*Int.J.Curr.Microbiol.App.Sci* (2020) *9*(12): 29-36

*International Journal of Current Microbiology and Applied Sciences*
***ISSN: 2319-7706*** **Volume 9 Number 12 (2020)**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2020.912.006

# Yield and Economics of Pearl Millet (*Pennisetum glaucum* L.) as influenced by Integrated Nutrient Management under Different Planting Pattern

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**Keywords**

Economics, Fertilizer grades, FRBD, Interaction, Pearl millet, Planting pattern

**Article Info**

***Accepted:***
04 November 2020
***Available Online:***
10 December 2020

**A B S T R A C T**

A field experiment was conducted during *Kharif* season of 2019-20 at Agronomy section, College of Agriculture, Latur. The experiment was laid out in a Factorial Randomized Block Design with two factor combinations i.e. planting patterns and fertilizer grades, consisting three levels each of factors. The planting patterns were $P_1$ - planting at 45 x 15 cm, $P_2$ - paired row planting 30/60 x 15 cm, $P_3$ - paired row with furrow 30/60 x 45 cm and the fertilizer grades viz., $F_1$-40:20:20 NPK Kg $ha^{1}$, $F_2$ - 60:30:30 NPK Kg $ha^{-1}$, $F_3$ - 80:40:40 NPK Kg $ha^{-1}$. The treatments were replicated thrice. The result revealed that pearl millet grown under paired row spacing with furrow was recorded higher seed yield (2324 kg $ha^{-1}$), higher gross monetary return (39510 Rs. $ha^{-1}$), higher net monetary return (11423 Rs. $ha^{-1}$) and B:C ratio (1.41). Application of 80:40:40 NPK kg $ha^{-1}$ produced higher seed yield (2255 kg $ha^{-1}$) and obtained higher gross monetary return (38340 Rs. $ha^{-1}$), net monetary return (10424 Rs. $ha^{-1}$), and B:C (1.37) ratio.

## Introduction

In India, area under pearl millet cultivation is about 6.93 million hectares, production of 8.61 million tonnes with productivity of 1243 kg/ ha (Anonymous, 2017-18). The higher production of pearl millet is recorded in Rajasthan, Maharashtra, Gujarat, Punjab, Haryana and Uttar Pradesh state in India where, it is grown both in *kharif* and summer seasons. In Maharashtra, pearl millet occupies an area of 0.50 million hectares producing 0.31 million tonnes with productivity of 623 kg/ha (Anonymous, 2017-18).

Pearl millet is a “high-energy” cereal that contains carbohydrates, protein, and fat rich in vitamins B and A, high in calcium, iron and zinc also contains potassium, phosphorus, magnesium zinc copper and manganese. Other than grain, the forage and stover is an important secondary product that can be used as animal feed and fuel.

Pearl millet is a tropical cereal and most drought resistant crop extensively grown in the arid and semi- arid regions of the world (Fageria, 1992). Among the major cereals, pearl millet is highly tolerant to heat drought, to saline and acid soils and is easy to grow in arid regions where rainfall is not sufficient for maize or even sorghum (FAO, 2004).

Poor soil fertility and erratic rains are the most important limitations that affect crop production in arid and semi arid region. Among the different nutrients particularly nitrogen (N) and phosphorus (P) plays a vital role in increasing production and productivity of pearl millet. Nitrogen is so vital because it's the major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide. It also major component of amino acid, the building blocks of proteins. Phosphorous is a major nutrient required by pearl millet which positively stimulate the root development, increase stalk and stem strength, it improve the flower formation and grain production. Potassium is major nutrient required by pearl millet and which play important role in growth and development.

Plant spacing plays a vital role which significantly affects growth, development and yield of pearl millet. Optimum plant density ensures that plants grow properly with their aerial and underground parts by utilizing more sunlight and soil nutrients (Miah *et al.*, 1990). Closer spacing cause difficulties in intercultural operations in a densely populated crop, the inter-plant competition for nutrients, air and light is very high, which usually results in mutual shading, lodging and thus favours more straw yield than grain yield (Bhowmik *et al*.,2012). Vegetative development in pearl millet is much influenced by the availability of moisture (Mahalakshmi *et al.,* 1987), soil fertility and the planting density (Azam-Ali *et al.,* 1984). Plant density is a management variable that affects the production and quality of most crops (Shaw *et al.,* 2008). Though the optimal plant densities for pearl millet production differ among geographic regions, Crop potential yield may also be affected by intra-row spacing (Jones and Johnson, 1991). It has been reported that effects of plant population are not easily disentangled from within-row spacing differences (Obi, 1991).

## Materials and Methods

### Experimental site

The field experiment was conducted during *kharif* season of 2019-20, at Agronomy Section Farm, College of Agriculture, Latur (Maharashtra).

### Soil characteristics

The soil of experimental plot was medium and black in color with good drainage. The topography of experimental field was uniform and fairly leveled. The representative soil samples from 0 to 30 cm depth were taken from randomly selected plots all over the experimental field before laying out the experiment. A composite soil sample of about half kg was taken and analyzed for the determination of various physical and chemical properties of soil. The data showed that the soil of experimental plot was clayey in texture with chemical composition such as low in available nitrogen (124.6 kg $ha^{-1}$), medium in available phosphorous (17.3 kg $ha^{-1}$) and very high in available potassium (496.7 kg $ha^{-1}$). The soil was moderately alkaline in reaction having $p^H$ (7.7).

### Experimental details

The experiment was laid out in a Factorial Randomized Block Design with two factor combinations i.e. planting patterns and fertilizer grades, consisting three levels each of factors. The planting patterns were $P_1$ - planting at 45 x 15 cm, $P_2$ - paired row planting 30/60 x 15 cm, $P_3$ - paired row with furrow 30/60 x 45 cm and the fertilizer grades viz., $F_1$-40:20:20 NPK Kg $ha^1$, $F_2$ - 60:30:30 NPK Kg $ha^{-1}$, $F_3$ - 80:40:40 NPK Kg $ha^{-1}$. The treatments were replicated thrice.

## Seed and seed treatment

A popular pearl millet in the region, 86R32, which is light brown to greyish in colour released by Rising Sun Seeds Private Limited, Nagpur, Maharashtra, was used in the present study. The seeds were treated with *Azospirillum* @ 10 ml $kg^{-1}$, before sowing.

## Manures and fertilizers

As per treatments, half dose of nitrogenous fertilizers and full dose of phosphatic and potassic fertilizers was applied to the respective plots one day before sowing and remaining half dose of nitrogen fertilizer was applied as band placement method as top dressing one month after sowing.

The sources of nitrogen, phosphorus and potash were urea, single super phosphate (SSP) and murate of potash (MOP) respectively. The biofertilizer *azospirillum* obtained from the biofertilizers Production Unit, VNMKV, Parbhani was applied as seed treatment (10 ml $kg^{-1}$) and seeds were dried under shed one day before sowing.

## Sampling technique

One plant from each end of the rows and one row from both the sides were considered as border plants. The remaining plants were considered as plants from the net plot. Five plants were randomly selected from each net plot for recording periodic biometric observation.

The observations were recorded on these selected five plants from each plot as per treatment. Net plot was harvested separately for the yield calculation.

## Yield and economics

The yield recorded at net plot basis converted to hectare and expressed in kg $ha^{-1}$. The cost of cultivation for each treatment was worked out taking in prevailing market price of inputs.

Similarly gross returns were calculated based on prevailing market price of the produce. The net returns $ha^{-1}$ was calculated by deducting the cost of cultivation from the gross returns $ha^{-1}$ basis.

## Results and Discussion

The data on grain, fodder and biological yield (kg $ha^{-1}$) with harvest index (%) are presented in Table 1. The mean grain, fodder and biological yield with harvest index were 2110, 7508, 9596 kg $ha^{-1}$ and 21.95 per cent respectively.

## Grain yield

The data presented in Table 1 showed that the grain yield was significantly influenced by different planting patterns and fertilizer grades. Regarding the effect of planting pattern**,** the significantly maximum grain yield 2324 kg $ha^{-1}$ was obtained with the paired row planting with furrow 30/60 cm x 15 cm. It was found significantly superior than planting at 45 cm x15 cm and at par to paired row planting 30/60 cm x 15 cm.

Regarding the effect of fertilizer grades, Application of 80:40:40 kg NPK $ha^{-1}$ produced higher seed yield (2255 kg $ha^{-1}$) as compare to lower grades of fertilizer. This treatment was found significantly superior than 40:20:20 kg NPK $ha^{-1}$and at par with 60:30:30 kg NPK $ha^{-1}$. Though the effect of interaction in grain yield was found non significant as influenced by different interactions.

**Fodder yield (kg ha$^{-1}$)**

The data on fodder yield is presented in table 1. It was significantly influenced by different planting patterns and fertilizer grades. Regarding the effect of planting pattern**,** the maximum fodder yield (7979 kg ha$^{-1}$) was produced due to paired row planting with furrow 30/60 cm x 15 cm.

It was found significantly superior than planting at 45 cm x15 cm and at par to paired row planting 30/60 cm x 15 cm.

Regarding the effect of fertilizer grades, significantly higher fodder yield 7815 kg ha$^{-1}$ was received by the application of fertilizer grade of 80:40:40 kg NPK ha$^{-1}$.

This treatment was found significantly superior than 40:20:20 kg NPK ha$^{-1}$ and at par with 60:30:30 kg NPK ha$^{-1}$. Though the effect of interaction in fodder yield was found non significant.

**Biological yield (kg ha$^{-1}$)**

Data on biological yield as affected by different treatment is presented in Table 1. Regarding the effect of planting pattern, the higher biological yield (10303 kg ha$^{-1}$) was obtained due to paired row planting with furrow 30/60 cm x 15 cm. It was found significantly superior than planting at 45 cm x15 cm and at par with paired row planting at 30/60 cm x 15 cm.

Regarding the effect of fertilizer grades, maximum biological yield (10070 kg ha$^{-1}$) was produced due to application of 80:40:40 kg NPK ha$^{-1}$ which was found at par with 60:30:30 kg NPK ha$^{-1}$ and significantly superior than 40:20:20 kg NPK ha$^{-1}$. Though, the effect of interaction in biological yield was not evident.

**Harvest index (%)**

Data regarding harvest index (%) as affected by different planting patterns and fertilizer grades are presented in Table 1. Regarding the effect of planting pattern, the data on harvest index revealed that the highest harvest index (22.56 %) was observed due to paired row planting with furrow 30/60 cm x 15 cm**.** Regarding the effect of fertilizer grades, the maximum harvest index (22.40 %) was observed with the application of 80:40:40 kg NPKha$^{-1}$ fertilizer grade.

**Economics of pearl millet cultivation**

The data on GMR, cost of cultivation, NMR and B: C ratio is presented in Table 2. The mean GMR, cost of cultivation, NMR and B: C ratio recorded as Rs. 35865, Rs. 27754, Rs. 35865 ha$^{-1}$and 1.29 respectively.

**Gross monetary return (**Rs. **ha$^{-1}$)**

Data pertaining to the gross monetary return (GMR) as influenced by various treatments are presented in Table 2. Regarding the effect of planting pattern, the on gross monetary returns (GMR) was found significant. The maximum gross monetary return (Rs. 39510 ha$^{-1}$) was received from paired row planting with furrow 30/60 cm x 15 cm. It was found significantly superior than planting at 45 cm x15 cm and at par to paired row planting 30/60 cm x 15 cm. Regarding the effect of fertilizer grades, the highest GMR (Rs. 38340 ha$^{-1}$) was recorded by the application of 80:40:40 kg NPK ha$^{-1}$ which was found significantly superior over 40:20:20 kg NPK ha$^{-1}$ and remained at par with 60:30:30 kg NPK ha$^{-1}$. Though, the effect of interaction in the gross monetary returns obtained from interaction between different planting patterns and fertilizer grades did not differ significantly.

**Table.1** Grain, fodder and biological yield, with harvest index (HI) as influenced by different treatments

| Treatments | Grain yield (kg $ha^{-1}$) | Fodder yield (kg $ha^{1}$) | Biological yield (kg $ha^{-1}$) | HI (%) |
|---|---|---|---|---|
| **A) Planting pattern (P)** | | | | |
| **$P_1$ - Planting at 45 cm X 15 cm** | 1849 | 7057 | 8839 | 20.92 |
| **$P_2$ - Paired row planting 30/60 cm X cm** | 2156 | 7490 | 9646 | 22.35 |
| **$P_3$ - Paired row planting with furrow30/ 60 cm X 15 cm** | 2324 | 7979 | 10303 | 22.56 |
| **SE±** | 82 | 221 | 239 | _ |
| **CD at 5%** | 245 | 663 | 716 | _ |
| **B) Fertilizer grades (F)** | | | | |
| **$F_1$ - 40:20:20 NPK kg $ha^{-1}$** | 1921 | 7015 | 8936 | 21.49 |
| **$F_2$ - 60:30:30 NPK kg $ha^{-1}$** | 2153 | 7695 | 9782 | 22.01 |
| **$F_3$ - 80:40:40 NPK kg $ha^{-1}$** | 2255 | 7815 | 10070 | 22.40 |
| **SE±** | 82 | 221 | 239 | _ |
| **CD at 5%** | 245 | 663 | 716 | _ |
| **C) Interaction (P X F)** | | | | |
| **SE±** | 142 | 383 | 497 | _ |
| **CD at 5%** | NS | NS | NS | |
| **General mean** | 2110 | 7508 | 9596 | 21.95 |

**Table.2** Gross monetary return, cost of cultivation (COC), net monetary return and B:C as influenced by different treatments

| Treatments | GMR (Rs. $ha^{-1}$) | COC (Rs. $ha^{-1}$) | NMR (Rs. $ha^{-1}$) | B:C Ratio |
|---|---|---|---|---|
| **A) Planting pattern (P)** | | | | |
| **$P_1$ - Planting at 45 cm X 15 cm** | 31431 | 27587 | 3844 | 1.14 |
| **$P_2$ - Paired row planting 30/60 cm X 15 cm** | 36654 | 27587 | 9067 | 1.33 |
| **$P_3$ - Paired row planting with furrows 30/60 cm X 15 cm** | 39510 | 28087 | 11423 | 1.41 |
| **SE±** | 1392 | _ | 1392 | _ |
| **CD at 5%** | 4173 | _ | 4173 | _ |
| **B) Fertilizer grades (F)** | | | | |
| **$F_1$ - 40:20:20 NPK kg $ha^{-1}$** | 32650 | 26925 | 5725 | 1.21 |
| **$F_2$ - 60:30:30 NPK kg $ha^{-1}$** | 36604 | 28420 | 8184 | 1.29 |
| **$F_3$ - 80:40:40 NPK kg $ha^{-1}$** | 38340 | 27916 | 10424 | 1.37 |
| **SE±** | 1392 | _ | 1392 | _ |
| **CD at 5%** | 4173 | _ | 4173 | _ |
| **C) Interaction (P X F)** | | | | |
| **SE±** | 2411 | _ | 2411 | _ |
| **CD at 5%** | NS | _ | NS | _ |
| **General mean** | 35865 | 27754 | 8111 | 1.29 |

**Net monetary return (Rs. ha$^{-1}$)**

The data on net monetary return as influenced by various treatments are presented in Table 2. Regarding the effect of planting pattern, the maximum net monetary return (Rs. 11423 ha$^{-1}$) was obtained by from paired row planting with furrow 30/60 cm x 15 cm. It was found significantly superior than planting at 45 cm x15 cm and at par to paired row planting 30/60 cm x 15 cm.

Regarding the effect of fertilizer grades, higher NMR (Rs. 10424 ha$^{-1}$) was received due to application of fertilizer grade of 80:40:40 kg NPK ha$^{-1}$. This treatment was found significantly superior than fertilizer grade of 40:20:20 kg NPK ha$^{-1}$ and statistically on par with 60:30:30 kg NPK ha$^{-1}$. Though, the effect of interaction in net monetary return, none of the interaction was found significant.

**Benefit: cost (B: C)**

Data in respect to B: C was presented in Table 2. Regarding the effect of planting pattern, the highest Benefit: cost ratio (1.41) was noticed due to paired row planting with furrow 30/60 cm x 15 cm. Whereas lowest B:C ration (1.14) was due to under planting at 45 cm x15 cm. Regarding the effect of fertilizer grades, the maximum B:C ratio (1.37) was obtained by the application of 80:40:40 NPK kg ha$^{-1}$ and lowest (1.21) B:C ratio received due to 40:20:20 NPK kg ha$^{-1}$.

**Effect of planting pattern**

Grain yield, fodder yield and biological yield was significantly influenced by various planting pattern. The maximum grain yield (2324 ha$^{-1}$), fodder yield (7979 kg ha$^{-1}$) and biological yield (10303 kg ha$^{-1}$) was observed by paired row planting with furrow 30/60 cm X 15 cm.

The result might be associated with more number of leaves and trapping of more sunlight that enhanced rate of photosynthesis and resulted much dry matter production assimilate in fruit (grain) of the plant at reproductive stage. These results are in conforming to the result of Kumar *et al.,* (2018) Radhakumari *et al.,* (2016).

Gross return is a function of production per unit area and price of the produce. The data on gross monetary returns (Rs. ha$^{-1}$), net monetary returns (Rs. ha$^{-1}$) and B: C ratio (%) revealed that paired row planting with furrow 30/60 cm x 15 cm gave higher gross monetary returns (Rs. 39510 ha$^{-1}$), net monetary returns (Rs. 11423 ha$^{-1}$) and benefit: cost ratio (1.41). The lowest B: C ratio was recorded by planting at 45 cm x15 cm (1.14). This may be under higher economic yield produced due to paired row planting with furrow 30/60 cm x 15 cm. Similar trends were showed by Kumar *et al.,* (2018), Rathore *et al.,* (2007) and Parihar *et.al*., (2010).

**Effect of fertilizer grades**

The application 80:40:40 kg NPK ha$^{-1}$ produced significantly higher grain yield (2255kg ha$^{-1}$), fodder yield (7815 kg ha$^{-1}$) and biological yield (10070 kg ha$^{-1}$). This might be cumulating effect in increasing growth contributing characters have been clearly exhibited on the final produce i.e. grain and fodder yield ha$^{-1}$. Similar results were reported by Kumari *et al.,* (2017), Yadav *et al.,* (2019), and Singh *et al.,* (2019).

Data pertaining to gross monetary returns, net monetary returns and B: C ratio was found significantly superior with 80:40:40 kg NPK ha$^{-1}$ than lower levels of fertilizer. Significantly maximum values of GMR, NMR and B: C ratio was Rs. 38340 ha$^{-1}$, Rs. 10424 ha$^{-1}$ and 1.37 respectively. This might be due to higher economic yield due to application of 80:40:40 kg NPK ha$^{-1}$ lead to got highest economic benefit from crop. This report is in conformity with finding of Bhuva *et al.,* (2018), Sagar *et al.,* (2017) and Kumar *et al.*, (2018).

## Interaction effect

It was revealed from the data on mean length of ear head (cm), breath of ear head, weight of ear head, test weight, grain yield plant$^{1}$, effective tiller plant$^{-1}$, grain yield (kg ha$^{-1}$), fodder yield, biological yield were not significantly influenced due to the interaction between planting pattern and fertilizer grades**.** The interaction between planting pattern and fertilizer grades did not affect significantly GMR and NMR.

## Conclusion

Higher economic return were received due to planting pattern of paired row planting with furrow 30/60 cm X 15 cm and Fertilizer grade of 80:40:40 NPK kg ha$^{-1}$.

## Acknowledgement

The authors gratefully acknowledge the College of Agriculture, VNMKV, Latur, Maharashtra, who permitted to carry out this research work by using all the facilities available.

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**How to cite this article:**

Harsha V. Bangar, Rohit Y. Karde and Nikita R. Lokhande. 2020. Yield and Economics of Pearl Millet (*Pennisetum glaucum* L.) as influenced by Integrated Nutrient Management under Different Planting Pattern. *Int.J.Curr.Microbiol.App.Sci.* 9(12): 29-36.
doi: https://doi.org/10.20546/ijcmas.2020.912.006