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Mono- and Double-Cropped Wheat and Grain Sorghum Under Rainfed and Irrigated Conditions

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Introduction

Double-cropping systems can be potentially successful in eastern Oklahoma. Success, however, depends on several factors. First there must be enough frost-free days after wheat harvest in order that the second crop of either grain sorghum or soybeans may be produced before the killing frost. Then there must be an appropriate amount and distribution of rainfall in the crop area. Though nothing can be done about the amount of frost-free days received, there is, in the case of limited rainfall, the benefit of supplemental irrigation. Before irrigating, however, care must be taken to see that the returns in grain per unit of supplemental water offset the cost of employing the irrigation system if the planting of more than one crop in the summer is to be economical.

Objectives

To compare the yields and net economic returns of mono- and double-cropped wheat and grain sorghum, a study was conducted at the Oklahoma Vegetable Research Station at Bixby, Okla. from 1980-87 on a Wynona silt loam soil with 0-1% slope. The wheat in this experiment was produced under rainfed conditions where the grain sorghum was produced under both rainfed and irrigated conditions. Both crop systems were established and maintained in the same area for eight years.

Application of Irrigated Water

Amounts and distribution of rainfall for 1980-87 at the Vegetable Research Station are given in Table 1. Table 2 presents the amount of supplemental irrigation water applied to a given cropping system each year. While conducting this study, no irrigation water was applied to mono- or double-cropped wheat. Irrigations were scheduled based on tensiometer readings at 10 inches below the surface. A less complicated way of scheduling irrigation, such as the checkbook method of keeping track of water inputs, could also be used. No supplemental irrigation was applied in 1987. Instrumentation did not indicate a need for supplemental water due to adequate rainfall in July.

Economic Considerations for Wheat and Grain Sorghum Cropping Systems

Eight year yields for wheat and grain sorghum cropping systems are given in Tables 3 and 4. In Table 5, average annual costs for seed, fertilizer, herbicides, machine operations and irrigation for the alternative production systems are included. A

Table 1. Rainfall from January 1, 1980, to October 31, 1987, and the 30-yr monthly average (1955-1986) at the vegetable research station near Bixby, Okla.

Month	Rainfall								
	1980	1981	1982	1983	1984	1985	1986	1987	30 year av
January	2.7	0.7	3.6	2.6	0.4	3.7	0.0	3.0	1.6
February	0.0	1.3	0.5	2.8	2.8	0.0	1.0	5.4	1.7
March	3.5	2.0	0.8	1.9	4.9	5.8	1.9	2.2	2.6
April	3.7	4.3	1.2	3.3	2.5	4.8	5.3	0.7	3.8
May	4.7	5.6	7.8	7.0	5.0	3.9	8.0	8.3	5.0
June	9.1	3.8	6.1	2.7	3.5	7.2	2.6	2.6	4.7
July	0.2	3.0	2.3	1.0	0.6	1.9	1.0	2.8	3.3
August	2.1	4.1	2.3	0.3	2.2	2.0	3.7	2.5	2.6
September	6.1	3.9	0.8	1.6	2.2	4.2	11.2	3.1	3.9
October	2.6	6.5	1.7	10.2	7.1	9.5	7.3	1.3	3.3
November	1.1	3.2	6.3	3.1	2.4	4.3	3.4	-	2.7
December	1.5	0.2	3.2	0.5	10.6	1.6	1.2	-	1.7
Totals	37.3	38.6	36.6	37.0	44.2	48.9	46.5	-	36.9

Table 2. Supplemental irrigation water applied to cropping systems.

Cropping system	1980	1981	1982	1983	1984	1985	1986	1987
	inches							
Mono-cropped grain sorghum	13	8	6	10	5	3	2	0
Double-cropped grain sorghum	15	10	7	6	8	4	2	0

Table 3. Wheat yields as affected by cropping system.

Cropping system	1980	1981	1982	1983	1984	1985	1986	1987	1980-87
	bu/acre								
RFMCW	55.9	55.3	39.8	54.0	54.4	48.6	44.1	42.5	49.3
RFDCW-IDCGS	47.0	45.5	33.2	41.8	43.6	32.0	27.5	32.5	37.9
RFDCW-RFDCGS	49.5	47.3	32.1	42.9	39.5	31.3	27.8	29.1	37.4
LSD (0.05)	2.5	3.1	3.8	2.8	4.2	3.6	3.9	3.8	1.7

a. Mean of four replications

b. Rainfed mono-cropped wheat (RFMCW); rainfed double-cropped wheat irrigated double-cropped grain sorghum (RFDCW-IDCGS); and rainfed double-cropped wheat rainfed double-cropped grain sorghum (RFDCW-RFDCGS).

Table 4. Yields of grain sorghum as affected by cropping system.

Cropping system	1980	1981	1982	1983	1984	1985	1986	1987	1980-87
	----------	----------	----------	lbs/acre	----------	----------	----------	----------	----------
ICT-MCGS	3961	4067	5260	5482	6372	6811	5369	6309	5454
RFCT-MCGS	2634	2830	5420	4441	6328	6538	5416	6247	4982
INT-DCGS	3782	4156	5304	4743	4156	4620	5046	5729	4692
RFNT-DCGS	3026	3399	5215	3124	2394	3584	4623	6233	3950
LSD (0.05)	521	579	NS	398	742	420	418	446	267

a. Mean of four replications.

b. Irrigated conventional tilled mono-cropped grain sorghum (ICT-MCGS); rainfed conventional tilled monocropped grain sorghum (RFCT-MCGS); irrigated no-till double-cropped grain sorghum (INT-DCGS); and rainfed no-till double-cropped grain sorghum (RFNT-DCGS).

summary of the annual economic returns to land, management, overhead and risk for the five cropping systems involving wheat and grain sorghum are given in Table 6. Over the eight year period (1980-87) the average return for RFDCW-RFNTDCGS>RFCT-MCG S>RFMCW>RFDCW-INTDCGS->ICT-MCGS were respectively 89, 87, 74, 40, and 26 dollars per acre (Table 6). Given the yields obtained and price relationships, irrigation for MCGS over the eight year period was not economical. While average MCGS yields improved by 531 pounds per acre, the average addition to returns of $22.26 per acre was insufficient to cover the $80.56 per acre cost of the irrigation. A yield increase of 1921 pounds per acre would have been necessary to cover the cost of irrigation. Alternatively, given the actual yield increase of 531 pounds per acre, the price of grain sorghum would have to increase from $4.19 per cwt to $15.17 per cwt to cover the irrigation costs. Irrigation of NT-DCGS increased yields an average of 920 pounds per acre with an average addition to returns of $38.58 per acre; however, this was also insufficient to cover the $84.27 per acre cost of irrigation. A yield increase of 2008 pounds per acre would have been necessary to cover the cost of irrigation. With the actual yield increase of 920 pounds per acre, the price of grain sorghum would have to increase from $4.19 per cwt to $9.15 per cwt to cover the cost of irrigating DCGS.

In planning for production of either irrigated or rainfed double-cropped grain sorghum, soil moisture holding capacity, soil fertility status, weed populations and timeliness of operations must also be taken into consideration.

Soil moisture is critical at the time of planting sorghum in stand establishment. To produce a stand there must be an adequate amount of moisture in the surface soil. If not, the subsoil moisture may be adequate to produce a crop contingent on the ability of the seed to initially germinate. Grain sorghum may be double-cropped behind wheat to provide two crops in one year, although the depletion of subsoil moisture by the wheat can vary with soil

Table 5. Average annual (1980-87) production cost.

Variable cost	Wheat cropping systems			Grain sorghum croppings systems			
	RFMCW	RFDCW-IDCGS	RFDCW-RFDCGS	ICT-MCGS	RFCT-MCGS	INT-DCGS	RFNT-DCGS
	dollars/acre						
Moldboard plowing	9.27	-----	-----	9.27	9.27	-----	-----
Tandem disking @$6.21/acre	(2) 12.44	(2) 12.44	(2) 12.44	(2) 12.44	(2) 12.44	-----	-----
Seed; @$0.12/lb Wh $0.53/lb GS	(60) 7.20	(90) 10.80	(90) 10.80	(2) 1.06	(2) 1.06	(2) 1.06	(2) 1.06
Planting (with fert. attach.)	4.85	4.85	4.85	5.06	5.06	5.06	5.06
Top dress NH NO	2.22	2.22	2.22	-----	-----	-----	-----
120 lbs/acre N @$0.24/lb N	28.98	28.98	28.98	28.98	28.98	28.98	28.98
P (maintenance) @$0.52/lb	7.10	5.78	5.78	8.08	6.95	7.12	5.51
K (maintenance) @$0.15/lb	1.96	1.60	1.60	2.26	1.95	1.99	1.55
Cultivation (mechanical)	-----	-----	-----	2.87	2.87	-----	-----
Herbicides	-----	-----	-----	17.65	17.65	38.30	38.30
Spraying @$2.45/acre	-----	-----	-----	(2) 4.90	(2) 4.90	(2) 4.90	(2) 4.90
Irrigation	-----	-----	-----	80.56	-----	84.27	-----
Harvesting	13.99	13.99	13.99	14.44	14.44	14.44	14.44
Hauling @$.0017/lb/15 miles	5.24	4.26	4.26	8.46	7.28	7.45	5.77
Total	93.34	85.12	85.12	197.31	114.14	194.86	106.86

Cost of equipment operations based on average annual custom rates for eastern Oklahoma.

Rainfed monocropped wheat (RFMCW); rainfed double-cropped wheat irrigated double-cropped grain sorghum (RFDCW-IDCGS); rainfed double-cropped wheat double-cropped grain sorghum (RFDWC-RFDCGS); irrigated conventional tilled monocropped grain sorghum (ICT-MCGS); rainfed conventional tilled monocropped grain sorghum (RFCT-MCGS); irrigated no-till double-cropped grain sorghum (INT-DCGS); and rainfed no-till double-cropped grain sorghum (RFNT-DCGS).

Based on P removal in wheat and grain sorghum grain of 8.80 and 6.20 lbs/ton, respectively and K removal in wheat and grain sorghum grain of 8.20 and 6.00 lbs/ton, respectively.

Cost of Milogard , 2,4-Dacamine, Glyphosate (Roundup), and Linuron (Lorox) were $4.20/lb, $3.37, $21.77, and $13.02/qt., respectively.

Table 6. Average (1980-87) return for land and management.

Cropping system	Gross value	Production cost	Return
	----------dollars per acre ----------		
RFMCW	168	94	74
RFCT-MCGS	201	114	87
ICT-MCGS	224	198	26
RFDCW-RFNTDCGS	281	192	89
RFDCW-INTDCGS	320	280	40

a. Rounded to nearest dollar.

b. Rainfed mono-cropped wheat (RFMCW); rainfed conventional tilled mono- cropped grain sorghum (RFCT-MCGS); irrigated conventional tilled mono-cropped grain sorghum (ICT-MCGS); rainfed double-cropped wheat rainfed no-till double-cropped grain sorghum (RFDCW-RFNTDCGS); and rainfed double-cropped wheat irrigated no-till double-cropped grain sorghum (RFDCW-INTDCGS).

c. Yearly day of harvest grain values in dollars per bu for wheat and dollars per cwt for grain sorghum, respectively. 1980; 3.71, 5.59: 1981; 3.81, 4.13: 1982; 3.65, 3.91: 1983; 3.57, 5.54: 1984; 3.57, 4.68: 1985; 2.84, 3.40: 1986; 2.21, 2.10: 1987; 2.40, 2.25.

moisture holding capacity and seasonal rainfall amounts.

If soil conditions are dry, particularly when planting sorghum, irrigation can be used to supplement the rainfall. The profitability of irrigating can be limited, though, depending on the source of water and its availablity. Shallow wells, lakes, ponds and rivers generally provide the cheapest source of water since pumping costs are lower than when pumping from deep wells. To allow full utilization of irrigation equipment there must be a ready supply of water.

Soil fertility levels, which can be adjusted prior to a tillage operation, must be annually monitored through routine sampling. If no-till sorghum is to be established, nutrient levels need to meet the requirements of both crops when double-cropping. See Fact Sheet 2225.

Weed control in both wheat and sorghum is important in minimizing soil water loss during the summer and reducing competition for double-cropped grain sorghum. Selection of a field with few weed problems can minimize stand establishment problems. Stand establishment of double-cropped sorghum using no-till techniques may not allow for following cultivations if weed populations increase. The use of conventional tillage to establish double-cropped sorghum will allow cultivations; however, loss of soil moisture through tillage may reduce yield potential.

Proper management of the wheat straw and planting equipment is important to insure a good stand of double-cropped sorghum. A straw chopper on the combine is useful to cut and distribute the straw so that excessive shading and mulch is not left in the combine path. Planting right after combining gives the maximum amount of growing time before frost. Equipment must be in good repair since timely planting usually follows up wheat harvest very closely.

Double-cropping sorghum after wheat is just one option. Soybeans can follow wheat in Eastern Oklahoma, if problems with birds or specific weed populations would be difficult to control in sorghum. With either crop, the management of resources must be flexible and closely monitored to see that insects, diseases or other pests do not become of economic importance.

Other Publications:

Research Report P-770
Fact Sheet 140
Circular E-866
Fact Sheet 2225

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