Report as of FY2007 for 2007TX272B: "Optimizing Irrigation of Oilseed Crops on the Texas High Plains"

Publications

Project 2007TX272B has resulted in no reported publications as of FY2007.

Report Follows

Optimizing Irrigation of Oilseed Crops on the Texas High Plains

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For
Texas Water Resources Institute (TWRI)
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Abstract:

Water supply increasingly constrains crop production on the High Plains, as West Texas continues to experience a steady decline in the Ogallala Aquifer. Crops currently important for this area need to be grown with less water, and new and higher value crops are needed to diversify cropping systems. Oilseed crop production in West Texas could help save water and enhance profitability for growers, and contribute to greater energy independence for the U.S. However, there has been little production of oilseed crops in West Texas and there is uncertainty about optimum management practices for oilseed production. Therefore, there is a critical need for information so farmers can make sound economic choices regarding crop selection and management. We propose to fill this information gap by growing a number of oilseed crops that show promise for West Texas under variable water regimes, to develop irrigation water production functions with respect to oil yield and quality. Experiments will be conducted during 2007-2010. The crops to be evaluated include canola, sunflower, safflower, soybeans, mustard, camelina, jatropha, castor, rapeseed, and cotton. We will develop water production functions to describe oilseed yield and oil quality as a function of irrigation applied. Thus, these results will help to close the gap that currently constrains efforts to optimize production of oilseed crops in West Texas.

Introduction:

Water supply has become the limiting factor in crop production on the Texas High Plains along with the cost of fuel to pump water and produce these crops. Producers continue to attempt to produce current crops with less available water at economically profitable levels, but this endeavor is proving to be more challenging and less obtainable as water supplies diminish. This fact establishes the need to determine just how much water is essential for profitable production, and what other new or non traditional high value crops may be incorporated into cropping systems that can provide alternatives to growers to optimize water use efficiency, helping to alleviate the depletion of the Ogallala Aquifer, while adding profit to producers.

Objectives:

Oilseed crops have been cultivated for millennia for food and fuel. Oilseed crop production in West Texas could help save water and enhance profitability for growers. Oilseed crop production would also contribute to greater energy independence for the U.S., however, there has been little research or production of oilseed crops in West Texas and there is uncertainty about optimum management practices for oilseed production. Therefore, there is a critical need for information so farmers can make sound economic choices regarding crop selection and management. This research is a first step in the evaluation of potential oilseed crops for use in the Texas High Plains region. Specific objectives for this research is to evaluate potential oilseed crops for West Texas, determine the water use efficiency for each crop as a function of seed yield per water regime, and evaluate possible winter varieties of oilseed crops.

Methods and Materials:

In 2007, seven species of spring seeded oilseed crops were planted on June first on plots located at the Texas Tech Quaker Street Research Farm in Lubbock Texas. The species evaluated included cotton, castor, camelina, mustard, soybean, safflower, and sunflower. Two cultivars of each species were planted in a randomized split block design with four replications. Irrigation rates were established using PET, calculated by environmental data collected from an on farm weather station. The trials were planted on subsurface drip irrigation, with tape injected 8-10 inches below root zone on 40 inch centers. Each crop species were grown under irrigation regimes ranging from dryland 0, 20, 40, 60, and 80 % PET. Data gathered was yield at each irrigation regime. For this first year of data, all plots were not fertilized and no pesticide treatments were applied to derive if any species were more susceptible to insects or if any species requires any fertilizer to produce yields. All plots were treated with Prowl herbicide at a rate of 2 quarts per acre. All plots were harvested by hand and yields derived from the hand harvested material.

Results:

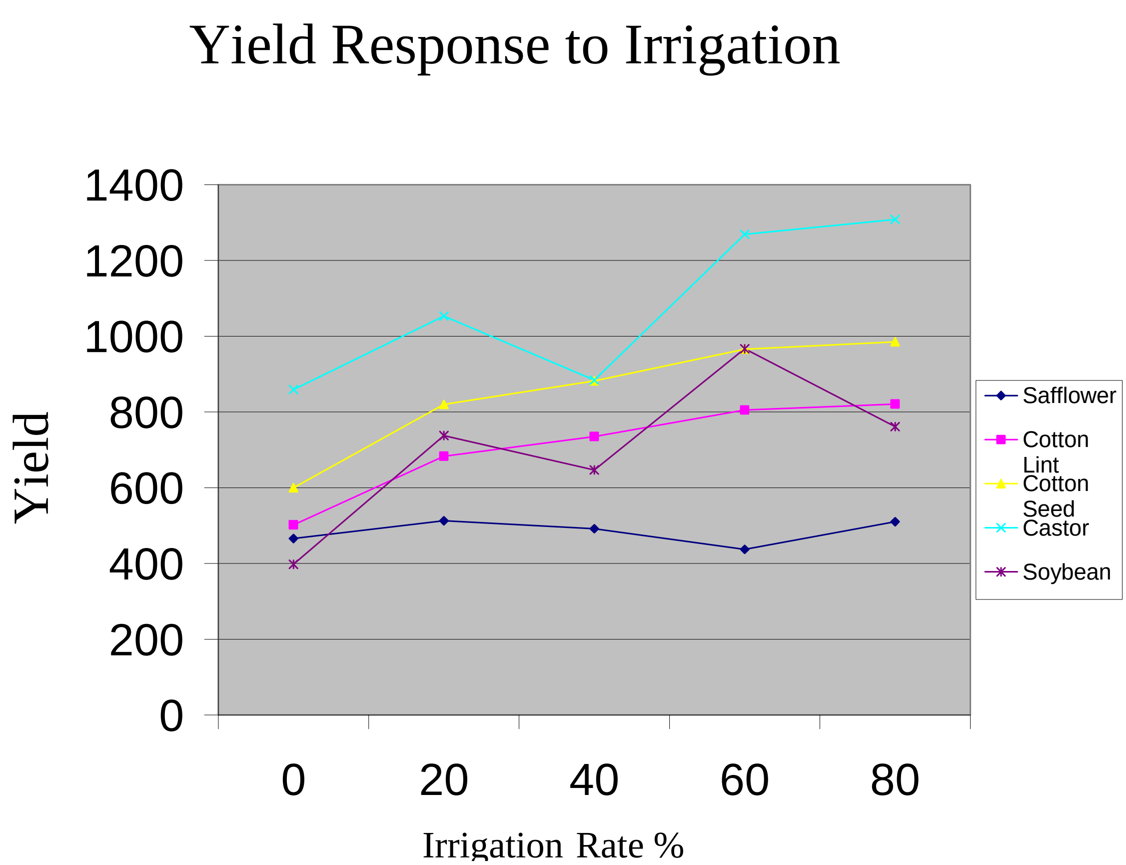
It must be noted that West Texas experienced heavy spring rainfall prior to planting, 18 inches, and higher than average rainfall during the growing season until July. For this reason, irrigation did not begin until July 14, but after this date until harvest 7 inches of rainfall were added to the year total of 25 total inches of rainfall, an amount 7 inches above the average for Lubbock Texas. Even with this high rainfall, irrigation rates of each regime was as follows; 20% PET 5.2 acre inches, 40%PET 7.1 acre inches, 60% PET 8.9 acre inches, and 80% PET 11 acre inches. Yield response to irrigation rates demonstrated significant response in all crops, except safflower. Cotton yield response to higher water rates resulted in higher cotton yields, as did soybean , and castor. It must be noted at this time that sunflower data was lost due to harvested sunflower heads becoming wet and molding in storage before analysis due to a heavy rainfall event entering the storage facility. Camelina and mustard data was not gathered due to early bloom, 30 days after planting. The remaining species data was gathered.

Safflower yields were very interesting, yield data exhibiting no added yield increase with any added irrigation. Table 1 below exhibits all data gathered.

Water Rate	**Safflower**	**Cotton Lint/ Seed**	**Castor**	**Soybean**
% PET	**lbs/acre**	**lbs/acre**	**lbs/acre**	**lbs/acre**
80 (11ac/inches)	510	881/985	1308	761
60 (8.9ac/inches)	437	805/966	1269	967
40(7.1ac/inches)	492	735/882	884	647
20(5.2ac/inches)	513	683/820	1053	738
0 (no irrigation)	466	502/600	859	398
LSD (0.05)	88	78	294	198
CV%	17.8%	10.7%	26.7%	27.5%
AOV				
Irrigation Rate	n.s	***	**	***
Cultivar	n.s	n.s	n.s	n.s
IxC	n.s	n.s	n.s	n.s

*** Highly Significant
** Significant

Using SAS to evaluate data resulted in these facts. Irrigation rates were significant to highly significant as to yield response. Cultivar response to irrigation rate as was cultivar yields were non significant. The CV% demonstrates very little variance between plots resulting in usable data. The LSD value demonstrates good values for cotton and safflower, but some variance in castor and soybeans. Table 2 below demonstrates yield response to irrigation rates.



This table exhibits the yield response to the irrigation rates, clearly demonstrating safflowers neutral response to added irrigation, while showing all other crops positive response to irrigation rates.

While yield alone was used to calculate the above data, oil percentage per crop species and fatty acid analysis of each species is another part of this study to expand the analysis of each potential oilseed crop. Average oil percentage of each crop are 14 % oil for cottonseed, 49% oil for castor, 20 % oil for soybean, and 40 % oil for safflower. When this information is added to the yield data an oil production per acre can be calculated and is listed below in Table 3.

Oil Production Per Acre for Each Species

Crop Species	Irrigation Rate 80%	60%	40%	20%	0
	Oil Yield Lbs/ac				
Cotton	138	135	123	115	84
Castor	641	622	433	516	421
Safflower	204	175	197	205	186
Soybean	152	193	129	148	80

The data above suggest that castor has the highest potential of oil production per acre, even at dryland production. Cotton oil yields are low for the amount of water used for production. Soybeans levels are also low, especially considering water application. Fatty acid analysis is being conducted at the time of this paper and data could not be entered. Fatty acid composition is important for the correct fatty acid profile is needed for quality Biodiesel production.

Conclusions:

Data gathered in my research project suggest the best crops for oil production based on first year data is castor and safflower. Castor has immense potential for oil production in West Texas. Due to its high oil content and yield in response to irrigation, castor can have immense profit potential at any irrigation level desired. At current oil prices for castor oil,

$1.80 per pound, gross profit is $1154 to $758 per acre, high irrigation to dryland respectively. Safflowers profit results are $150 dryland to $165 per acre irrigated based on $.80 per pound . Safflower is promising as a crop due to its drought tolerance as indicated by the flat production curve as seen on table 2. Both cotton and soybean were lower than both castor and safflower, and due to its high water requirements for high yields, will not be evaluated in 2008. It must be noted that the only input in this year's data was irrigation and if fertilizer and other production enhancement practices were applied, yields would have been much higher. The purpose of the production practices used in this trial was to simulate growing these crops on marginal land with just water as a variable.

The continuation of this trial in 2008 is to add other inputs such as fertility to attempt to push production to higher levels. In 2008, this trial will focus only on castor, safflower and sunflower, using three cultivars from each species, with more diversity in cultivars to obtain data as to which cultivar is most suited for the West Texas environment. Also as a continuation of this trial, winter species were planted in September of 2007 to evaluate which if any species has promise as a winter grown crop for West Texas. To date, I have identified eight accessions of winter hardy safflower that has shown to produce yields as high as 3600 pounds per acre, a seven time increase in yield potential as spring safflower. If these trials prove true, a new winter crop can be developed that has immense potential for the southern United States that is very drought tolerant with high economic return for the farmers.

It is my opinion that this research is in its infancy, and needs to be continued not only this year, but for many years to come. High yielding crops that is drought tolerant is a necessity for agriculture to continue. Genetic research must also be continued in producing cultivars that are more adaptable to every specific environment, such as a spring safflower with more yield potential for West Texas. As a result of this experiment, my research is continuing in crop analysis and a breeding program to improve available cultivars of the species with the most promise. This is an exciting time to be involved in agriculture.

Literature Cited

Robbelen, Gerhard; Downey, R Keith; Ashri, Amram 1989. *Oil Crops of the World* pp.283, 30, 363, 438, 533

Hughes, Harold D.; Metcalfe, Darrel S.; *Crop Production.* Pp 408,411

Purdue University, Center for New Crops and Plant Products: http://www.purdue.edu/newcrop/

North Dakota State University Agriculture and University Extension http://www.ag.ndsu.edu/pubs/alt-ag/

Postel, Sandra L.; *Water for Food Production: Will There Be Enough In 2025.* BioScience, Vol 48, No 8 (Aug, 1998) pp. 629-637 dol:10.20307/1313422

Gomez, Kwanchai A.; Gomez, Arturo A. *Statistical Procedures for Agricultural Research*, 2nd Edition pp. 84-99, 357-423