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# Effect of Varieties and Varied Nitrogen Levels on Growth and Green Fodder Yield of Pearl Millet (*Pennisetum glaucum* (L.) Br Emend Stuntz.) under Custard Apple (*Annona squamosa* L.) Based Horti-Pastoral System

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**Abstract** A field experiment was conducted during rainy season of 2017-18. Fodder pearl millet was sown in custard apple based horti-pastoral system adopting three varieties ($V_1$ : Bahubali GK-1183, $V_2$ : Virat-9 and $V_3$ : Kaveri Super Boss) with four varied nitrogen levels ($N_0$ : control, $N_1$ : 40 kg ha$^{-1}$, $N_2$ : 60 kg ha$^{-1}$ and $N_3$ : 80 kg ha$^{-1}$). Experiment was laid out in a randomized complete block design (RCBD) replicated thrice. Among all three varieties, Kaveri Super Boss given significantly higher plant height (cm), number of nodes and internodes, leaf area index, number of leaves, shoot fresh weight (g), shoot dry weight (g), green and dry fodder yield (kg) but does not significant affected on initial and final plant population. Application of 80 kg N ha$^{-1}$ resulted significant increase in the plant population, plant height (cm), number of leaves, nodes and internodes, leaf area index, shoot fresh weight (g), shoot dry weight (g), green and dry fodder yield at harvest over 60, 40 kg N ha$^{-1}$ and control. Net returns and B : C ratio was highest under combination of Kaveri Super Boss ($V_3$) and 80 kg N ha$^{-1}$.

**Keywords** Fodder pearl millet, Horti-pastoral system, Nitrogen levels, Custard apple, Varieties.

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## Introduction

An agroforestry, growing of multipurpose trees (MPTs) in combination with arable crops and or animals, is assured system for increasing diversified yield per unit area in affected areas. Hortipastoral is a type of agroforestry in which multipurpose trees are planted in combination with pasture to increases overall production fruit trees and dairy animals, besides imparting stability to the farming. Horti-pastoral systems are popular worldwide and promising option due to their increased return per unit area, high market value of product and contribution of fruits to household dietary needs.

Custard apple (*Annona squamosa* L.), a versatile fruit tree, is widely grown in an agroforestry system due to its better adoptablity to various soil and climatic conditions, being hardy and resistant to pest and diseases and safe from animal damage. In India, custard apple is cultivated in an area of 22, 000 ha with production of 1, 65,000 tonnes (Anony-

mous 2015). Pearl millet (*Pennisetum glaucum* (L). Br Emend Stuntz.) is the most widely grown *kharif* crop of family Poaceae. It is highly tolerant to heat and drought, problem soils and is easy to grow in regions with low rainfall. In India it is predominantly cultivated as a rainfed crop under diverse soil and climatic conditions and is an indispensible arid zone crop (Ramesh et al. 2006). In india, it is cultivated in an area of 9.4 million hectares with a total production of 10.1 million tones and productivity of 1069 kg $ha^{-1}$ (Anonymous 2011). Pearl millet produces green fodder in short duration because of its quick growth compared to maize and sorghum. The demand of green and dry fodder are 816.8 million tonnes and 508.9 million tonnes, but supply is 525.5 million and 453.2 million, respectively reasonably less than demand (Dikshit and Birthal 2010). India is facing an acute shortage of fodder and cause negative influence on the dairy economy. If the deficit of quality fodder continues then this demand supply gap is likely to increase in near future.

Selection of an appropriate variety for the region is of prime importance to raise the fodder productivity of the area and to overcome green fodder shortage. Selection of good variety will increase the yield to the tune of 15–24% (Sannagoudar et al. 2017).

The application of nitrogenous fertilizer either in excess or less than optimum rate may affect both fodder yield and quality to a remarkable extent. It increases vegetative growth of fodder crop and herbage quality which is highly desirable for the forage yield and dry matter accumulation. Therefore, the present investigation was undertaken to find out appropriate dose of N application for increase in the fodder production and nutritional quality of fodder pearl millet grown under rainfed conditions (Damame et al. 2013).

In agroforestry system, the tree and crop components help each other by creating favorable conditions for their growth in a way to provide efficient land use system for better economic return than the corresponding sole crop. Rainfed farming situation and poor water holding capacity of Vindhyan region soil facilitate only option for growing of short duration arable crops during *kharif* to local farmers. Agroforestry system provides better opportunity to enhance total production and profitability than growing sole crops under rained conditions.

**Materials and Methods**

Experimental site and treatment details

The experiment was carried out at Agricultural Research Farm, Rajiv Gandhi South Campus, Barkachha, Banaras Hindu University, Mirzapur situated at 25° 10' N latitude and 82°37' E longitudes and at an altitude of 427 meters above mean sea level. An experiment was laid out during rainy *kharif* season of 2017 in a factorial randomized complete block design with three varieties ($V_1$ : Bahubali GK-1183, $V_2$ : Virat-9 and $V_3$ : Kaveri Super Boss) and four nitrogen levels ($N_0$ : control, $N_1$ : 40 kg $ha^{-1}$, $N_2$ : 60 kg $ha^{-1}$ and $N_3$ : 80 kg $ha^{-1}$), replicated thrice. Experimental crop fodder pearl millet was sown as intercrop at a row distance of 45 cm manually in the alleys of 10 year old custard apple planted in August, 2006 at a spacing of 5 × $5m^2$. Composite soil samples prior to the experiment were analyzed for different physico-chemical properties of the soil. The soil of the experimental field was sandy clay loam in texture, acidic in reaction with pH 5.9, EC of 0.11 $dSm^{-1}$, low in organic carbon (0.37%), available nitrogen (225.63 kg $ha^{-1}$) and phosphorus (20.97 kg $ha^{-1}$) and medium in available potassium (243.38 kg $ha^{-1}$). Field was ploughed with the help of disc plough and harrowing was done followed by planking.

Recommended dose of phosphorus @ 40 kg $ha^{-1}$ and potassium @ 40 kg $ha^{-1}$ were applied in the form of single super phosphate (SSP) and muriate of potash (MOP) respectively. Nitrogen was applied through urea as per the treatments; half as basal and remaining half was top dressed after 30 days of sowing. The rainfall received during crop season was about 485.20 mm. Recommended agronomic practices were followed to raise the crop.

Growth and yield attributes

Initial and final plant population was recorded at 15 DAS and just prior to harvest of crop respectively, expressed in $m^{-2}$. Five plants randomly from net plot were tagged to record biometric observations. Plant

height was measured from base of the plants to growing tip of main stem and expressed in cm. Number of leaves, leaf area index (LAI), nodes and internodes, from five plants were recorded 20, 40 DAS and at harvest. Shoot fresh weight of five plants from border rows in each plot were cut from the ground level and weighted. Thereafter, shoots were sundried for 2-3 days separately and oven dried at 70°C for 48 h to get constant shoot dry weight and expressed as g plant$^{-1}$.

Then the crop from net plot area of 9 m$^{-2}$ was harvested close to the ground, bundled and weighed as green fodder yield and expressed in kg ha$^{-1}$. The harvested produce was sundried for 4 days, weighed and expressed as dry fodder yield in kg ha$^{-1}$.

Economics

Economics of treatments was calculated separately by taking into account the existing price of inputs and produce. Gross return was calculated by multiplying the green fodder yield with the prevailing market price (Rs 3.0 kg$^{-1}$). Net return and benefit : Cost ratio was worked out with the help of the following formulas :

$$\text{Net return (Rs ha}^{-1}\text{)} = \text{Gross return (Rs ha}^{-1}\text{)} - \text{Cost of cultivation (Rs ha}^{-1}\text{)}$$

$$\text{Benefit : Cost ratio} = \frac{\text{Net return (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs ha}^{-1}\text{)}}$$

Statistical analysis

For determining the significance between the treatment means and to draw valid conclusion, statistical analysis was done. Data collected on growth and yield of the experimental crop were tabulated and statistically analyzed as per the standard analysis of variance. The treatment differences were tested by F test and difference of treatment mean was tested using critical differences at 5% level of probability.

**Results and Discussion**

Plant population and plant height (cm)

Plant population (initial and final) of fodder pearl millet did not turn up significantly with varieties (Table 1). Similar results for plant populations were reported by Bramhaiah et al. (2018) and Hassan et al. (2014). Nitrogen levels brought significant variation in plant population (initial and final), registered maximum with highest level of nitrogen (80 kg ha$^{-1}$) (Table 1). Maximum plant height of fodder pearl millet was recorded at all the stages in the treatments where Kaveri Super Boss variety was used. The variety Kaveri Super Boss attained significantly taller height than other two varieties (Table 1). This result is confirmed by Obeng et al. (2012), Hassan et al. (2014), Ibrahim et al. (2014). The maximum plant height was recorded

**Table 1.** Effect of varieties and varied nitrogen levels on growth of fodder pearl millet grown as custard apple based horti-pastoral system at harvest.

| Treatments | Plant population (m$^{-2}$) | | Plant height | No. of leaves | No. of nodes | No.of internodes | Leaf area | Shoot weight (g) | |
|---|---|---|---|---|---|---|---|---|---|
| Varieties | Initial | Final | (cm) | plant$^{-1}$ | plant$^{-1}$ | plant$^{-1}$ | index | Fresh | Dry |
| $V_1$ : Bahubali GK-1183 | 19.24 | 18.04 | 188.43 | 22.86 | 7.80 | 6.80 | 3.43 | 149.36 | 24.45 |
| $V_2$ : Virat-9 | 19.96 | 18.47 | 187.27 | 20.06 | 7.31 | 6.31 | 3.24 | 144.11 | 21.28 |
| $V_3$ : Kaveri Super Boss | 21.89 | 19.53 | 207.10 | 27.75 | 7.93 | 6.93 | 3.62 | 156.13 | 25.04 |
| SEm | 0.74 | 0.41 | 2.32 | 0.63 | 0.09 | 0.09 | 0.05 | 2.28 | 0.80 |
| CD ($p$=0.05) | NS | NS | 6.79 | 1.84 | 0.27 | 0.27 | 0.15 | 6.70 | 2.35 |
| Nitrogen levels (kg ha$^{-1}$) | | | | | | | | | |
| $N_0$ : Control | 18.31 | 16.91 | 183.06 | 19.48 | 7.10 | 6.10 | 2.80 | 122.16 | 18.57 |
| $N_1$ : 40 | 20.64 | 18.70 | 183.06 | 21.20 | 7.39 | 6.39 | 3.37 | 130.29 | 20.54 |
| $N_2$ : 60 | 20.57 | 18.90 | 196.88 | 24.60 | 7.65 | 6.65 | 3.63 | 162.11 | 25.00 |
| $N_3$ : 80 | 21.94 | 20.21 | 212.00 | 28.96 | 8.58 | 7.58 | 3.93 | 184.89 | 30.26 |
| SEm | 0.86 | 0.48 | 2.67 | 0.72 | 0.11 | 0.11 | 0.06 | 2.64 | 0.92 |
| CD ($p$=0.05) | 2.51 | 1.40 | 7.84 | 2.12 | 0.31 | 0.31 | 0.17 | 7.74 | 2.71 |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS | NS |

with highest level of nitrogen application (80 kg N $ha^{-1}$). Nitrogen helps in vegetative growth thus these results are obvious. This result is in confirmation with Myandoab et al. (2011). Interaction of varieties and nitrogen levels could not differ significantly.

Number of leaves, number of nodes and internodes

The number of leaves $plant^{-1}$ increased significantly at all the stages. Maximum number of leaves $plant^{-1}$ was obtained with variety Kaveri Super Boss (Table 1). These results are in confirmation with those of Kumawat et al. (2017). The maximum number of leaves were recorded with 80 kg N $ha^{-1}$. The number of leaves increased with age of fodder crop and reach to maximum at harvest (Table 1). The results are in accordance with the findings of Puri and Tiwana (2005) and Ibrahim et al. (2014). Nodes and internodes $plant^{-1}$ were also recorded significantly higher with variety Kaveri Super Boss at all the stages (20 DAS, 40 DAS and at harvest). Significantly higher nodes and internodes obtained by application of the highest dose of 80 kg N $ha^{-1}$ (100% recommended dose of nitrogen). Similar, results were recorded by Sheta et al. (2017).

Leaf area index, shoot fresh weight and shoot dry weight

A gradual increase in the leaf area index of fodder pearl millet observed with advancement in the crop stage up to harvest. Maximum leaf area index was recorded with variety Kaveri Super Boss significantly superior over others (Table 1). These results are in agreement with earlier reports. Maximum leaf area index was recorded with 80 kg N $ha^{-1}$ and it increased with advancement in the crop age till harvest. Nitrogen increases protein synthesis and consequently vegetative growth thus increased leaf area index and as a result increases the photosynthetic surface and stimulated the growth further. Shootfresh weight and dry weight were also recorded significantly higher with variety Kaveri Super Boss at all the stages (20 DAS, 40 DAS and at harvest). Significantly higher shoot fresh weight and shoot dry weight was obtained by 80 kg N $ha^{-1}$ (100% recommended dose of nitrogen) which was significantly higher than its lower doses of nitrogen application (Table 1). The ultimate reason of higher shoot fresh and shoot dry weight with treatment 80 kg N $ha^{-1}$ is due to increased quantity of nitrogen provided vigorous growth and larger photosynthetic surface area to intercept more solar energy. The above results are supported by the findings of Obeng et al. (2012) and Ibrahim et al. (2014).

**Table 2.** Effect of varieties and varied nitrogen levels on number of tillers, green fodder yield dry fodder yield of pearl millet under custard apple based horti-pastoral system at harvest stage.

| Treatments<br>Varieties | No. of tillers $plant^{-1}$ | Green fodder yield kg $ha^{-1}$ | Dry fodder yield kg $ha^{-1}$ |
|---|---|---|---|
| $V_1$ : Bahubali GK-1183 | 1.44 | 7496.58 | 2399.58 |
| $V_2$ : Virat-9 | 1.49 | 7674.08 | 2456.33 |
| $V_3$ : Kaveri Super Boss | 1.88 | 9602.17 | 3082.75 |
| SEm | 0.06 | 525.19 | 170.59 |
| CD ($p$=0.05) | 0.16 | 1540.31 | 500.31 |
| Nitrogen levels (kg $ha^{-1}$) | | | |
| $N_0$ : Control | 1.20 | 5930.44 | 1893.33 |
| $N_1$ : 40 | 1.42 | 6486.44 | 2071.67 |
| $N_2$ : 60 | 1.68 | 8345.67 | 2677.89 |
| $N_3$ : 80 | 2.13 | 12267.43 | 3942.00 |
| SEm | 0.06 | 606.43 | 196.98 |
| CD ($p$=0.05) | 0.19 | 1778.59 | 577.71 |
| Interaction | NS | NS | NS |

Yield

Number of tillers, green fodder yield and dry fodder yield of pearl millet varied significantly with varieties. Maximum at all the stages of crop growth was recorded by variety Kaveri Super Boss. This variety established its significant superiority over other two. All the parameters like plant height, number of leaves, leaf area index and shoot fresh and dry weight increased with variety Kaveri Super Boss (Table 2). Similar results have been reported by Kumar et al. (2017). The superior yield of all yield parameter was obtained with variety Kaveri Super Boss was due to its overall vigorous growth parameters than other varieties. Better performance of Kaveri Super Boss is justified in light of the findings reported by Kapoor and Singh (2017).

Maximum number of tillers $plant^{-1}$ also obtained with 80 kg N $ha^{-1}$ (Table 1). Higher dose of nitrogen responsible for more tillers from lower nodes (Table

Table 3. Relative economics of fodder pearl millet as influenced by varieties and varied nitrogen levels under custard apple based horti-pastoral system.

| Treatments | Gross return (Rs ha$^{-1}$) | Net return (Rs ha$^{-1}$) | Benefit : Cost ratio |
|---|---|---|---|
| Bahubali (GK-1183) + control | 47909.00 | 30785.10 | 1.79 |
| Bahubali (GK-1183) + 40 kg ha$^{-1}$ N | 49541.00 | 31721.50 | 1.77 |
| Bahubali (GK-1183) + 60 kg ha$^{-1}$ N | 55931.00 | 37763.70 | 2.04 |
| Bahubali (GK-1183) + 80 kg ha$^{-1}$ N | 64340.00 | 45824.90 | 2.47 |
| Virat-9 + control | 48410.00 | 31286.10 | 1.82 |
| Virat-9 + 40 kg ha$^{-1}$ N | 49529.00 | 31709.50 | 1.77 |
| Virat-9 + 60 kg ha$^{-1}$ N | 56114.00 | 37946.70 | 2.08 |
| Virat-9 + 80 kg ha$^{-1}$ N | 65795.00 | 47279.90 | 2.55 |
| Kaveri Super Boss + control | 52877.00 | 35753.10 | 2.08 |
| Kaveri Super Boss + 40 kg ha$^{-1}$ N | 55130.00 | 37310.50 | 2.09 |
| Kaveri Super Boss + 60 kg ha$^{-1}$ N | 58886.00 | 40718.70 | 2.24 |
| Kaveri Super Boss + 80 kg ha$^{-1}$ N | 76094.00 | 57578.90 | 3.10 |

2). Above results are in confirmation with findings Kumawat et al. (2017). Favorable effect of nitrogen application on growth parameters resulted in significantly higher green fodder and dry fodder yields. Application of 80 kg N ha$^{-1}$ recorded significantly highest green fodder and dry fodder yields. Higher nitrogen improved the growth viz. number of leaves, plant height, shoot fresh weight and shoot dry weight. Higher green fodder yield was obtained due to higher nitrogen levels was actually due to the accelerated formation of nucleotides and co-enzymes, protein synthesis, meristematic and photosynthetic activity. Above results were confirmed by findings of Bramhaiah et al. (2018).

## Relative economics

Economic analysis is the mandatory part of research, maximum net return and B : C ratio was obtained from the variety Kaveri Super Boss + 80 kg nitrogen ha$^{-1}$ (Table 3). This treatment proved most effective in terms of the net return because of relatively more green fodder yield obtained. The practical utility of any treatment can be judged by net returns of economics. Similar, results found by Thumar et al. (2016).

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