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Research Article

Effect Of Nitrogen Fertilizer on The Growth of Hybrid Sorghum Sudan Grass

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Abstract:

A pot experiment was conducted at Experimental area, Agronomy Department PMAS- University of Arid Agriculture Rawalpindi to see the effect of different levels of nitrogen fertilizer on the growth and physiological traits of Sorghum Sudan Grass during March, 2022. Completely randomized designed was applied along with three replications. Seeds of Sorghum Sudan grass were collected from NARC Islamabad. Nitrogen fertilizer was applied in pots on 30th March, 2022, according to the treatments. Nitrogen played a significant role in the growth and physiology of Sorghum Sudan Grass. Nitrogen @ 150 $kgha^{-1}$ is the best among other four treatments and attained the highest plant heights in three times (21.355, 65. 153 and 100.620 cm) respectively. However, results of nitrogen @ 200$kgha^{-1}$ are approximately statistically at par with NPK. Nitrogen @ 150 $kgha^{-1}$ gained the highest position in two times data (0.7050 and 1.4250) respectively. Nitrogen @ 200 $kgha^{-1}$ gained less value than nitrogen @150$kgha^{-1}$ might be excessive dose. Nitrogen nutrition played a key role in the enhancement of leaf area values; however nitrogen @150$kgha^{-1}$nutrition had the top position (1.140 and 1.950) during two times respectively. Leaf area index data had statistically significant results but among the nutrition treatments nitrogen @150$kgha^{-1}$nutrition is the best option attaining the highest values (91.475 and 152.550) respectively in two times. Nitrogen fertilizer at different levels had statistically significant effect on crop growth rate of sorghum plants; however nitrogen @150$kgha^{-1}$nutrition treatment attained the highest value (0.5333) which was statically at par @200$kgha^{-1}$nutrition treatment. Nitrogen @150$kgha^{-1}$nutrition treatment had the top position (4061.9) but other three doses of nitrogen values having minute difference with nitrogen @150$kgha^{-1}$ and higher than control. Four doses of nitrogen fertilizer produced more net assimilation rates than control and nitrogen @150$kgha^{-1}$gained the highest value (45.653) which was statistically at par with nitrogen @200$kgha^{-1}$(43.521).Nitrogen fertilizer is an inorganic fertilizer provides the nutrition the plant fastly and provides better performance at nitrogen @150$kgha^{-1}$. Nitrogen @200$kgha^{-1}$ showed better performance than control but less than nitrogen @150$kgha^{-1}$, therefore this finding improves the economics of the study.

Key words: forage production; economics of nutrition; dry biomass and physiological traits

Introduction

salinity tolerance (Jung *et al*., 2015). SSH can be successfully grown with winter forage crops, such as Italian ryegrass (*Lolium multiflorum* Lam.), forage barley (*Hordeum vulgare* L.) and rye (*Secale cereale*) in double cropping systems (Ji *et al*., 2010). The sorghum × sudangrass hybrid [*Sorghum bicolor* (L.) Moench] (SSH) is widely cultivated as forage during the summer season all over the world. It considered as promising source for hay, silage and green chop (Ali *et al*., 2014). SSH has an advantage of fast growth and multicuts, however it has a lower feed value than corn (Kim *et al*., 2012). SSH is one of the most important summer forage crops together with forage corn widely used to produce silage in the South Korea (Seo *et al*., 2000). SSH is grown on more than 26,491 hectares with productivity of 397,372 ton in 2014 that approximately 59% of the total land area of summer forage crops in South Korea (MAFRA, 2015).

Nitrogen (N) fertilization is a very essential nutrient to increase productivity and feed values of forage material (Turgut *et al*., 2005). SSH is very sensitive to N fertilization. Forage sorghum accumulate great amount of nutrients from soil to meet its high nutrient requirements, making it important to create optimum soil conditions by frequently monitoring (Lopez-Bellido *et al*., 2006; Marsalis, 2006; Khosla *et al*.,

2000). According to Beyaert and Roy (2005), the best productivity was obtained at N rate of 125kg ha^{-1}, the most economical rates ranging from 83 to 107 kg ha1. NUE and apparent N recovery (ANR) were improved by two equal applications of N, compared to a single application (Beyaert and Roy, 2005). Studies of BMR (brown mid rib) SSH response to nitrogen rates and application method have shown that the greatest productivity was obtained by N rate of 222 kg ha1in split applications, split applications of N was improving productivity and increasing N uptake efficiency (Kilcer *et al*., 2002). Split N application treatment had effect on yield in the study of wheat response to nitrogen fertilization timing (Prokopy and Widhalm, 2011).

Most of the country's 30 million cattle, 27 million buffalos, 54 million goats, 27 million sheep and 1 million camels are owned by rural families or small farmers (of whom there are more than 8 million), and herein lies the challenge (Rehman *et al*., 2017; Tahir *et al*., 2019). Green forage demands for rapidly expanding livestock industry is increasing day by day in Pakistan. Livestock has a great contribution in the economy of Pakistan having 11.5% share in total GDP (Govt. of Pakistan, 2021). Plant populations and nitrogen fertilizers need to be reduced as much as possible so that ravage is minimized and resource use efficiency is maximized. Reducing plant densities and N fertilizer rates may affect yield and nutritive value of forage sorghum and corn when grown in limited irrigation situations (Marsalis *et al*., 2009).

Nitrogen should be applied to a crop at times that avoids periods of significant loss and provide adequate N when needed. Studies with grain sorghum have shown that fertilizer knifed-in at planting has increase yields relative to broadcast application (Khosla *et al*., 2000; OMAF, 2002). Multicut sorghum forage should be fertilized more like an intensively managed perennial grass than a corn crop with N fertilizer being applied before planting and after each cut in a multicut system (Ketterings *et al*., 2004; Rahman *et al*., 2001; Lauriault *et al*., 2002; Eltelib, 2004). Application of urea increased the fresh and dry weight of multicut sorghum (Khair and Salih, 2007; Eltelib, 2004; Neylon *et al*., 2002; Reddy *et al*., 2003).

It is important to optimize the application of N fertilizer levels to increase productivity, but consider economic efficiency and avoid soil pollution (Hirel *et al*., 2001; Moon *et al*., 2010; Tamme *et al*., 2009; Brady and Weil, 2008; Liu *et al*., 2014). Pollution from N fertilization is the main ozone depletion and global warming via N_2O emission to the atmosphere (Nadeem *et al*., 2012; Solomon, 2007). Previous studies show that increasing N fertilizer levels result in taller plants, as N enhances plant growth (Turgut *et al*., 2005; Rizan *et al*., 2003; Sher *et al*., 2016; Gebremariam and Assefa, 2015; Liu *et al*., 2014). Moghimi and Emam (2015), leaf width is in high correlation with leaf area index, which is significantly affected by N rates. Stem diameter increased with increasing N application (Clough *et al*., 2003; Ayub *et al*., 2002; Afzal et al., 2013;Almodares *et al*., 2006; Kilcer *et al*. ,2002; Beyaert and Roy, 2005; Ketterings *et al*., 2007; Lopez-Bellido *et al*., 2006 ; Howard *et al*., 2001; Clay *et al*., 2001;Howard *et al*., 2001 and Nicholos *et al*., 2004).

Net assimilation rate (NAR), this is a physiological index that allows us to know the amount of biomass accumulated by the plant per unit of leaf area at a given time (g $cm^{-2}day^{-1}$) (Carpio *et al*., 2016; Escalante and Kohashi, 2014;Mora *et al*., 2006). On the other hand, the importance of nitrogen as a fertilizer is known, it increases growth and higher biomass yields, and it affects the proportion of amino acids lysine and threonine; in oilseeds, protein content increases but has an adverse effect on oil content; it is used to maintain high production levels of quantity and quality (Maheswari *et al*., 2017). When the nitrogen content in the soil is not known, fertilizer doses higher than those required by the crop are applied, causing intoxication (Villareal *et al*., 2002). Other authors cite that, for nitrogen, in soils suitable for agriculture in tropical areas, they present severe deficiencies and low availability of this, and, therefore, it is important to carry out a soil analysis before planting a crop (Sosa and Garcia, 2018;Pichardo *et al*., 2007; Pacheco and Cabresa, 2003).

Therefore, this pot experiment was carried out to investigate the effect of nitrogenous fertilizer on the growth and physiological traits of Sorghum Sudan Grass.

Materials And Methods

A pot experiment was conducted at Experimental area, Agronomy Department PMAS- University of Arid Agriculture Rawalpindi to see the effect of nitrogen fertilizer on the growth and physiological traits of Sorghum Sudan Grass during March, 2022. Completely randomized designed was applied along with three replications. Treatments were; T_1= Control (without Nitrogen), T_2= 50 kg Nha^{-1} (49.5mg X10= 495.6 mg $NPot^{-1}$), T3= 100kg Nha^{-1} (99mg X10 = 990 mg $NPot^{-1}$), T_4= 150kg Nha^{-1} (148.5mg X10 = 1485 mg $NPot^{-1}$) and T_5= 200kg Nha^{-1} (198mg X10 = 1980 mg $NPot^{-1}$). Seeds of Sorghum Sudan grass were collected from NARC Islamabad. 10 seeds of Sorghum Sudan grass were sown in each pot having 10 kg soil. Three plants were maintained in each pot.

Nitrogen fertilizer was applied in pots on (30^{th} March, 2022) according to the treatments. All other agronomic practices were applied similarly. Growth parameters i.e. Plant Height (cm), Leaf Diameter (cm), Leaf Area (m^2), Net Assimilation Rate (NAR) [g/m^2/day or week], Crop Growth Rate (CGR) [g/m^2/day or week], Leaf Area Duration (LAD) [cm^2 day or week] and Leaf Area Index (LAI) were determined during crop duration.

Results And Discussions

Nitrogen played a significant role in the growth and physiology of Sorghum Sudan Grass. The results of plant height, leaf diameter and leaf area as affected by different doses of nitrogen are presented in table-1.

Plant height is a main contributor in plant growth of soybean crop. **Table-1** showed statistically significant results of plant height in different three intervals. Nitrogen @ 150 $kgha^{-1}$ is the best among other four treatments and attained the highest plant heights in three times (21.355, 65. 153 and 100.620 cm) respectively. However, results of nitrogen @ 200$kgha^{-1}$ are approximately statistically at par with NPK. This minute difference in plant height is might due to excessive nitrogen supplementation. The increasing trend in plant height was observed in all the treatments with the passage of time but the maximum at nitrogen @ 150 $kgha^{-1}$ treatment. The findings of the study are in line with the investigations of (Maughen *et al*., 2012; Haankuku *et al*., 2014; Turgut *et al*., 2007; Damien *et al*., 2017; Restellatto *et al*., 2013; Marsalisa *et al*., 2009;Coblentz *et al*., 2017;Nakano *et al*., 2011; Khalid *et al*., 2003 and Sarker, 2000).

Growth of every plant is determined by the leaf diameter of the plant. Statistically significant results during two times were indicated in table-1. Nitrogen @ 150 $kgha^{-1}$ gained the highest position in two times data (0.7050 and 1.4250) respectively. Nitrogen @ 200 $kgha^{-1}$ gained less value than nitrogen @150$kgha^{-1}$ might be excessive dose. This finding saved the nitrogen fertilizer and improves the economics. All the doses of nitrogen performed better performance than without nitrogen. The study results of this parameter are in agreement of the results (Roy and Khandakar, 2010; Zewdu *et al*., 2002b; Khaleduzzaman *et al*., 2007; Tassema *et al*., 2003;Kumar *et al*., 2001;Saha *et al*. ,2001;Uddin *et al*., 2005a ;Singh *et al*.,2000 and Lee and Lee, 2000).

Leaf area is a vegetative growth parameter directly related to the photosynthesis and depicted statistically significant results in table-1. Nitrogen nutrition played a key role in the enhancement of leaf area values; however nitrogen @150$kgha^{-1}$nutrition had the top position (1.140 and 1.950) during two times respectively. Without nitrogen nutrition minimum leaf area was observed in control treatment (0.3167and 0.5633) respectively in two times. Similar results were also found in the investigations of (Rahman *et al*., 2001;Maughen *et al*., 2012; Haankuku *et al*., 2014; Turgut *et al*., 2007;Marsalisa *et al*., 2009; Damien *et al*., 2017;Restellatto *et al*., 2013; Belanger *et al*., 2017).

Treatments	Plant Height (cm)			Leaf diameter (cm)		Leaf Area (m^2)	
	30th March	13rd April	27th April	6 th April	27th April	6 th April	27th April
T_1 (0 kg Nha^{-1})	18.845b	47.480b	70.867c	0.2250c	0.5667b	0.3167c	0.5633c
T_2 (50 kg Nha^{-1})	19.783ab	52.578ab	84.995b	0.2433c	0.7000b	0.4725bc	0.8700b
T_3 (100 kg Nha^{-1})	20.333a	62.227a	91.668a	0.4400b	1.2250a	0.9375ab	1.1500b
T_4 (150 kg Nha^{-1})	21.355a	65.153a	100.620a	0.7050a	1.4250a	1.1400a	1.9050a
T_5 (200 kg Nha^{-1})	20.012a	60.231a	88.256ab	0.5512ab	1.3150a	1.0020a	1.4902ab
LSD	2.201	17.670	12.364	0.2412	0.8573	0.2493	0.7205

Means followed by different letter (s) within the columns differ significantly at 5% level of significance

Table 1: Effect of Nitrogen fertilizer on the growth and physiological trait of Hybrid Sorghum Sudan Grass

Growth and physiology of plant are the important contributors of the plant life. Physiological traits; leaf Area index (LAI), Crop Growth rate (CGR), Leaf Area Duration (LAD) and Net Assimilation Rate (NAR) results were depicted in table-2. Nutrition played a key role in the growth as well as physiology of soybean crop.

Leaf area index data had statistically significant results **(Table-2)** but among the nutrition treatments nitrogen @150$kgha^{-1}$nutrition is the best option attaining the highest values (91.475 and 152.550) respectively in two times. Four nitrogen nutrition treatments performed better than control i.e. without nutrition. Leaf area index refers to the efficiency of photosynthetic process. It is the ratio of total leaves area to the ground cover, which increases to maximum after crop emergence (Reddy, 2004). These results are closely related to the conclusions of (Aguilar *et al*., (2005; Koutroubas *et al*., 2008; Zubillaga *et al*., 2002; Snyder and Tegeder, 2021;Hassan *et al*., 2020; Ashraf *et al*., 2019; Evans and Clarke, 2019; Khaliq *et al*., 2008; Nasim *et al*., 2012; Al Hasnawi *et al*., 2020; Beig *et al*., 2010;Zhang *et al*., 2014; Naz and Sulaiman 2015; Smith & Siciliano, 2015; Trinh *et al*., 2015; Anggoro, 2011; Thind *et al*., 2009 and Min *et al*., 2019).

Crop growth rate is a fundamental determinant of plant physiology. Proper nutrition availability is the basic requisite of the plant for the better performance in growth as well as plant physiology. Nitrogen fertilizer at different levels had statistically significant effect on crop growth rate of sorghum plants, however nitrogen @150$kgha^{-1}$nutrition treatment attained the highest value (0.5333) which was statically at par @200$kgha^{-1}$nutrition treatment (Table-2).Organic fertilizers are the good sources of macro and micro nutrients and environmentally approach. Crop growth rate is the dry matter production per unit time which is affected by temperature, solar radiation, age of cultivar and water/nutrient supply. Micronutrients application enhances the plant growth through increased photosynthesis and other plant pathways (Reddy, 2004). Dry weight increase in time interval in relation to the initial weight expresses the relative growth rate (RGR) while crop growth rate is an absolute measure of growth, therefore, similar values could be expected for different initial weights (Reddy, 2004). Similar findings were obtained by the results of (Nasim *et al*., 2011; Wang *et al*., 2013; Javeed *et al*., 2021; Perveen *et al*., 2021; Ghafoor *et al*., 2021; Glass, 2003; Ahmad *et al*., 2018; Jin *et al*., 2010; Zahoor *et al*., 2010; Wajid *et al*., 2010; Zubillaga *et al*., 2002; Abbadi and Gerendas, 2009; De La Vega and Hall, 2002; Tovar *et al*., 2021).

Leaf area duration (LAD) results were statistically significant with the application of NPK, FYM and poultry manure nutrition (Table-2). This physiological trait is mainly dealt with plant leaf physiology and nutrition showed significant values as presented in table-2. Nitrogen @150$kgha^{-1}$nutrition treatment had the top position (4061.9) but other three doses of nitrogen values having minute difference with nitrogen @150$kgha^{-1}$ and higher than control. Leaf area duration provides means for comparing various treatments on the basis of leaf persistence which reflects the extent of light interception and it is directly associated with leaf area index (Reddy, 2004). These results are supported by those of (Nasim *et al*., 2017;Ahmad *et al*., 2018;Hassan *et al*., 2021; Li *et al*., 2018; Wajid *et al*., 2012).

Net assimilation rate (NAR) is an important physiological trait in the growth and plant physiology and showing positive results with application of nutrition as indicated in **table-2**.Four doses of nitrogen fertilizer produced more net assimilation rates than control and nitrogen @150$kgha^{-1}$gained the highest value (45.653) which was statistically at par with nitrogen @200$kgha^{-1}$ (43.521). Nitrogen fertilizer is an inorganic fertilizer provides the nutrition the plant fastly and provides better performance at nitrogen @150$kgha^{-1}$. Nitrogen @200$kgha^{-1}$ showed better performance than control but less than nitrogen @150$kgha^{-1}$, therefore this finding improves the economics of the study. Net assimilation rate (NAR) refers the plant capacity to increase dry weight in terms of area of its assimilatory surface. It represents the photosynthetic efficiency in the overall sense and in connection with relative growth rate (Reddy, 2004). Different factors influence the NAR such as temperature, light, CO_2, water, leaf age, mineral elements, chlorophyll and genotype (Reddy, 2004). Supporting findings of this study are found by the scientists of (Cantarella *et al*., 2018; Manzoor *et al*., 2021;Mandal *et al*., 2016; Rasuli *et al*., 2021;Garcia *et al*., 2018; Perveen *et al*., 2021; Jin *et al*., 2010; Koutroubas *et al*., 2008 ;Nasim *et al*., 2017and Geng *et al*., 2016).

Treatments	LAI		CGR [g/m^2/day]	LAD[cm^2/day]	NAR [g/m^2/day]
	6 th April	27th April			
T_1 (0 kg Nha^{-1})	26.767c	45.000c	0.1783b	1354.3c	38.544b
T_2 (50 kg Nha^{-1})	37.900bc	69.750bc	0.1987b	1541.8bc	40.371ab
T_3 (100 kg Nha^{-1})	54.950b	91.750b	0.3448ab	2563.6b	42.091ab
T_4 (150 kg Nha^{-1})	91.475a	152.550a	0.5333a	4061.9a	45.653a
T_5 (200 kg Nha^{-1})	72.762ab	122.150ab	0.4356a	3250.2a	43.521a
LSD	32.054	53.079	0.3321	2701.2	7.009

LAI= Leaf Area Index, CGR= Crop growth Rate, LAD= Leaf Area Duration, NAR= Net Assimilation Rate

Means followed by different letter (s) within the columns differ significantly at 5% level of significance

Table 2: Effect of Nitrogen fertilizer on physiological traits of Hybrid Sorghum Sudan Grass

Conclusion

Availability of macro nutrients (NPK) to the plant fastly through the combined NPK fertilizer treatment attained the highest values of growth and physiological traits of soybean plants.

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