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# EFFECT OF PLANT GEOMETRY AND NITROGEN LEVELS ON YIELD, NUTRIENT UPTAKE AND POST HARVEST SOIL AVAILABLE NUTRIENT STATUS OF BROWNTOP MILLET UNDER SOUTHERN AGRO-CLIMATIC ZONE OF ANDHRA PRADESH

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## ABSTRACT

A field experiment was conducted at S.V. Agricultural College Farm, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during *kharif* season of 2020 to analyze the yield, nutrient uptake and post-harvest soil available nutrient status of browntop millet under varied plant geometry and nitrogen levels. The treatments include three plant geometry *viz*., $P_1$ (30 cm × 20 cm), $P_2$ (45 cm × 20 cm) and $P_3$ (60 cm × 20 cm) and four nitrogen levels, *viz*., 20 kg N ha$^{-1}$ ($N_1$), 40 kg N ha$^{-1}$ ($N_2$), 60 kg N ha$^{-1}$ ($N_3$) and 80 kg N ha$^{-1}$ ($N_4$). Plant geometry $P_2$ resulted in significantly highest grain yield but it was statistically on par with $P_3$ and significantly superior straw yield was recorded with $P_1$ plant geometry.[ Uptake of higher nitrogen and potassium was recorded with $P_2$ and $P_1$ plant geometry respectively with no significant disparity among $P_1$, $P_2$ and $P_3$, while phosphorus uptake was recorded higher with $P_3$ plant geometry which was on par with $P_2$. Significantly lower amount of post harvest soil available nutrients were observed in $P_3$ plant geometry which was on par with $P_2$. Among the nitrogen levels tested, application of 60 kg N ha$^{-1}$ produced higher grain yield which was on par with application of 80 kg N ha$^{-1}$, higher straw yield and nutrient uptake was recorded with 80 kg N ha$^{-1}$ but it was statistically comparable with 60 kg N ha$^{-1}$.]

**KEYWORDS**: Browntop millet, nutrient uptake, plant geometry, nitrogen levels and post-harvest soil available nutrients.

## INTRODUCTION

Browntop millet (*Brachiaria ramosa* (L.) Stapf. or *Urochloa ramosa* (L.) R.D. Webster) is an annual hardy, heat and drought tolerant minor millet crop that grows to a height of 90 to 150 cm. Unlike other millets, brown-top millet has a unique quality as it can be grown in the partial shade which ensures wider choice of adoption even in fruit orchards or in agro-forestry system. Crop matures early approximately 75-90 days. It is known for its rapid forage production (hardly 50 days duration) act as a cover crop in plantation crops for soil erosion control and for high straw production. 100 grams of browntop millet contains 8.98, 1.89, 3.90, 8.20 and 71.32 per cent of protein, fat, minerals, crude fiber and carbohydrates respectively.

Low productivity in browntop millet is a major problem due to lodging during *kharif* normally when it is sown at closer spacing or broadcasting. The productivity of brown top millet can be increased by applying of fertilizers at optimum dose, especially nitrogen is required for initial establishment, vigorous and robust tillers with broad leaves which enhances the quality and productivity of grain. Therefore, the optimum plant geometry and nitrogen management provides favourable environmental conditions to the crop during various growth and developmental stages, resulting in better performance and enhanced productivity of browntop millet.

## MATERIAL AND METHODS

The present field experiment was carried out at dryland farm, S.V. Agricultural College, Tirupati of Acharya N.G. Ranga Agricultural University. The experiment was laid out in a random block design with factorial concept with twelve treatment combinations and replicated thrice. The treatments include three plant geometry *viz*., $P_1$ (30 cm × 20 cm), $P_2$ (45 cm × 20 cm) and $P_3$ (60 cm × 20 cm) and four nitrogen levels, *viz*., 20 kg N ha$^{-1}$ ($N_1$), 40 kg N ha$^{-1}$ ($N_2$), 60 kg N ha$^{-1}$ ($N_3$) and 80 kg N ha$^{-1}$ ($N_4$). The experimental field was sandy loam in texture which is low in organic carbon (0.38%). The soil is alkaline in reaction (pH 7.7), low in available N (151.0 kg ha$^{-1}$), medium in available phosphorus (207.0 kg ha$^{-1}$) and potassium (34.0 kg ha$^{-1}$). The variety of browntop millet

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tested was GPUBT-6. A total rainfall of 859.0 mm was received in 33 rainy days during the crop growing period. Recommended dose of fertilizers was 40-20-20 kg N, $P_2O_5$ and $K_2O$ ha$^{-1}$. The nutrients were applied in the form of urea, single super phosphate and muriate of potash. Available soil nitrogen (N) was estimated by the method described by Subbiah and Asija (1956) and the nitrogen status was expressed in kg ha$^{-1}$. Soil available phosphorus was determined as described by Olsen *et al.* (1954) using spectrophotometer and expressed in kg ha$^{-1}$. Soil available Potassium was estimated by neutral normal ammonium acetate extraction method using Flame Photometry (Jackson, 1973) and expressed in kg ha$^{-1}$.Plants from each treatment in the plot were selected at random and tagged for taking the observation *viz*, nutrient uptake of NPK. The oven dried samples of plants material were ground in a willey mill and analyzed for N, P and K contents. The nitrogen, phosphorus and potassium uptake were calculated by multiplying the nutrient content of the plant sample with corresponding total dry matter and expressed in kg ha$^{-1}$. The total nitrogen content in the plant sample was estimated by the Micro Kjeldal method as suggested by (Association of Official Agricultural Chemists (AOAC), 1960). The total phosphorus content in the plant sample was estimated with vanado-molybdo phosphoric acid method by Jackson (1973). The total potassium content in the plant sample was estimated with triple acid digestion method using Flame Photo Meter as suggested by Jackson (1973). The data collected were analyzed statistically following the procedure given by Panse and Sukhatme (1985) wherever the treatmental differences were significant, critical differences were worked out at five per cent probability level. Treatment differences that were not significant are denoted as NS.

## RESULTS AND DISCUSSION

### Grain yield

Grain yield of browntop millet varied significantly due to plant geometry as well as nitrogen levels tried, while the interaction effect was found to be non significant.

The highest grain yield of browntop millet was realized with plant geometry $P_2$ (45 cm × 20 cm) which was statistically on par with that of $P_3$ (60 cm × 20 cm). This might be due to optimum plant geometry provided favourable microclimate which enables the individual plant in efficient utilization of growth resources like light, moisture and nutrients which in turn to achieve the maximum productivity. Even though all the yield attributes were maximum in wider plant geometry, panicles on late formed tillers were not attained full maturity there by reduced the grain yield per unit area when compared to optimum plant geometry. Whereas severe intra-plant competition and lodging at reproductive stage due to higher plant height might have negative effect on grain yield under closer plant geometry. The results were in confirmity with the findings of Natarajan *et al.* (2019) and Santosh *et al.* (2020).

Among nitrogen levels tested, higher grain yieldwas registered with the application of 60 kg N ha$^{-1}$ ($N_3$) which was comparable with 80 kg N ha$^{-1}$ ($N_4$) followed by 40 kg N ha$^{-1}$ ($N_2$) which was in turn exhibited significant difference to both of them. Higher yield with increase in nitrogen level up to 60 kg N ha$^{-1}$ ($N_3$) might be due to the reason that better availability and uptake of nutrients resulted in enhanced chlorophyll synthesis, leaf area, photosynthetic efficiency, better growth and dry matter production which ultimately led to efficient partitioning and translocation of photosynthates from source to sink. Application of 80 kg N ha$^{-1}$ ($N_4$) resulted in more vegetative growth which in turn reduced the grain yield when compared to 60 kg N ha$^{-1}$ ($N_3$). Significantly lower grain yield was noticed with 20 kg N ha$^{-1}$ ($N_1$). The present results are in accordance with the findings of Vimalan *et al.* (2019) and Anitha *et al.* (2020).

### Straw yield

Varied plant geometry and nitrogen levels exerted significant influence on the straw yield of browntop millet, while their interaction effect was found to be non significant.

Significantly higher straw yield was recorded at $P_1$ (30 cm × 20 cm) than that of $P_2$ (45 cm × 20 cm). This might be due to closer plant geometry which resulted in taller plants with high dry matter and more plant population per unit area and ultimately increased the straw yield. These results were in accordance with the findings of Mane *et al.* (2019) and Sanjay *et al.* (2021). The lower straw yield was observed with the $P_3$ (60 cm × 20 cm) plant geometry which was statistically differed from other plant geometry tried.

Under varied nitrogen levels tested, straw yieldwas significantly higher with the application of 80 kgNha$^{-1}$ ($N_4$) which was comparable with 60 kg N ha$^{-1}$ ($N_3$)

**Table 1. Grain yield, straw yield (kg ha$^{-1}$) and harvest index (%) as influenced by varied plant geometry and nitrogen levels in browntop millet**

| Treatments | Grain yield | Straw yield | Harvest index |
|---|---|---|---|
| **Plant Geometry** | | | |
| $P_1$: 30 cm × 20 cm | 1353 | 5262 | 20.3 |
| $P_2$: 45 cm × 20 cm | 1548 | 4663 | 24.8 |
| $P_3$: 60 cm × 20 cm | 1470 | 4294 | 25.4 |
| **SEm±** | 36.9 | 119.2 | 0.59 |
| **CD (P = 0.05)** | 108 | 350 | 1.7 |
| **Nitrogen levels** | | | |
| $N_1$: 20 kg ha$^{-1}$ | 1075 | 4047 | 21.1 |
| $N_2$: 40 kg ha$^{-1}$ | 1427 | 4616 | 23.7 |
| $N_3$: 60 kg ha$^{-1}$ | 1682 | 5041 | 25.1 |
| $N_4$: 80 kg ha$^{-1}$ | 1643 | 5254 | 23.9 |
| **SEm±** | 42.6 | 137.7 | 0.68 |
| **CD (P = 0.05)** | 125 | 404 | 2.0 |
| **Interaction** | | | |
| **SEm±** | 75.6 | 238.4 | 1.18 |
| **CD (P = 0.05)** | NS | NS | NS |

followed by 40 kg N ha$^{-1}$ ($N_2$) which in turn statistically not comparable with 60 kg N ha$^{-1}$ ($N_3$). The increased dose of nitrogen leads to higher availability of nitrogen along with enhanced absorption of other nutrients. Nitrogen plays a key role in the synthesis of chlorophyll and higher availability of nitrogen tends to increase leaf area, plant height, number of tillers and dry matterdue to higher photosynthetic efficiency ultimately increased growth and straw yield. The similar results were reported by Prabudoss *et al*. (2017) and Saikishore *et al*. (2020). Significantly lower straw yield was noticed with 20 kg N ha$^{-1}$ ($N_1$).

**Nutrient uptake**

Nutrient uptake of browntop millet differed significantly due to varied plant geometry and nitrogen levels, while the interaction effect found to be non significant.

Nitrogen uptake was higher with plant geometry $P_2$ (45 cm × 20 cm) which was comparable with $P_3$ (60 cm × 20 cm) and $P_1$ (30 cm × 20 cm)plant geometry. Phosphorus uptake was higher in wider plant geometry $P_3$ (60 cm × 20 cm) which was statistically superior to $P_1$ (30 cm × 20 cm) but was on par with that of $P_2$ (45 cm × 20 cm). Lower uptake of nitrogen and phosphorus was noticed with $P_1$ (30 cm × 20 cm) plant geometry. Whereas potassium uptake was higher with $P_1$ (30 cm × 20 cm) plant geometry which was statistically on par with that of $P_2$ (45 cm × 20 cm) and $P_3$ (60 cm × 20 cm) plant geometry. Lower potassium uptake was noticed with $P_3$ (60 cm × 20 cm). The difference in uptake of potassium was might be due to higher per cent of potassium content in straw. These findings were in conformity with Natarajan *et al*. (2019) and Thakur *et al*. (2019).

**Table 2. Nutrient uptake (kg ha$^{-1}$) and post-harvest soil available nutrient status (kg ha$^{-1}$) at harvest as influenced by varied plant geometry and nitrogen levels in browntop millet**

| Treatments | Nitrogen uptake | Phosphorous uptake | Potassium uptake | Soil available nitrogen | Soil available phosphorous | Soil available potassium |
|---|---|---|---|---|---|---|
| **Plant Geometry** | | | | | | |
| $P_1$: 30 cm × 20 cm | 64 | 28.4 | 109 | 113 | 19.4 | 154 |
| $P_2$: 45 cm × 20 cm | 69 | 31.0 | 106 | 106 | 16.7 | 147 |
| $P_3$: 60 cm × 20 cm | 67 | 32.3 | 102 | 101 | 14.8 | 142 |
| **SEm±** | 2.0 | 1.08 | 3.8 | 2.7 | 0.46 | 3.7 |
| **CD (P = 0.05)** | NS | 3.2 | NS | 8 | 1.3 | 11 |
| **Nitrogen levels** | | | | | | |
| $N_1$: 20 kg ha$^{-1}$ | 47 | 21.6 | 75 | 101 | 26.1 | 166 |
| $N_2$: 40 kg ha$^{-1}$ | 64 | 29.3 | 103 | 104 | 18.4 | 153 |
| $N_3$: 60 kg ha$^{-1}$ | 75 | 34.1 | 118 | 109 | 13.8 | 140 |
| $N_4$: 80 kg ha$^{-1}$ | 80 | 37.2 | 127 | 113 | 9.6 | 131 |
| **SEm±** | 2.3 | 1.25 | 4.4 | 3.1 | 0.53 | 4.3 |
| **CD (P = 0.05)** | 7 | 3.7 | 13 | 9 | 1.5 | 13 |
| **Interaction** | | | | | | |
| **SEm±** | 4.0 | 2.16 | 7.6 | 5.4 | 0.91 | 7.4 |
| **CD (P = 0.05)** | NS | NS | NS | NS | NS | NS |

Uptake of nutrients was maximum with application of 80 kg N ha$^{-1}$ ($N_4$) which was on par with 60 kg N ha$^{-1}$ ($N_3$) followed by 40 kg N ha$^{-1}$ ($N_2$) which was inturn significant difference to that of later one. The growth and yield of crop was determined by the presence and availability of nutrients in the soil for uptake. Uptake of nutrients depends on the concentration of ions in the available form in the external medium. Increased levels of nitrogen might be increased the availability of nitrogen ions in the soil solution resulted in higher absorption of P and K along with nitrogen. Similar findings were also observed by Jyothi *et al.* (2016) and Vimalan *et al*. (2019). Significantly lower nutrient uptake was noticed with 20 kg N ha$^{-1}$ ($N_1$).

**Post-harvest soil available nutrient status**

Varied plant geometry and nitrogen levels have exerted significant influence on the post harvest soil nutrient status (available nitrogen, phosphorus and potassium), while the interaction effect was not statistically traceable.

Post-harvest soil available nitrogen and potassium were higher with $P_1$ (30 cm × 20 cm) plant geometry which was however on par with that of $P_2$ (45 cm × 20 cm followed by $P_3$ (60 cm × 20 cm) which inturn on par with that of $P_2$ (45 cm × 20 cm). The highest post-harvest soil available phosphorous was noticed with $P_1$ (30 cm × 20 cm) followed by $P_2$ (45 cm × 20 cm) with significant disparity between them. This might be due to higher uptake of nutrients by browntop millet in wider plant geometry resulted in lower available nitrogen and potassium in the soil after harvest. Lower post-harvest soil available nitrogen, phosphorous and potassium were recorded with $P_3$ (60 cm × 20 cm). This might be due to large root system in wider plant geometry helped in better absorption of nutrients which in turn exhibited more number of tillers with increased leaf area plant$^{-1}$.

Post-harvest available soil nitrogen was higher with application of 80 kg N ha$^{-1}$ ($N_4$) and lower with 20 kg N ha$^{-1}$ ($N_1$). The difference might be due to increase in nitrogen levels which resulted in overall growth and yield of crop with well developed root system by releasing root exudates helps in mineralization of organic nitrogen by microorganisms, ultimately increase in available nitrogen status of the soil. The highest post-harvest soil available phosphorous and potassium availability were registered with 20 kg N ha$^{-1}$ ($N_1$) and significantly lower were noticed with application 80 kg N ha$^{-1}$ ($N_4$). With increase in nitrogen levels, phosphorous and potassium content in the soil after harvest was decreased. This might be due to the reason that higher uptake of phosphorus and potassium with increase in nitrogen level might have limited the availability phosphorous and potassium in the soil after harvest. The similar results were reported by Jyothi *et al*. (2016) and Anitha *et al*. (2020).

Finally, it can be concluded that higher grain yield of browntop millet could be achieved with plant geometry of 45 cm × 20 cm along with the application of 60 kg N ha$^{-1}$on sandy loam soils of Southern Agro-climatic Zone of Andhra Pradesh.

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