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EFFECT OF NITROGEN AND SULPHUR LEVELS ON GROWTH AND YIELD OF PEARLMILLET (*Pennisetum glaucum* L.)

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ABSTRACT
The field experiment was conducted during *Zaid* 2019 at Central Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The experiment was conducted to study the effect of nitrogen and sulphur levels on growth and yield of Pearl millet *(Pennisetum glaucum L.)* The experiment was laid out in Randomised block design comprising of 10 treatments and replicated thrice where, Nitrogen applied in three levels 40,60,80 kg/ha and Sulphur is also applied in three levels 15,20,25 kg/ha. The experimental results revealed that, maximum Plant height (166.33 cm), plant dry weight (59.54 g), ears/plant (4), grains /ear head (2172), grain yield (3.4 t/ha), stover yield (7.76 t/ha), and test weight (8.63 g) was obtained with the application of 80 Kg Nitrogen + 25 Kg Sulphur. The maximum harvest index (31.57 %), net return (¹ 111989.43) and B:C ratio (3.99) was obtained highest with application of 80 Kg N/ ha + 20 Kg S /ha. On the basis of one season experimentation, application of 80 Kg N/ ha along with 25 Kg S/ha is more productive whereas 80 Kg N/ha + 20 Kg S/ha was economically effective.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is one of the major coarse grain cereal crop and is considered to be a poor people's food. Pearl millet is the staple cereal in arid and semi- arid regions of the country. It is the only cereal crop that is capable of producing a reliable yield under the marginal environment and simultaneously responds to high management conditions. Its nutritious grain forms the important ration for the livestock during the dry season. Pearl millet is a crop grown mostly in tropical climate. It is the most drought tolerant crop among cereals and millets. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. During 2017- 2018, pearl millet was grown in 7.4 million ha with an average production of 9.13 million tonnes and productivity of 1237 kg/ha (Directorate of Millets Development, 2019). The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana which accounts for more than 90% of pearl millet acreage in the country and commonly grown in (rainy) kharif season. It is also cultivated during summer season in parts of Gujarat, Rajasthan and Uttar Pradesh; and during the (post-rainy) rabi season at a small scale in Maharashtra and Gujarat. (Directorate of Millets Development, 2019).

The contribution of fertilizer in increasing agricultural production has been very well demonstrated in India and elsewhere, it was found that fertilizer was the largest single factor responsible for increasing total crop production and recounted for 50 percent increase in yield (Randhawa and Dev,1972).

Nitrogen is the most important nutrient for the growth and yield of pearl millet crop and requires more or less throughout the growth period of pearl millet. As nitrogen is mobile element, the time and rate of nitrogen application with different quantity as per requirement of crop growth stage is most important for efficient utilization as well as for maximization of the crop yield. Nitrogen plays an important role in the synthesis of chlorophyll as well as amino acids, which is the building unit of the protein. Nitrogen also influences the dry matter production and partitioning of photosynthesis from the source to a sink. Judicious and appropriate use of fertilizer not only increases yield but also improves quality. Nitrogen is the motor of plant growth and makes up 1 to 4 percent of dry matter of the plants (Anonymous, 2000). Nitrogen is a component of protein and nucleic acids and when N is suboptimal, growth is reduced (Haque et al., 2001). Nitrogen is the major nutrient required by pearl millet and has shown variable growth and yield response to N application. Generally, pearl millet has been known for growing under low N management (Gascho *et al*., 1995). Adequate N nutrition is required for full development of tillers and leaves and also enables the plant to operate at peak photosynthetic capacity. N is the major nutrient required by pearl millet and has shown variable growth and yield response to N application. (Sunil *et al.,* 2018).

Sulphur is now recognized as the 4th major plant nutrient along with nitrogen, phosphorus and potassium. It is a constituent of three amino acids and thus vital for protein production. Sulphur is associated with the production of crops for superior nutritional and market quality produce. Pearl millet is also rich in threonine, methionine and cysteine. Thus, this nutritious cereal is comparable even superior than the fine cereals and therefore the inclusion of these cereals would

definitely ensure the fulfillment of dietry requirement. Sulphur plays an important role in formation of S-containing amino-acids, which act as building blocks in the synthesis of proteins. It has to role to play in increasing chlorophyll formation and aiding photosynthesis.

Nitrogen and sulphur play vital role in the nutrition of plants. In fact, these nutrients are lacking mostly in soils. Fertility analysis of Indian soils has indicated that the soils are highly deficient in nitrogen and sulphur. Therefore, application of chemical fertilizers becomes essential to raise the crop yield. Keeping in view the above fact, the experiment was conducted to assess the effect of nitrogen and sulphur levels on growth and yield of Pearl millet.

MATERIALS AND METHODS

The experiment was conducted during the Zaid season of 2019 at the Crop research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj. The crop has received highest temperature of 46.4ºC in the month of June and lowest temperature 20.65ºC in the month of April. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (7.10), available N (171 kg/ha), available P (15.20 kg/ha), available K (232.50 kg/ha). d was 26.2ºC. Composite soil samples were collected before layout of the experiment to determine the initial soil properties. The soil samples were collected from 0-15 cm depth and were dried under shade, were powdered with wooden pestle and mortar, passed through 2 mm sieve and were used for analysis. Available nitrogen content was determined by alkaline permanganate method as described by Subbiah and Asija (1956). Available phosphorus content was determined by Olsen's method as outlined by Jackson (1967). Available potassium content was determined by extracting with neutral normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973). There were 10 treatments and each replicated thrice. The experiment was laid out in Randomised Block Design. The crop was sown at a spacing of 45 cm × 10 cm. The treatments comprised of T_1 - Control plot (60-30-20 Kg N-P-K/ha), T_2 - 40 kg N/ha + 15 kg S/ha, T_3 - 60 kg N/ha + 15 kg S/ha, T_4 - 80 kg N/ha + 15 kg S/ha, T_5 - 40 kg N/ha + 20 kg S/ha, T_6 - 60 kg N/ha + 20 kg S/ha, T_7 - 80 kg N/ha + 20 kg S/ha, T_8 - 40 kg N/ha + 25 kg S/ha, T_9 - 60 kg N/ha + 25 kg S/ha and T_{10} - 80 kg N/ha + 25 kg S/ha. The recommended dose of 60 kg N, 30 kg P, 20 kg K per ha was applied according to treatment details through urea, DAP, MOP and Sulphur through Sulfex. Experimental data collected was subjected to statistical analysis by adopting Fishers method of Analysis of Variance (ANOVA) as outlined by Gomez and Gomez (2010). Critical Difference (CD) value were calculated whenever the 'F' test was found significant at 5 % level.

RESULTS AND DISCUSSION

Effect of Nitrogen and Sulphur levels on Growth attributes of Pearl millet.

Plant height

At 80 DAS, maximum plant height (166.33 cm) was observed with application of 80 kg N/ha + 25 kg S/ha which was significantly superior over control (RDF) (135.54 cm) and 40 kg N/ha + 15 kg S/ha (136.25 cm). Whereas rest of all the treatments were at par. The reason might be positive effect of nitrogen on growth character due to augmentation of cell division and cell expansion. The study was in close conformity with Patel *et al*.,2014, Meena *et al*.,2012. The Increase in plant height with an increase in sulphur level might be due to the beneficial effect of sulphur on the various metabolic activities and also because of its important role in cell division, photosynthetic process and formation of chlorophyll in the leaf. Therefore, an increase in plant height due to application of sulphur. The similar findings were also reported by Sarkar *et al*. (1991).

Dry weight

At 80 DAS the highest dry matter was observed with application of 80 kg N/ha + 25 kg S/ha (65.27 g/plant) which was significantly superior over all the treatments except with the application of 80 kg N/ha + 20 kg S /ha (60.83 g/plant) which was statistically at par. A significant increase in plant dry matter at different stages of growth due to increase in nitrogen levels might be attributed to the effect of nitrogen in increasing the amount and efficiency of chlorophyll which influence the photosynthetic efficiency and formation of other nitrogen compounds. Similar result also reported by Heringer and Moojen (2002) and Singh *et al*. (2000).

Effect of Nitrogen and Sulphur levels on Yield attributes of Pearl millet.

No. of ears /plant, grains/earhead and test weight were observed to be maximum with the application of 80 Kg N/ ha+25 Kg S/ha *i.e.,* 4.00, 2172 and 8.63 respectively which were 41.75 ,34.65 and 34.18% higher than control (60-30-20 Kg N-P-K/ha) respectively. The maximum grain yield (3.4 t/ ha) and stover yield (7.7 t/ha) was obtained with the application 80 Kg N/ ha + 25 Kg S /ha which was significantly 14.07 % and 28.35 % higher than the control respectively. Maximum harvest index (31.57%) was recorded with application of 80 Kg N/ ha + 20 Kg S /ha, which was 10.51% more than control. All the yield attributes were remarkably improved and gained significant response of Nitrogen and Sulphur application. The beneficial effect of Nitrogen in growth and yield attributes

Table 1: Effect of Nitrogen and Sulphur levels on Growth attributes of Pearl millet.

Treatment Combinations	Plant height (cm) 80 DAS	Plant dry weight (gm/plant) 80 DAS
Control (60-30-20 Kg N-P-K/ha)	135.54	46.2
40 Kg Nitrogen + 15 Kg Sulphur	136.25	48
60 Kg Nitrogen + 15 Kg Sulphur	147.52	49.54
80 Kg Nitrogen + 15 Kg Sulphur	144.05	53.85
40 Kg Nitrogen + 20 Kg Sulphur	144.86	49.8
60 Kg Nitrogen + 20 Kg Sulphur	142.27	49.58
80 Kg Nitrogen + 20 Kg Sulphur	151.44	60.83
40 Kg Nitrogen + 25 Kg Sulphur	142.29	51.8
60 Kg Nitrogen + 25 Kg Sulphur	153.08	55.59
80 Kg Nitrogen + 25 Kg Sulphur	166.33	65.27
SEm±	2.35	2.47
CD (P = 0.05)	7	7.35

Table 2: Effect of Nitrogen and Sulphur levels on Yield attributes and yield of Pearl millet.

Treatment Combinations	Ears/plant (No)	Grains/ear head (No.)	Test weight (g)	Grain Yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
Control (60-30-20 Kg N-P-K/ha)	2.33	1419.33	5.68	2.93	5.56	28.25
40 Kg Nitrogen + 15 Kg Sulphur	2.67	1592	5.77	2.73	6.62	29.25
60 Kg Nitrogen + 15 Kg Sulphur	3.00	1947.33	6.99	3.07	6.96	30.66
80 Kg Nitrogen + 15 Kg Sulphur	3.67	1961.67	7.27	3.09	7.1	30.35
40 Kg Nitrogen + 20 Kg Sulphur	2.67	1655.67	6.2	2.81	6.67	29.64
60 Kg Nitrogen + 20 Kg Sulphur	2.67	1931	6.44	2.86	6.9	29.36
80 Kg Nitrogen + 20 Kg Sulphur	3.67	2138.33	8.5	3.36	7.28	31.57
40 Kg Nitrogen + 25 Kg Sulphur	2.67	1873.33	6.27	2.84	6.74	29.74
60 Kg Nitrogen + 25 Kg Sulphur	3.67	2013	7.57	3.11	7.19	30.24
80 Kg Nitrogen + 25 Kg Sulphur	4.00	2172	8.63	3.41	7.76	30.55
SEm (±)	0.34	59.38	0.22	0.1	0.3	1.08
CD (P=0.05)	1.01	176.43	0.65	0.3	0.9	3.22

Table 3: Effect of nitrogen and Sulphur levels on economics of Pearl millet.

Treatment combinations	Economics of treatments	
	Net returns	B:C ratio
Control (60-30-20 Kg N-P-K/ha)	7048.4	3.84
40 Kg Nitrogen + 15 Kg Sulphur	88432.26	3.55
60 Kg Nitrogen + 15 Kg Sulphur	102283.7	3.92
80 Kg Nitrogen + 15 Kg Sulphur	102917.1	3.92
40 Kg Nitrogen + 20 Kg Sulphur	89108.42	3.41
60 Kg Nitrogen + 20 Kg Sulphur	91538.4	3.46
80 Kg Nitrogen + 20 Kg Sulphur	111989.4	3.99
40 Kg Nitrogen + 25 Kg Sulphur	88477.68	3.26
60 Kg Nitrogen + 25 Kg Sulphur	99997.9	3.54
80 Kg Nitrogen + 25 Kg Sulphur	112510.4	3.84
SEm±	3357.85	0.09
CD (P = 0.05)	9976.69	0.27

were also reported by Patel *et al*. (2014). The highest grain & straw yield could be due to the cumulative effect of improvement in yield attributes *viz*., number of Ears/plant, grains/ear head and test weight. The improvement in straw yield was mainly on account of increase in the growth parameters due to nitrogen application. These results are also in agreement with findings of Hegde *et al*. (2006), Ayub (2009), Jadhav *et al*. (2011), Sakarvadia (2012) and Patel (2014). The probable reason for increase in test weight due to highest level of nitrogen might be attributed to the better filling of grains resulting into bold sized seeds and conserved highest test weight. Sulphur has direct role in protein synthesis and is also a structural component in protein structure. Application of sulphur brought significant variation in grain yield. The highest yields with sulphur application could be ascribed to accelerated nutrients uptake which helped the plants to put optimum growth. As these growth and yield attributes as well as nutrients uptake showed significant increase in grain yield with sulphur fertilization. Similar results were reported by Jat *et al*. (2002).

Effect of nitrogen and Sulphur levels on Economics of Pearl millet.

The highest net returns was obtained with the application of 80 kg N/ ha + 25 kg S/ ha (112510.37) Which was significantly superior over rest of the treatments except with the application of 80 kg N/ ha + 15 kg S /ha(102917.13) and 80 kg N/ ha + 20 kg S /ha (111989.43) which were statistically at par with 80 kg N/ ha + 25 kg S /ha .

The highest B:C was obtained with the application of 80 kg N /ha + 20 kg S/ ha (3.99) which is statistically superior over rest of the treatments except with the application of 60 kg N/ ha + 15 kg S/ ha (3.92) and 80 kg N/ ha + 15 kg S /ha (3.92) and significantly at par with 80 kg N /ha + 20 kg S/ ha .

The combined application of nitrogen and sulphur increases the grain yield, stover yield and which ultimately increases the gross and net returns. These results were in line with results of (Jeet *et al*., 2012).

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