.9$) or upon the cultivar significance ($F=67.8$) from this pooled analysis (Table V). Changes in weather characteristics, particularly in rainfall amount and distribution from 1987 to 1988, associated with diverse genetic potentials of cultivars solid-seeded appeared to influence yields the most.

Three cultivars, Corsoy 79 (MG I), Essex (MG V), and Sohoma (MG VI) among the eleven cultivars planted in both years yielded 31, 16, and 13% less, respectively, in 1988 than in 1987 (Tables II and III). The eight remaining cultivars yielded 5 to 179% higher in 1988 than in 1987 (Tables II and III). The MG III cultivar yield increase ranges from 93 to 179%. Egyptian and Douglas (MG IV) yielded 5% and 62% higher, respectively. Forrest and Bay (MG V) yields increased by 9 and 12% from 1987 to 1988 (Tables II and III).

Weed Control

Weed control may very well be one of the most limiting factors in solid-seeded soybean production. Solid-seeding soybeans with minimal tillage and usage of herbicides should be done with caution in order to increase chances for success. Weed species vary from field to field and the magnitude of weed pressure should be studied carefully prior to attempting this method of production.

Under the conditions of this study, where no postemergence herbicides were used, complete weed control was not achieved by preemergence incorporation of trifluralin herbicide at a rate of 1.1 kg ha⁻¹ (a.i.) just prior to planting. Escape weeds were removed by hand, however, when complete canopy was achieved very little problem with weeds prevailed. More research is needed where at least one postemergence application is made of a tank-mix spray containing herbicide for both grass and broadleaf weed control.

Fields with severe infestation of johnsongrass and morningglory species are not good candidates for solid-seeded soybean production. These fields may require rotations involving other cropping systems or cropped in the more conventional manner where postemergence herbicide application(s) and mechanical cultivation(s) are accepted ways of production.

CHAPTER V

CONCLUSIONS

A total of 31 soybean cultivars ranging in maturity groups (MG) I through VI were monocropped, solid-seeded (25-cm rows) under rainfed conditions in eastern Oklahoma in 1987 and 1988. Those 31 cultivars were partitioned into five MG I, five MG II, six MG III, seven MG IV, six MG V, and two MG VI cultivars. Plantings were made on 12 May 1987, and on 26 April and 27 May 1988 with the objective of comparing their seed yields.

Cultivars within or across maturity groups did not respond uniformly to monocropped, solid-seeded, and rainfed conditions (Tables II and III). Cultivars interacted significantly with planting date and year to year environments (Tables IV and V). At the close of the two years of study, concrete choices and conclusions can not be made. However, based upon their yield performance, Bay, Essex, Forrest, Narow, OK-3015 (all MG V), and Sharkey and Sohoma (MG VI) consistently produced the highest yields regardless of the year or time of planting.

In addition, more intensive weed control measures should be explored to ascertain the most economical postemergence herbicide applications for complete weed control in a solid-seeded soybean production system. Emphasis needs to be placed on weed control during the first 3-4 weeks after soybean emergence.

REFERENCES

- Alessi, J., and J.F. Power. 1982. Effects of plant and row spacing on dryland soybean yield and water-use efficiency. *Agron. J.* 74:851-854.
- Altieri, M.A. 1982. Ecology and management of weed populations. Eugene Memmler Publisher, Glendale, CA.
- Anderson, J.M., and C.G. McWhorter. 1976. The economics of common cocklebur control in soybean production. *Weed Sci.* 24:397-400.
- Beatty, K.D., I.L. Eldridge, and A.M. Simpson, Jr. 1982. Soybean response to different planting patterns and dates. *Agron. J.* 74:859-862.
- Beaver, J.S., and R.R. Johnson. 1981. Response of determinate and indeterminate soybeans to varying cultivar practices in the northern United States. *Agron. J.* 73:833-838.
- Board, J.E., and W. Hall. 1984. Premature flowering in soybean yield reductions at nonoptimal planting dates as influenced by temperature and photoperiod. *Agron. J.* 76:700-704.
- Boerma, H.R. 1979. Comparison of past and recently developed soybean cultivars in maturity groups VI, VII, and VIII. *Crop Sci.* 19:611-613.
- Boquet, D.J., K.L. Koonce, and D.M. Walker. 1982. Selected determinate soybean cultivar yield response to row spacings and planting dates. *Agron. J.* 74:136-138.
- Boyer, J.S., R.R. Johnson, and S.G. Saupe. 1980. Afternoon water deficits and grain yields in old and new soybean cultivars. *Agron. J.* 72:981-986.
- Carter, J.L., and E.E. Hartwig. 1962. The management of soybeans. *Adv. Agron.* 14:359-412.
- Caviness, C.E., and D.E. Smith. 1959. Effect of different dates and rates of planting on soybeans. *Univ. of Arkansas Agric. Exp. Stn. Rep. Series 88.*

- Chandler, J.M., A.S. Hamill, and A.G. Thomas. 1984. Crop losses due to weeds in Canada and the United States. Spec. Rep.(May). Weed Sci. Soc. of Am., Champaign, Il.
- Coble, H.D., and R.L. Ritter. 1978. Pennsylvania smartweed interference in soybeans. Weed Sci. 26:556-559.
- Coble, H.D., F.M. Williams, and R.L. Ritter. 1981. Common ragweed (*Ambrosia artemisiifolia*) interference in soybeans. Weed Sci. 29:339-342.
- Constable, G.A. 1977. Effect of planting date on soybeans in the Namoi Valley, New South Wales. Aust. J. of Exp. Agric. and Anim. Husb. 17:148-155.
- Cooper, R.L. 1971. Influence of soybean production practices on lodging and seed yield in highly productive environments. Agron. J. 63:490-493.
- Cooper, R.L. 1977. Response of soybean cultivars to narrow rows and planting rates under weed-free conditions. Agron. J. 69:89-92.
- Cooper, R.L. 1980. Solid-seeded soybean production systems. p. 9-16. In Proc., Solid-seeded Soybeans Conference, Indianapolis, Ind. 21 and 22 Jan. 1980. Am. Soybean Assoc., St. Louis, Mo.
- Cooper, R.L. 1981. Development of short-statured soybean cultivars. Crop Sci. 21:127-131.
- Costa, J.A., E.S. Oplinger, and J.W. Pendleton. 1980. Response of soybean cultivars to planting patterns. Agron. J. 72:153-156.
- Crabtree, R.J., R.G. Greenland, S.O. Mehdawi, and P.L. Claypool. 1986. Mono- and double-cropped wheat and grain sorghum under rainfed and irrigated conditions. Agron. J. 78:986-990.
- Donavan, L.S., F. Dimmock, and R.B. Carson. 1963. Some effects of planting pattern on yield, percent oil and percent protein in mandarin (Ottawa) soybeans. Can. J. Plant Sci. 43:131-140.
- Doorenbos, J., and W.O. Pruitt. 1977. Guidelines for predicting crop water requirements. FAO irrigation and drainage paper 24. FAO Rome, Italy.
- Doss, B.D., R.W. Pearson, and H.T. Rogers. 1974. Effect of soil water stress at various growth stages on soybean yield. Agron. J. 66:297-299.
- Eaton, B.J., K.C. Feltner, and O.G. Russ. 1973. Venice mallow competition in soybeans. Weed Sci. 21:89-94.

- Fenster, C.R. 1976. Conservation tillage. Great Plains Agric. Council, Fort. Collins, Co. Publ. no.77.
- Graves, C.R., J.R. Overton, and H. Morgan. 1978. Soybean-variety-date of planting study from 1974-1976. Univ. of Tennessee Agric. Exp. Stn. Bull. 582.
- Greb, B.W. 1979. Reducing drought effects on croplands in the west-central Great Plains. USDA Bull. no. 420. U.S. Gov. Print. Office, Washington DC.
- Griffin, J.L., R.M. Lawrence, R.J. Habetz, and D.K. Babcock. 1983. Response of soybeans to planting date in southwest Louisiana. Louisiana Agric. Exp. Stn. Bull. no 747.
- Hartwig, E.E. 1954. Factors affecting time of planting soybeans in the southern states. Circular no. 943, USDA. U.S. Gov. Print. Office, Washington DC.
- Henson, P.R., and R.S. Carr. 1946. Soybean varieties and dates of planting in the Yazoo-Mississippi Delta. Mississippi Agric. Exp. Stn. Bull. 428.
- Herpich, R.L. 1963. Irrigating soybeans. Kansas State Univ. Agric. Ext. Engineering in balanced farming. Land reclamation 12.
- Hicks, D.R., J.W. Pendleton, R.L. Bernard, and T.J. Johnston. 1969. Response of soybean plant type to planting patterns. Agron. J. 61:290-293.
- Hiler, E.A., T.A. Howell, R.B. Lewis, and R.T. Boss. 1974. Irrigation timing by the stress day index method. Trans. Am. Soc. Agric. Eng. 17:393-398.
- Hodges, H.F., F.D. Whisler, N.W. Buehrig, R.E. Coats, J. McMillan, N.C. Edwards, and C. Hovermale. 1983. The effect of planting date, row spacing and variety on soybean yield. Mississippi Agric. & Forestry Exp. Stn. Res. Highlights 46:1-7.
- Johnson, B.J., and H.B. Harris. 1967. Influence of plant population on yield and other characteristics of soybeans. Agron. J. 59:447-449.
- Jordan, T.N., H.D. Coble, and L.M. Wax. 1987. Weed control. In J.R. Wilcox (ed.) Soybeans: Improvement, production, and uses. 2nd ed. Agronomy 16:429-460.
- Kanemasu, E.T., L.R. Stone, and W.L. Powers. 1976. Evapotranspiration model tested for soybean and sorghum. Agron. J. 68:569-572.

- Lehman, W.F., and J.W. Lambert. 1960. Effects of spacing of soybean plants between and within rows on yield and its components. *Agron. J.* 52:84-86.
- Lolas, P.C., and H.D. Coble. 1982. Noncompetitive effects of johnsongrass (*Sorghum halepense*) on soybean. *Weed Sci.* 30:588-593.
- Luedders, V.D. 1977. Genetic improvement in yield of soybeans. *Crop Sci.* 17:971-972
- Mangold, G. 1987. Narrow rows take long strides. *Soybean Digest.* 47(7):38-39.
- McCarty, M.T. 1983. Economic thresholds of annual grasses in agronomic crops. Ph.D. Diss. North Carolina State Univ., Raleigh (Diss. Abstr. DA8318959).
- McWhorter, C.G., and E.E. Hartwig. 1965. Effectiveness of preplanting tillage in relation to herbicides in controlling johnsongrass for soybean production. *Agron. J.* 57:385-389.
- Musick, J.T., L.L. New, and D.A. Dusek. 1976. Soil water depletion-yield relationships of irrigated sorghum, wheat, and soybeans. *Trans. Am. Soc. Agric. Eng.* 19:489-493.
- Nave, W.R., and L.M. Wax. 1971. Effect of weeds on soybean yield and harvesting efficiency. *Weed Sci.* 19:533-535.
- Oliver, L.R., R.E. Frans, and R.E. Talbert. 1976. Field competition between tall morningglory and soybean. I. Growth analysis. *Weed Sci.* 24:482-488.
- Parker, M.B., W.H. Marchaut, and B.J. Mullinix, Jr. 1981. Date of planting and row spacing effects on four soybean cultivars. *Agron. J.* 73:759-762.
- Parks, W.L., John Davis, Reid Evans, Marshall Smith, Tom McCutchen, Lawson Syfley, and William Sanders. 1982. Soybean yields as affected by row spacing and within row plant density. *Univ. of Tennessee Agric. Exp. Stn. Bull.* 615.
- Parks, W.L. 1983. Soybean row width more important than plant spacing within row. *Better Crops Plant Food* 67:20-23.
- Pendleton, J.W., and E.E. Hartwig. 1973. Management. In Caldwell, B.E. (ed.) *Soybeans: Improvement, production, and uses.* *Agronomy* 16:211-231.
- Peters, D.B., and L.L. Johnson. 1960. Soil moisture use by soybeans. *Agron. J.* 52:687-689.

- Reiss, W.D., and L.V. Sherwood. 1965. Effect of row spacing, seeding rate, and potassium and calcium hydroxide additions on soybean yields on soils of southern Illinois. *Agron. J.* 57:201-203.
- Robinson, R.G., and R.S. Dunham. 1956. Preplanting tillage for weed control in soybeans. *Agron. J.* 48:493-495.
- Safo-Kantanka, O., and N.C. Lawson. 1980. The effect of different row spacings and plant arrangements on soybeans. *Can. J. Plant Sci.* 60:227-231.
- Scott, W.O., and S.A. Aldrich. 1983. Modern soybean production. 2nd ed. S & A Publications, Inc. Station A. Box 2660 Champaign, IL.
- Shaw, W.C. 1978. Herbicides: The cost/benefit ratio.-The public view. *Proc. South. Weed Sci. Soc.* 31:28-43.
- Shibles, R.M., and C.R. Weber. 1965. Leaf area solar radiation interception and dry matter accumulation by soybeans. *Crop Sci.* 5:575-578.
- Shibles, R.M., and C.R. Weber. 1966. Interception of solar radiation and dry matter production by various soybean planting patterns. *Crop Sci.* 6:55-59.
- Slife, F.W. 1956. The effect of 2,4-D and several other herbicides on weeds and soybeans when applied as postemergence sprays. *Weeds* 4:61-68
- Smika, D.E., and G.A. Wicks. 1968. Soil water storage during fallow in the central Great Plains as influenced by tillage and herbicide treatment. *Soil Sci. Soc. Am. Proc.* 32:591-595.
- Smith, R.L. 1968. Effect of date of planting and row width on yield of soybeans. *Soil Crop Sci. Soc. Florida, Proc.* 28:130-133.
- Somerhalder, B.P., and P.E. Schleusener. 1960. Irrigation can increase soybean production. *Nebraska. Exp. Stn.* 7:16-17.
- Taylor, H.M. 1980. Soybean growth and yields as affected by row spacing and by seasonal water supply. *Agron. J.* 72:543-547.
- Taylor, O. 1987. Solidseeding shows solid results. *Soybean Digest.* 47(4):12-13.
- Thurlow, D.L., and G.A. Buchanan. 1972. Competition of sicklepod with soybeans. *Weed Sci.* 20:379-384.
- Van Doren, Jr. D.M., and D.C. Reicosky. 1987. Tillage and irrigation. In J.R. Wilcox (ed.) *Soybeans: Improvement, production, and uses.* 2nd ed. *Agronomy* 16:391-428.

- Walker, H.L., and G.A. Buchanan. 1982. Crop manipulation in integrated weed management systems. *Weed Sci.* (suppl.) 30:17-24.
- Weber, C.R., R.M. Shibles, and D.E. Byth. 1966. Effect of plant population and row spacing on soybean development and production. *Agron. J.* 58:99-102.
- Whitt, D.M., and C.H.M. Van Bavel. 1955. Irrigation of tobacco, peanuts, and soybeans. p. 376-381. In *Water*. USDA Yearbook. U.S. Gov. Print. Office, Washington DC.
- Wiggars, R.G. 1939. The influence of space and arrangement on the production of soybean plants. *J. Am. Soc. Agron.* 31:314-321.
- Wilcox, J.R., W.T. Schapaugh, R.L. Bernard, R.L. Cooper, W.R. Fehr, and M.H. Niehaus. 1979. Genetic improvement of soybeans in the Midwest. *Crop Sci.* 19:803-805.

VITA²

Mbolda

Candidate for the Degree of
Master of Science

Thesis: SOLID-SEEDED SOYBEANS IN EASTERN OKLAHOMA

Major Field: Agronomy

Biographical:

Personal Data: Born in Banka (Haut-Nkam), Republic of Cameroon on February 23, 1953, the son of Nkanfah and Djambou.

Education: Graduated from the College St. Paul de Banka (Haut-Nkam) with the Baccalaureat Degree Mathematics, Physics, and Natural Sciences in September 1974; completed two years at the University of Yaounde, Cameroon 1974-1976; received the Diplome d'Ingenieur Agronome at the National Advanced School of Agriculture, Dschang, Cameroon in July 1978; Completed the requirements for the Master of Science Degree at Oklahoma State University in December 1988.

Professional Experience: Assigned in September 1978 by the Minister of Agriculture to serve as agronomist under the Mission de Developement des Semences et des Cultures Vivrieres, MIDEVIV. Three months later I joined the northern branch of MIDEVIV, Seed Project (ProSem), where I served from December 1978 to January 1986. During the period of 1978-1986 I served as Assistant Supervisor of Seed Production Service, Maroua, 1979; Chief of Sanguere Seed Production Center, Garoua, 1979-1983; Chief of Extension and Liaison Service, Garoua, 1983-1984; and Sanguere Farm Manager, Garoua, 1984-1986. The seed production involved the following crops: peanut, corn sorghum, cowpea, and onion.