**Project Title** – Seeding date, variety maturity, and location influence on soybean performance in eastern North Dakota

Principle Investigator(s): Burton Johnson, Dept. of Plant Sciences, NDSU Dept. 7670, Fargo, ND 58108-

6050, phone 701-231-8895, fax 701-231-8474, Burton.Johnson@ndsu.edu

Final report for research from July 1, 2014 to June 30 2015 and July 1, 2015 to June 30, 2016

Introduction

Determination of proper soybean seeding date requires growers to consider cultivar maturity ratings appropriate for their production region and the calendar date when actual planting occurs. Normal seeding dates became later in North Dakota in 2011 and again in 2013 due to excessively wet spring conditions that shifted seeding dates towards the end or beyond the seeding date window for optimum crop performance. In North Dakota only 29% of soybeans had been planted by June 1 in 2011 (Aakre, 2011) and just 51% were planted by June 3 in 2013 (NASS, 2013). Yield reductions with late seeding of full season frost sensitive crops such as soybean are related to shortening of the growing season and often failure to reach maturity before a fall killing frost. Selecting the proper maturity soybean variety for seeding at late seeding dates would improve crop yield performance, value, and profits. These factors are extremely important regarding on-farm and community sustainability.

Aakre, S. 2011. North Dakota and South Dakota planting progress reports. American Ag Radio Network. Available at:

<http://americanagnetwork.com/2011/06/north-south-dakota-planting-progress-reports/>

Verified Sept. 24, 2012.

NASS, 2013. North Dakota crop progress and condition.

[http://www.nass.usda.gov/Statistics\_by\_State/North\_Dakota/Publications/Crop\_Progress\_&\_Condition/2013/cw-0603.pdf](http://www.nass.usda.gov/Statistics_by_State/North_Dakota/Publications/Crop_Progress_%26_Condition/2013/cw-0603.pdf)

Verified June 30, 2016.

An experiment was designed to evaluate the effect of soybean variety maturity rating, seeding date, and location on soybean performance in eastern North Dakota.

Objectives

1.) to determine the influence of cultivar maturity rating on soybean performance

2.) to determine the influence of seeding date on soybean performance

3.) to determine the influence of location on soybean performance

Methods

The experimental design was a RCB 6 x 3 factorial design with four replicates conducted at Carrington, Prosper, and Lisbon, ND, during the 2014 and 2015 growing seasons. There were six seeding dates at each location and one Asgrow cultivar AG00932 and two pioneer cultivars 90Y70 and 91Y41 corresponding to maturity ratings 00.9, 0.7, and 1.4, respectively. Seeding rate was 200,000 PLS/acre sown with an Almaco 6-row belt cone plot grain drill with double-disk openers at 12-inch row spacings with twin vee-arranged press wheels. Plots were 6 x 25 feet consisting of 6 rows with data collected from the four center rows of each plot where the edge rows were non-harvested border. Seeding depth was 1 inch at all locations. Traits evaluated included plant height, plant lodging, flowering (stage R1), physiological maturity (stage R7), reproductive growth duration, seed weight, seed yield, and seed oil content. Reproductive growth duration was the number of days from stage R1 to R7. Trait means separation was performed with *F*-Protected LSD comparisons at *P*≤0.05. Seeding date and variety were considered fixed effects and environment (location-year) a random effect in the statistical analysis performed with SAS. Analysis for yield was performed across six environments. Analysis for R1, R7, and reproductive duration (RGrow) were for individual environments in 2014 and across environments in 2015.

Results and Discussion

Location climatic growing conditions in 2014

Climatic conditions were below mean monthly normal rainfall, and below normal monthly average temperatures from May to Oct. at Carrington (NDAWN, data not shown). Mean monthly average temperatures were markedly cooler than normal at -4 F and -3 F during July and August, respectively, at Carrington.

Rainfall, at Prosper, was below normal all months of the growing season except June where rainfall exceeded the long term average by 0.27 inches (NDAWN, data not shown). Greatest below normal rainfall amounts were during May (-1.00 inches) and July (-2.15 inches). Mean monthly average temperatures at Prosper were near normal in May, August, and Sept. with June and July mean monthly average temperatures +2 and -2 F, respectively, compared to normal.

At Lisbon mean monthly rainfall was -0.99, -2.46, -1.98, and -1.87 inches below normal during May, July, Sept. and Oct., respectively, and 1.25 and 2.91 inches above normal during June and August (NDAWN, data not shown). Mean monthly average temperatures were slightly below or normal during May, June, and Sept. with July and Aug. -4 F and -2 F below normal, respectively, and Oct. 2 F above normal.

Growing season rainfall was 69, 67, and 80% of normal at Carrington, Prosper, and Lisbon, respectively, in 2014. Lack of rainfall during the growing season limited yield at all the locations, but more so at Carrington and Lisbon where soil profile moisture is typically less than at Prosper.

In 2014 the majority of the soybean treatments reached physiological maturity (R7) before a killing frost at all the locations. The soybean plots were killed by daily low temperatures of 27, 28, and 29 at Carrington, Prosper, and Lisbon, respectively, on Oct. 8, Oct. 8, and Oct. 4, respectively (NDAWN).

Location climatic growing conditions in 2015

Monthly rainfall at Carrington in 2015 was 94% of normal from May through Oct. with May and July above normal and June and Sept. below normal (NDAWN, data not shown). Monthly average air temperatures were near normal in June and July; above normal in Sept. and below normal in May, August, and Oct. Mean monthly average temperatures from May through Oct. were 4.3 degrees F. below normal.

At Prosper in 2014, growing season rainfall from May through Oct. was 108% of normal and caused mostly from 5 inches above normal rainfall during May (NDAWN, data not shown). The other monthly rainfall amounts were generally below normal with amounts less than 1 inch. Mean monthly average temperatures from May through Oct. were 10 degrees F. above normal with greatest above normal temperatures in Sept. and Oct.

Lisbon rainfall from May through Oct. was 88% of normal with above normal rainfall in May and June and below normal rainfall in July, August, and Sept (NDAWN, data not shown). Growing season monthly average temperatures from May through Oct. were 8.4 degrees F. above normal with greatest above normal temperatures in Sept. and Oct.

In 2015 the majority of the soybean treatments reached physiological maturity (R7) before a killing frost at all the locations except Carrington where stage R7 was not reached for the 1.4 maturity rating at seeding Dates 5 and 6. The soybean plots were killed by daily low temperatures of 27, 28, and 23 degrees F at Carrington, Prosper, and Lisbon, respectively, on Oct. 9, Oct. 7, and Oct. 16, respectively (NDAWN).

Seed Yield

Soybean cultivar maturity rating and seeding date influenced yield response differently at each of the locations, between 2014 and 2015, due to yearly differences in rainfall, temperature, and soil water status. Lower yield performance in 2015 was primarily due to less available soil water in the 2015 season caused by low fall rainfall and soil water recharge in 2014 even though growing season rainfall in 2015 was 94, 108, and 88% of normal for Carrington, Prosper, and Lisbon, respectively. Soil water recharge in fall of 2013 was above normal at each location and benefited early seeding date soybean yield for all maturity groups in 2014 (NDAWN, data not shown).

In 2014, the Carrington and Prosper locations cultivar maturity rating and seeding date yield responses ranged from 30 to 45 bu/acre and 40 to 64 bu/acre, respectively, between Date 1 and Date 4 for 00.9 and 0.7 maturity rated cultivars, respectively (Table 1). Yield for the late maturity group 1.4 cultivar was 17 and 26 bu/acre at seeding Date 4 at Carrington and Prosper, respectively. This indicates seeding later than June 12 resulted in substantial yield reduction at these locations for the late maturity rating cultivar. At the southern Lisbon location yield was 36 bu/acre at seeding Date 4 on June 23 and 46 bu/acre at seeding Date 3 on June 12. The general response for all maturity ratings was yield decline as seeding date was delayed. This was most pronounced after Date 4 for maturity ratings 00.9 and 0.7 and after Date 3 for maturity rating 1.4 in 2014.

In 2015 the Carrington, Prosper, and Lisbon locations cultivar maturity rating and seeding date yield responses ranged from 13 to 23 bu/acre, 28 to 42 bu/acre, and 24 to 39 bu/acre, respectively, between Date 1 and Date 4 (Table 1). As a result there are no clear maturity rating seeding date yield responses at Carrington in 2015 for any of the maturity ratings due to constricted yields. At Carrington in 2015 the late maturity rating 1.4 yielded as well or greater than maturity ratings 00.9 and 0.7 for the first four seeding dates. At the Prosper location in 2015 greater than 30 bu/acre yields were achieved from Dates 1 through 3 for maturity ratings 00.9 and 0.7, and Dates 1 through 4 for maturity rating 1.4. In 2014 maturity ratings 00.9 and 1.4 yielded 40 bu/acre or greater when seeded before Date 4 on June 23. At the southern Lisbon location in 2015 the 0.7 maturity rating did not yield greater than 30 bu/acre at any of the seeding dates (Table 1). Yield for the 00.9 maturity was greater than 30 bu/acre for seeding Dates 1 and 2 and 22 to 24 bu/acre for seeding Dates 3, 4, and 5. The 1.4 maturity rating seeding Date 1 yielded 39 bu/acre with later seeding Dates 2, 3, and 4 yielding between 30 and 33 bu/acre. The decline in yield as seeding date was delayed was less pronounced in 2015 compared to 2014 because yield was lower at earlier seeding dates and higher at late seeding dates in 2015 as compared to 2014.

Flowering and Physiological Maturity

Days from seeding to first flower, stage R1, and physiological maturity of first pod, stage R7, response were different among maturity groups as seeding date advanced for the analysis across the 2015 environments (Table 2). Reduction in days to stage R1 was 10, 16, and 16 days for cultivar maturity ratings 00.9, 0.7, and 1.4, respectively, between the first and last seeding dates. Reduction in days to R1 with later seeding dates indicates the short day flowering response of the cultivars and their respective maturity ratings. The decrease in days to R1 was less for the early 00.9 maturity rating cultivar AG00932 than for the later maturity rating cultivars. Decrease in days to stage R7 between the first and last seeding dates were 17, 24, and 21 days for cultivar maturity ratings 00.9, 0.7, and 1.4, respectively (Table 3). Shortening of the soybean life cycle as seeding date was delayed resulted in less plant growth and lower yield for each cultivar maturity rating (Table 3).

Yield reduction ranking was 21, 24.5, and 35.6 bu/acre for cultivar maturity ratings 00.9, 0.7, and 1.4, respectively, when comparing the highest and lowest yields at seeding Date 1 and Date 6 for each maturity rating (Table 3). Attaining high yield from late maturity rating cultivars requires early seeding to avoid steeper yield decline as seeding date becomes delayed. In this study the early maturity rating 00.9 cultivar yielded approximately 7 bu/acre less than the late maturity rating 1.4 cultivar at the first seeding date, but yield reduction was less severe at later seeding dates as compared to the 1.4 maturity rating cultivar. Selecting the proper cultivar maturity rating that will maximize growth resources with growth and development is important for optimizing yield. Important in season grow resources include rainfall and temperature amounts and patterns, soil water availability, and length of the growing season.

In summary, based on this study with six environments, seeding date recommendations for 00.9 and 0.7 maturity ratings and yield potential of 30 bu/acre or greater requires seeding on/before June 23, and for maturity rated cultivars 1.4 on/before June 11. Yield was generally greatest at the earliest and second seeding dates, declined as seeding date was delayed, and was lowest at the later seeding dates for all cultivar maturity ratings. The late maturity rating 1.4 cultivar experienced yield reduction at earlier seeding dates as location became more northern as compared to the 00.9 and 0.7 maturity rating cultivars.