VARIATION IN NITROGEN USE EFFICIENCY FOR MULTIPLE WHEAT GENOTYPES ACROSS DRYLAND AND IRRIGATED CROPPING SYSTEMS

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ABSTRACT

Globally, nitrogen use efficiency (NUE) is estimated to be 33% for cereal production. The N fertilizer prices increasing and environmental problems are both encouragement producers to improve NUE. There are two major ways to improve NUE as documented in the literature: (i) breeding genotypes with high NUE and (b) N management. The objective of this study was to quantify the Nitrogen Use Efficiency (NUE) of multiple wheat genotypes by two different methods under irrigated and dryland cropping systems. This study was conducted in north-eastern Colorado 2010-2011. NUE was calculated by two ways as grain yield per unit of N applied (PFP) and as grain N uptake per kg N applied (PNB) across twenty four winter wheat genotypes. Destructive sampling of plants was done at several growth stages to determine total nitrogen in plant tissue. The results from two methods PFP and PNB indicate that NUE was significantly different ($p < 0.05$) among multiple wheat genotypes across irrigated cropping system and there is no significant different among multiple wheat genotypes under both conditions. The results showed nitrogen utilization efficiency was low influenced by genotypes with ($p < 0.10$) under both irrigated and dryland conditions and the nitrogen uptake efficiency was not influenced by genotypes under both conditions.

Keywords: nitrogen use efficiency (NUE), Partial Factor Productivity (PFP), Partial Nitrogen Balance (PNB), wheat genotypes, dryland and irrigated.

INTRODUCTION

The nitrogen use efficiency (NUE) is generally defined as the grain yield produced per unit of N available from the soil and applied fertilizer (Moll et al., 1982). The NUE is determined by the ability of plants to uptake nitrogen (N) from soil and convert or utilize absorbed N for grain production **(**Baligar et al., 2001; Nelson and Fritz, 2011). Recent review reported that there are not less than 18 different definitions and measurements for NUE in cereal crops (Snyder and Bruulsema, 2007; Good et al., 2004). Genetic variations in NUE were found that in maize and winter wheat (Moll et al., 1982; Van Sanford and Mackown). Significant genotypic variation in NUE observed with total N uptake efficiency accounting for 54 % among 25 soft red winter wheat genotypes for two years under a single N rate (Van Sanford and Mackown, 1986).
The objective of this study was to quantify the Nitrogen Use Efficiency (NUE) of multiple wheat genotypes.

MATERIALS AND METHODS

Partial Factor Productivity (PFP) and Partial Nitrogen Balance (PNB) were used as an indicator of NUE. The PFP was calculated as weight in kg of harvested grain per kg of N applied as suggested by (Moll et al., 1982; Dobermann, 2005) and PNB was calculated as kg grain N uptake per kg N applied as suggested by (Snyder and Bruulsema, 2007). The experimental design was a split plot with three replications. This study was conducted in north-eastern Colorado over 2010-2011 and it was located at the USDA-ARS Limited Irrigation Research Farm, near Greeley, Colorado, USA. Individual plot dimensions were of 3.7 m x 1.4 m with 6 rows with spacing of 22.8 cm. Winter wheat genotypes was planted on October 8th, 2010 at a rate of 197,600 seeds ha^{-1}. Nitrogen and phosphorus fertilizer were applied pre plant on October 7th, 2010 and nitrogen fertilizer was applied at a rate of 84 kg N/ ha as Urea (46-0-0) and phosphorous fertilizer was applied at rate of 56 kg P_2O_5 / ha as Mono-Ammonium Phosphate (11-52-0). Biomass was collected five times during growing season. It was taken from different location for each plot at the early spring, jointing, anthesis, mid grain filling, and maturity [at the Feekes growth stages 3- 4 stage, 6 stage, 10.5 stage, 11.1 stage, and 11.4 stage (Large, 1954)] respectively. Samples were cut off aboveground, bagged and transferred to a cooler and stored at 4 oC until processed and were placed into an oven and dried at 68 oC until constant weight. Then, total aboveground weighted and analyzed for total N. Statistical analysis (ANOVA) was performed in R statistical software to determine differences among twenty four wheat genotypes based on NUE as PFP and PNB.

RESULTS AND DISCUSSION

Statistical analysis results with ANOVA have shown significant differences among twenty four wheat genotypes ($p < 0.05$) based on nitrogen use efficiency as both (PFP) and (PNB) across 24 winter wheat genotypes under irrigated condition. The NUE as (PFP) ranged from 78.75 to 109.65 kg of grain yield per kg of N applied (Fig1) and the NUE as (PNB) ranged from 1.91to 2.42 kg grain N uptake per kg N applied (data not shown)

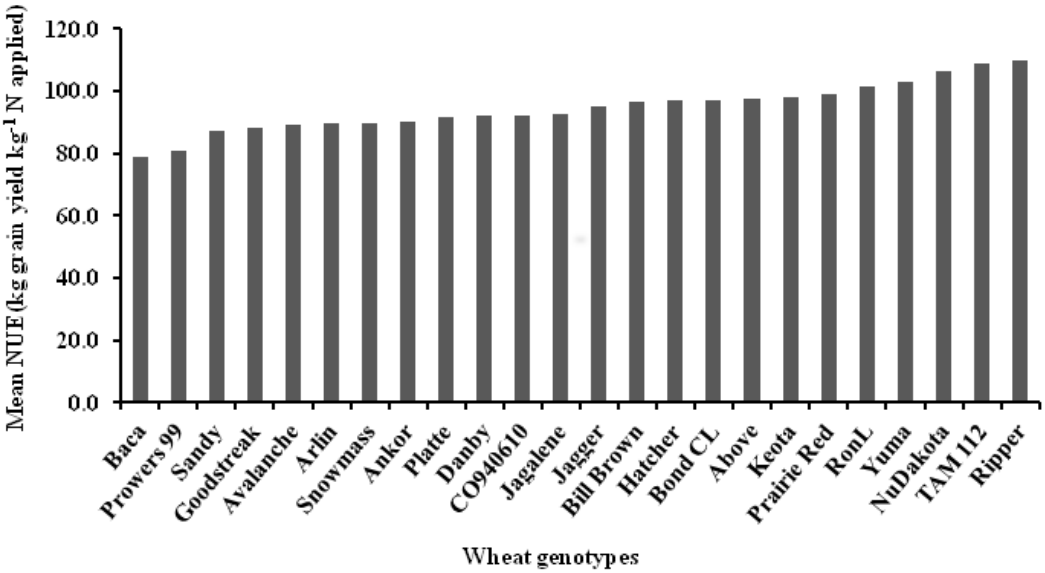

Figure 1. The mean Nitrogen use efficiency as (PFP) across 24 winter wheat genotypes under irrigated condition**.**

On the other hand, statistical analysis results with ANOVA have shown no significant differences among twenty four wheat genotypes based on nitrogen use efficiency as both (PFP) and (PNB) across 24 winter wheat genotypes under dryland condition. The NUE as (PFP) ranged from 34.38 to 50.78 kg of grain yield per kg of N applied and the NUE as (PNB) ranged from 0.84to 1.23 kg grain N uptake per kg N applied (data not shown).

In addition, the nitrogen utilization efficiency was low influenced by genotypes with ($p < 0.10$) (data not shown) under both irrigated and dryland cropping systems. While, the nitrogen uptake efficiency was not influenced by genotypes under both irrigated and dryland conditions. This result suggest that differences in NUE by two ways under irrigated cropping system possibly due to differences in the ability of wheat genotypes to convert or utilize absorbed N form soil rather than the ability of genotypes to uptake N to produce grain. Our results agree with findings of (Nelson and Fritz, 2011) that nitrogen utilization efficiency was influenced by genotypes.

References: Available upon request