**Soybean Council Progress Report (July 1, 2017 to June 30, 2018)**

**Title:** Assessment of soybean plant population and planting date impact on performance in Western and Central North Dakota

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**Introduction**

The limitations of soybean expansion in Western ND have largely been due to dry summers and low moisture availability at critical growth stages, and early frost damage when seeds are planted late. However, with improved soil organic matter from long-term no-till farming, crops can benefit from better soil moisture conservation, soil water holding capacity, and improved water availability for warm season crops in summer (Carr et al., 2006). In addition, since 2002, the rainfall trend in part of Western ND, west of the Missouri River, has been above normal, and enough to produce competitive and profitable soybean yields up to and above state average of about 35 bu/ac. Attractive soybean market prices and low crop input requirements are incentives for farmers to increase soybean production. Soybean is also an alternative rotation crop.

It is therefore imperative that farmers be better equipped with current research information to help guide their planting decisions, as production acreage gradually grows in the west. Planting date studies from Carrington, Minot, and Hettinger, within the past 15 years, have shown that in some years there is no economic yield advantage for seeding soybean as early as May 10 (early) or May 20 (normal), compared to the first week of June (considered late). The factors that may have a greater impact on performance and input cost are planting date, and population, both depending on environmental factors.

Higher seeding rates used several decades ago to control weed infestation have been reduced in many soybean production operations since alternative weed management methods using herbicides with better efficacy became commonplace. Plant population may affect yields due to its effect on soil moisture and crop moisture stress. The use of aerial imagery to monitor crop performance is also gaining traction in ND. Such an assessment can be used for different soybean planting densities. From such an assessment it will be possible for us to assess how planting date, seeding rate and maturity influence canopy coverage under dryland and irrigated conditions. This means the effect of seeding rates on yields may not be as impactful on irrigated soybeans as it would be under dryland conditions.

**Research Objectives**

1. Assessment of the effects of planting dates on soybean performance in dryland and irrigated conditions
2. Determination of the impact of three practicable seeding rates on yields and economic return
3. Evaluation of how early or late maturity (maturity group) soybean might impact seed yields
4. Verifying added value of aerial imagery and remote sensing for soybean crop assessment

**Materials and methods**

Trials were conducted at NDSU Research Extension Centers located at Hettinger, Carrington (dryland and irrigated), Minot, and Dickinson. The Dickinson site was lost to destruction from animals and drought. Two soybean varieties from the same seed company were planted at each site. Proseed 10-20 (an early variety) of relative maturity group (MG) 0.2, and Proseed 30-80 (later variety of MG 0.8) were planted on three different dates (Table 1) considered to be early (greater risk of late spring frost), normal (more commonly planted period in the area), and late (commonly considered as past ideal seeding time). Row spacing was 30 inches at Hettinger and Minot, and 14 inches at Carrington. The third treatment in the three-way treatment combination included seeding at rates to achieve three plant populations, 150,000 (150K), 175,000 (175K), and 200,000 (200K) plants/acre. Each trial was set up in a randomized complete block design with a split-plot arrangement, and four replicates. Each planting date was analyzed as a main plot; meanwhile population and the two MG varieties were randomized as a factorial within sub-plots. Planting date, and replication, and their interaction were analyzed as random effects, meanwhile MG and population were considered fixed effects in the data analysis. Data were analyzed for each site by the linear mixed model in SAS. Recommended agronomic production practices for weed control and disease management were employed to ensure optimal conditions besides treatments used. An aerial view of the crops established at Carrington, is presented on figure 1.



Figure 1. Aerial photo of plots of soybeans planting on three different dates at Carrington, ND



**Results**

Results are reported for each location with particular emphasis on yields

**Hettinger:** Average yield at Hettinger was low (24 bushels), probably due to crop water stress during the 2017 cropping season. There was no statistical evidence of any impact on yield that could be attributed to the treatment interactions. Planting date and MG had significant impact on every response variable measured (Table 1). Yields were significantly greater with early planting (27 bu/ac) than with late planting (22 bu/ac). The later maturity group variety (MG 0.8) produced significantly greater yield compared to the early maturing MG 0.2 variety (23 bushels). This was probably because early planting allows for longer period of growth and development thus longer time to accumulate dry matter produced. Seeding population had no significant impact on yields. Seed protein and oil typified an inverse relationship often observed in seeds whereby, protein was less in treatments that produce better yields and greater concentration of oil.

**Minot:** Average yield was quite low (25 bushels) due to drought (Table 3). Yields were not significantly impacted by planting date or population. Meanwhile, maturity group had significant effect on yields. 2.4 more bushels in yield produced by MG 0.2 was significant compared to MG 0.8.

**Carrington:** Yields under dryland were lower than under irrigated soybeans. There was an interaction effect of MG and date on yields, test weight, protein, and oil (Table 4). The effects on yield suggest that significant yield decline by planting late was more severe on the late MG variety 0.8. compared to the short season variety, 0.2. Meanwhile, the short season variety did not lose as much yield from early planting to late planting (Figure 2), losing about 3 bushels compared to 11 bushels lost by planting MG 0.8 late. Results from 2015 and 2016 at Carrington showed that MG 0.8 or 0.6 produced greater yields, than MG 0.2. Yield differences in plant population were significant. Mean yield at 175K (50 bushels) was significantly greater than at 150K (47 bushels). At 200K, yields were not different from the other plant population. This could have been due to plant competition for moisture during prolonged droughts between mid-May to late July.

It was evident that greater protein accumulation happened with delayed planting of MG 0.8 soybeans. This was not evident with MG 0.2. Protein content of MG 0.2 was significantly greater than MG 0.8 for early planting date, but not later. This may be a result of protein dilution by the relatively higher yield of MG 0.8 compared to MG 0.2 at early planting. Meanwhile, seed oil was greatest for MG 0.2 especially with early planting. Oil produced by MG 0.8 was not different between early and normal planting, but decreased significantly at late planting. Seeding date and maturity group each had significant effects on seed weight. Seed weight decreased significantly, and linearly from early to late planting. Seed weight of MG 0.2 soybean was significantly greater than for MG 0.8.

At the irrigation site, yields were significantly greater for early and normal planting dates compared to yields at late planting (Table 5). Similar to dryland, higher seeding rates enhanced yields from 53 bushels at 150K to 56 bushels at 175K and 58 bushels at 200K. Yields were significantly different only between 150K and 200K. Under irrigation, where moisture was adequate, yields at 200K were likely unaffected by moisture stress, which probably explained higher yields (56 bu/ac) under irrigation compared to dryland (49 bu/ac).

**Conclusion**

Our results support previous studies that planting soybeans at the Carrington area early, or before mid-May, will likely produce better yields than planting later. Delaying beyond May increases the risk of yield loss, except in years where moisture is adequate year-round and growing season is long. Under conditions where drought can be an impediment to crop yields, early planting in May enabled soybeans to use early spring soil moisture for growth. Meanwhile the longer growing season due to late rainfall in August, allowed the earlier planted crop to grow and accumulate dry matter for a longer period. Planting at 175,000 seeds/ac gave the best yields of the three used in this study. Later maturity group 0.8 consistently produced better yields than 0.2 for a three-year period. Despite some risks of late spring frost associated with early planting results from these studies suggest that later maturity variety 0.8 performed better than 0.2, and planting between May 10 and May 21st is the optimal window for seeding soybeans. Seeding as early as the first week of May can consistently produce higher yields than later, at Hettinger.







