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Original Research Article

Effect of Farm Yard Manure and Nitrogen on Growth and Yield of Pearl Millet under Custard Apple Based Agri-Horti System

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Keywords

Pearl millet, FYM, Nitrogen; Growth; Yield; Custard apple

A B S T R A C T

A field experiment was conducted at Rajiv Gandhi South Campus (Banaras Hindu University), Barkaccha, Mirzapur during the 2018 kharif season to evaluate the effects of farm yard manure and nitrogen on the production of pearl millet under the agri-horti system. The experiment was laid out according to factorial randomized block design with three replication, comprised with three FYM level (control, 10 and 15 ton ha^{-1}) and four different rates of nitrogen (control, 50, 80 and 110 kg ha^{-1}), respectively. The result showed that higher plant height, number of internode $plant^{-1}$, length of internode, number of tillers $plant^{-1}$, dry matter accumulation, panicle length, girth of panicle, number of grain $panicle^{-1}$, test weight, grain, Stover and biological yield were recorded highest with 15 tonnes FYM ha^{-1} and 110 kg N ha^{-1} as compared to control.

Introduction

Pearl millet (*Pennisetum glaucum* L.) is one of the essential cereal crops is grown in arid and semi-arid regions of the world, where moisture is a limiting factor for crop growth development. It is a rapidly growing short-term crop with a high potential for biomass production, quick growing crop with good salinity tolerant characteristics, so it has an advantage in salt-affected regions over other cultivated fodder (Makarana *et al.,* 2016). It is the only cereal crop that has the potential to produce a good yield while reacting to high management conditions at the same time. It is the fifth largest commonly cultivated cereal grain crop in India, next to rice, wheat, maize and sorghum (Yadav *et al.,* 2014). In our region, it is cultivated mainly in Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. Rajasthan is the first country's and produces 4.85 million tonnes with an average productivity of 890 kg / ha from the 4.09 m ha area (Anonymous, 2016-17). The grain of Pearl millet is more nutritious and contains 11-19% protein, iron 8.8%, 69.4% carbohydrates and 3.0-4.6% fat and has a good amount of phosphorus and iron (Reddy *et al.,* 2016). Among the major cereals, pearl millet is highly resistant of heat and drought, saline and acidic soils, and simple to grow in arid regions where maize or even sorghum do not have sufficient rainfall (FAO, 2004). India produces over half the world's pearl millet and contributing 42% of total world production (FAO, 2006). Pearl millet is the richest sources of nutrition, especially iron, calcium and zinc among cereals and hence can provide all the nutrients at the least cost compared to wheat and rice (Parthasarathy *et al.,* 2006).

Nitrogen is considered as most important mineral for the production of cereal crops. It has the greatest impact on the growth of plants. Adequate N is required for the development of leaves and tillers and also enables the plant to operate at peak photosynthetic capacity. N is the major nutrient required by pearl millet and variable growth and yield response to N application has been demonstrated. In general, pearl millet has been recognized for cultivation under low N management (Gascho *et al.,* 1995). It is the main components of protein and nucleic acid that supports the synthesis of protoplasm in plant body, promotes photosynthesis, plant size, contributing characteristics of yield and crop yield (Meena *et al.,* 2012).

Farm yard manure refers to the decomposition of farm animals such as mixture of dung and urine along with litter and left over roughage or fodder material fed to the cattle. There is 0.5% N, 0.2% P_2O_5 and 0.5% K_2O in the decomposed farmyard manure. FYM has improved the N-use productivity of the crop and the status of organic carbon, available N, P and trace elements in the soil. FYM also enhance the physical state of the soil (Laxmansinh *et al.,* 2016). FYM is used as a major source of organic manure in field crops. FYM transforms inaccessible soil nutrients into usable form and thus the nutrient requirement can be reduced to medium to high levels of available nutrient status (Lakum *et al.,* 2011). FYM is a well-recognized, balanced, bulky organic manure that enhances soil moisture retention and helps to dissolve nutrients (Bama *et al.,* 2017). In addition to its own nutrient content, the role of the FYM in mineralization is applied nutrients through fertilizers improved the available nutrient pool of the soil after harvesting. Due to the addition of FYM incorporated with other nutrients, favorable conditions for microbial and chemical activities increased nutrient mineralization and consequently the usable nutrient status of the soil (Vasanthi *et al.,* 1999).

It is also recognized that FYM helps to minimize soil pH to some degree by generating organic acids while decomposing them, which may also be the reason for greater nutrient availability and mobility, mainly of micronutrients. This may also have contributed to additional nutrient uptake by plants (Singh *et al.,* 2005). This indicates that the potential use of farmyards manure to maintain the soil fertility.

Agri-horti-system is an enhanced cropping method in which the optimum use of natural resources and it also gives more income to the farmer per unit area of land than pure agriculture (Singh *et al.,* 1987). Biomass production from trees in the agroforestry system sufficiently compensates for crop loss due to tree competition. The land equivalent ratio of land use in agroforestry is comparable to, or even better than, mono-cropping systems that indicate the suitability of the system (Narain *et al.,* 1998). The main effects of tree-crop interactions are complementary (e.g. increased productivity, improvement of soil fertility, nutrient cycling, improvement of microclimate and sustainability) and competitive (decrease of crop components in different systems due to tree components) (Nawaj *et al.,* 2005). The interspaces of the fruit trees have enough scope to exploit during the initial 5-6 years viz. custard apple, guava and aonla for growing arable crops. Studies at Jhansi have also shown that interspaces of custard apple orchards may be used during the initial stage of the establishment of fruit trees by intercropping grain and fodder crops (Gill and Gangwar, 1992). To keep above view in this study was undertaken to evaluate the effect of Farm yard manure and Nitrogen on growth and yield of pearl millet under custard apple based agri-horti system.

Materials and Methods

Experimental site

The field experiment was conducted during *kharif* season five consecutive years from 2018 - 19 to study the effect of Farm yard manure and Nitrogen on growth and yield of pearl millet under custard apple based agri-horti system at Agronomy Farm of Rajiv Gandhi South Campus, Barkachha (BHU), Mirzapur which is situated in Vindhyan region (25 10 ' latitude, 82^0 37 ' longitude and 427 (MSL) occupying more than 1000 ha of land where crops such as agricultural, horticultural, medicinal and aromatic plants are cultivated. The climate of Barkachha is usually semi-arid, characterized by high temperature in both summer and winter with low rainfall and moderate humidity. Maximum summer temperature is up to 39.85°C and the minimum winter temperature falls below 7.04°C.

Soil analysis

From the experimental plot, the soil samples were collected and then air-dried and sieved to prepare a mixed soil sample using a 2 mm sieve.

The soil of the experimental field was sandy clay loam in texture and classified as Typic Ustochrepts, 50.4, 19.38, 21.93% sand, silt, clay respectively, organic carbon 0.36%, slightly acidic in reaction pH 5.9 with normal electrical conductivity (0.27 dS m^{-1}), available N 187.26 kg ha^{-1}, and available Zn 0.40 ppm.

Experimental design and treatment

The experiment was laid out factorial randomized block design with two factors and replicated thrice. There were 12 treatment combinations comprising 3 FYM level *viz*. 0 (control), 10 and 15 tonnes ha^{-1} and 4 levels of nitrogen *viz*. 0 (control), 50, 80 and 110 kg ha^{-1}. The fertilizer application was done with full dose of K and P fertilizer was applied as a basal before sowing to each plot. FYM and Nitrogen application was done according to the treatments. In two equal splits, i.e. half at sowing and half at three weeks after sowing, full nitrogen dose was applied. FYM was applied as per treatment 10 and 15 ton ha^{-1} before sowing of pearl millet.

The "Mammoth" custard apple was planted at a distance of 5 m × 5 m. Pearl millet variety (Crystal Dhoom) was sown on 14 August 2018 in alleys of the custard agri-horti system. Plot size of custard agri-horti system with a gross plot size 5 m x 5 m and a net plot size 3.2 m x 4.4 m, respectively. The seed was manually sown in the furrow opened by kudal at a row spacing of 45 cm and plant to plant 15 cm after application of the fertilizer. For proper plant population maintenance, a relatively higher seed rate (5 kg ha^{-1}) was used. A plant spacing of 15 cm in the row was maintained by thinning approximately 21 days after seeding. Five plants were randomly selected from each plot and tagged to record the biometric observations. At an interval of 30 days, i.e. 30th, 60th, at harvest, the observations on growth attributes were recorded. Before and after harvesting, yield attributes and yield were recorded net plot was harvested separately as per treatment and the values were converted into hectare basis and expressed in kg.

Growth parameter i.e. plant height, internodal count (no. per plant), internodal length, number of tillers per plant, leaf area index, dry matter accumulation per plant and yield attributes i.e, number of panicle , length of panicle , girth of panicle , number of grain per panicle, test weight, harvest index and yield (grain and straw) were recorded at final harvest. The area of leaves of five plants was measured with the help of meter tape. Leaf area index (LAI) and crop growth rate (CGR) were calculated by using the following formula (Radford, 1967):

LAI= Leaf area plant/plant (cm^2)/Ground area plant^{-1}/ plant (cm^2)
CGR=W_2–W_1/T_2–T_1 g/plant/day

Where,
W_1 and W_2 are the dry weights recorded at time T_1 and T_2, respectively. T_1 and T_2 are time in days.

Stalks were cut at ground level and weighed after drying in the sun to assess Stover yield. The net return was calculated by deducting the overall cost of cultivation from the gross return of respective treatment. Statistically significance was tested by F-value at 0.05% level of probability and critical difference was worked out where ever the effect were significant. The observation recorded from the field experiment were subjected to statistical analysis of variance procedures as outlined for randomized block design factorial concept described by Gomez and Gomez *et al.,* (1984).

Results and Discussions

Plant height of pearlmillet at 30th, 60th and at harvest as shown in table 1. Plant height was steadily increased as crop age progressed to harvest, 110 kg ha^{-1} N through 15 tonnes FYM ha^{-1} showed higher plant height compared to their other treatment at 30th, 60th DAS and at harvest, regardless of treatment.

Growth attributes

Effect of FYM

FYM improves the physical condition of the soil, including water retaining capacity, soil hydraulic conductivity, and accessibility of N, P, K, increasing the growth of micronutrients from the plant and soil bedside that serve as a plant nutrient store. It may be due to the action of polysaccharides and other organic compounds released by FYM during the decomposition of organic matter. This accelerated the growth of new tissues and the development of new shoots, which eventually increased the height of the plant and the accumulation of dry matter. The findings of Kumar and Gautam (2004), Lakshmipathi *et al.,* (2012), Thumar *et al.,* (2016) confirm these results.

Effect of Nitrogen

Nitrogen is the main component of the protoplasm which is involved in various metabolic processes *viz.,* photosynthesis (Corsi *et al.,* 995), stimulation of cell division and elongation (Ali *et al.,* 2010). This contributes to an increase in the accumulation of dry matter, higher plant height and tillers per plant (Ayub *et al.,* 2009).

The height of the plant is controlled by the genetic composition of the species and the climate to which the plant is exposed during growth and development. Because of an improvement in cell number and cell size, this may have a beneficial impact on the growth character of nitrogen. Significant increase in plant height and tillers with higher nitrogen levels per plant in the pearl millet crop.

Maximum plant height was obtained when 110 kg N ha^{-1} of nitrogen was applied, which was statistically at par to all treatments other than 80 and 50 kg of nitrogen per hectare. Reddy *et al.,* (2016), Rajput *et al.,* (2008), Meena *et al.,* (2012), Prasad *et al.,* (2014) have also reported nearly similar results.

Maximum number of internodes (7.12 plant^{-1}) and internode length (18.16 cm) was observed with 110 kg N ha^{-1}. Due to the impact of nitrogen rates, this substantially increased number of internode plant^{-1} and internode length (cm) increases in increased all stages of crop development. In this point, it may be due to adequate nutrition supply in favourable conditions. This may have enabled the crop to optimize the use of available nutrients, which increased pearl millet vegetative growth and influenced the growth rate of crops.

Maximum dry matter accumulation (30.69 g plant^{-1}) was observed with 110 kg N ha^{-1}. Ultimately, growing the leafy portion due to higher rates of nitrogen application may have resulted in higher photosynthetic activities as well as further photosynthesis efficiency. The rapid supply of food-growing components could have helped increase growth and yield. The effect of nitrogen on raising the quantity and quality of chlorophyll, which affects the photosynthetic efficiency and the formation of other nitrogen compounds, could be related to a substantial increase in plant dry matter at various stages of growth due to increase in nitrogen levels. Singh *et al.,* (2000), Tiwana and Puri (2005), due to similar findings stated by Heringer and Moojen (2002).

Yield attributes

Effect of nitrogen

Nitrogen and FYM doses greatly affected the yield is shown in table 2. Yield attributes *i.e.* number of panicle plant^{-1}, length of panicle, girth of panicle, number of grain panicle^{-1}, grain weight panicle^{-1} and test weight. Significantly higher grain yield was obtained by the application of 110 kg N ha^{-1} and was statistically at par with 80 kg N ha^{-1}. This may be the explanation why, due to the highest levels of nitrogen, the test weight may increase due to improved grain filling resulting in bold seeds and therefore the highest test weight. Ali *et al.,* (2010) and Patel *et al.,* (2014) have also recorded the improvement of yield characteristics with a gradual rise in nitrogen levels.

Effect of FYM

FYM levels significantly influenced yield attributes, *viz.,* number of panicle plant^{-1}, length and girth of panicle, number and weight of grain panicle^{-1}. Application of 15 tonnes FYM ha^{-1} recorded significantly higher number of panicle length (22.43 cm), girth of panicle (9.30 cm), number of grain panicle^{-1} (1228.44), test weight (9.39 g) was statistically at par with 10 kg ton FYM ha^{-1}. Increased growth of FYM produced greater photosynthesis site and diversion of photosynthates towards sink (ear and grain) Khan *et al.,* (2000).

Grain yield, straw yield and biological yield

Effect of FYM

Application of 15 ton FYM ha^{-1} showed maximum grain yield, straw yield and biological yield as compare to other treatment. However application of 10 kg ton FYM ha^{-1} was statistically at par with application of 15 ton FYM ha^{-1}. The use of organic materials with better control results may be attributed to a balanced supply of major and micro nutrients and an improvement in soil water holding capacity of (Bana *et al.,* 2016). Due to the maximum plant nutrients available under this procedure, the positive impact of FYM concentrations retained a stronger source-sink relationship. This means the quantity of dry matter or photosynthates provided by source organs that are transferred to sink organs (economic component) and the yield of grain is increased. Thus, the comparable outcome stated by (Husain *et al.*, 2017).

Table.1 Effect of Farm yard manure and Nitrogen on growth attributes of pearl millet under custard apple based agri-horti system

Treatment	Plant height (cm)	No. of internode plant^{-1}	No. of tillers plant^{-1}	Dry matter (g plant^{-1})	Leaf area index
FYM rates (F)					
F_1	147.83	5.06	0.44	20.60	2.21
F_2	149.97	5.78	0.58	23.57	2.23
F_3	161.25	6.53	0.74	30.81	2.33
Nitrogen rates (N)					
N_1	118.77	4.00	0.19	19.83	1.82
N_2	143.14	5.78	0.52	21.29	2.18
N_3	161.44	6.26	0.77	28.16	2.33
N_4	177.66	7.12	0.89	30.69	2.70
FYM (F)	16.41	1.04	NS	5.89	NS
Nitrogen (N)	18.95	1.10	0.35	6.80	0.32
F×N	NS	NS	NS	NS	NS

Significant at 0.05 level, NS – non significant

Table.2 Effect of Farm yard manure and Nitrogen on yield attributes and yield of pearl millet under custard apple based agri-horti system

Treatments	Panicle length (cm)	Girth of panicle (cm)	No. of grain panicle^{-1}	Test weight (g)	Grain yield (kg h^{-1})	Stover yield (kg h^{-1})
FYM rates (F)						
F_1	18.61	8.15	910.97	7.44	1354.31	4584.46
F_2	21.86	8.72	1120.53	8.44	1581.26	4743.55
F_3	22.43	9.30	1228.44	9.39	1632.67	5181.14
Nitrogen rates (N)						
N_1	17.47	7.51	832.59	5.70	1276.08	4327.84
N_2	19.52	8.63	1039.04	8.56	1474.80	4892.36
N_3	22.71	9.16	1154.04	9.40	1570.04	5056.44
N_4	24.17	9.59	1320.93	10.02	1770.08	5068.44
FYM (F)	0.67	0.71	136.95	1.01	128.04	488.22
Nitrogen (N)	2.25	0.82	158.14	1.16	147.85	563.74
F×N	NS	NS	NS	NS	NS	NS

Effect of Nitrogen

Grain yield was significantly influenced by levels of nitrogen and maximum grain yield, straw yield and biological yield was recorded with 110 kg N ha^{-1} was found to be at par with 80 kg N ha^{-1}. This may be due to the fact that nitrogen being a major nutrient that increases in grain yield as well as improved root growth and development owing to all physicochemical processes impacted (Ayub *et al.* 2009). The improvement of yield characteristics with a steady rise in nitrogen levels was also reported by (Ali *et al.*, 2010).

Finding of the above experiment concluded that 15 tonnes FYM ha-1 most suitable and recorded maximum grain yield (1632.67 kg ha^{-1}), nitrogen (1.54 %), phosphorous (0.36 %) and potassium content (1.44 %) as well as BC ratio (1.82 %) under custard apple based Agri-horti system.

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