Original Research Article

EFFECT OF BIOFERTILIZER AND ORGANIC MANURE ON GROWTH AND YIELD OF PEARL MILLET (*Pennisetum glaucum* L.)

ABSTRACT

A field experiment was conducted during *kharif season* of 2021, at crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj in North Eastern plains of Eastern Uttar Pradesh. The ~~with the~~ objective ~~to~~of the research study was to determine the effect of Bio–fertilizer and Organic manure on growth and yield of Pearl millet ~~(*Pennisetum glaucum* L.)~~ under Randomized block design comprising of 9 treatments of which treatments with different combination of Bio–fertilizer like *Rhizobium* and VAM along with Organic manure like FYM and Vermicompost which were~~are~~ replicated thrice. The experimental results revealed that plant height (201.20 cm) and plant dry weight (50.05 gm) were recorded significantly highest in treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. The maximum number of ears/hill (2.43), number of grains/ear head (2157.33), grain yield (1973.00 Kg/ha), straw yield (3920 kg/ha) and harvest index (41.32%) were recorded with treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha.

Key words: *Growth, Economics, FYM, Pearl millet, Rhizobium, VAM, Vermicompost, Yield.*

Comment [FK1]: Give specific rhizobium strain that was used. Why use Rhizobium? Does millet fix nitrogen?

Formatted: Font: Italic

Comment [FK2]: Indicate probability level e.g plant dry weight (50.05gm were recored significantly (P<0.05) higher etc

Comment [FK3]: Include the recommendation to the pearl millet farmers on the best treatment to use

Formatted: Font: Italic

1. 0INTRODUCTION

Formatted: List Paragraph, Outline numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Font: (Default) Times New Roman, 12 pt, Bold

Pearl millet (*Pennisetum glaucum* L.) is the most widely grown drought tolerant warm season coarse grain cereal grown on 26 million ha in some of the harshest semi-arid tropical environments of south Asia and sub-Sahara Africa(indicate reference/citation). It is also consumed as feed and fodder for livestock. It is the sixth most important cereal crop in the world next to maize, rice, wheat, barley and sorghum. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. It occupies an area of 6.93 million ha with an average production of 8.61 million tones and productivity of 1243 kg/ha

during 2018-19 (Directorate of Millets Development, 2020; Project Coordinator Review, 2020). It excels all other cereals due to its unique features - C4 plant with high photosynthetic efficiency, high dry matter production capacity and is grown under the most adverse agro-climatic conditions where other crops like sorghum and maize fail to produce economic yields.

Pearl millet is rightly termed as "nutricereal" as it is a good source of energy, carbohydrate, protein, fat, ash, dietary fiber, iron and zinc. Its grain is more nutritious and the protein content is not only high but it is also of good quality(Reference/citation). The grain contains 11-19% protein, 60-78% carbohydrates and 3.0-4.6% fat and also has good amount of phosphorous and iron. It is fairly rich in fat content as compared to the other cereals. It has the maximum potential of all the millets and is mainly grown in drought prone areas and marginal soils. India is one of the largest producers of coarse cereals with as many as 10 predominantly rained crops, grown in diverse soils, climate and harsh environments. Pearl millet occupies fourth place in cereals and second place in coarse cereals and is the most widely cultivated millet next to jowar in India. (References?Citation)

Bio-fertilizer is microbial inoculants of selective microorganisms like bacteria, fungi already existing in nature. The importance of bio-fertilizer is increasing day by day especially in view of the increasing price of the chemical fertilizer and effect on soil physical condition. It also improves physico-chemical properties of soil and enhances the efficiency of applied fertilizers. Add more information too short paragraph

Azotobacter is one of the most important non-symbiotic N-fixing microorganisms. A large number of experiments conducted have shown a positive response of Azotobacter application in wide range of crops like cereals, vegetables, cotton, sugarcane etc. The benefits are due to its N-fixing capacity, ability to produce growth promoting substances and antifungal antibiotics, which inhibit the growth of root pathogens. Azotobacter is a free-living nitrogen fixing bacteria which has been reported to fix about 20 kg N/ha in nonlegumes (Subba Rao, 1982). It fixes elemental nitrogen into ammonical form (NH_4^+) which is being utilized by the crop. In addition to this, the ability of Azotobacter to synthesize auxins, vitamins, growth substances and antifungal antibiotics confer it with supplementary advantage. The nitrogen which is being fixed by the Azotobacter in soil near root zone (Rhizosphere) was absorbed by the roots that might have improved the growth

parameters of the crop (Rathore and Gautam, 2003; Kumar *et al*., 2012).

Azospirillum is benefit to plants by mechanisms related to enhancement of plant growth, increases the mineral uptake, increases the dry matter, improve the water absorption and improve the yield. The carrier based Azospirillum inoculant for non-leguminous crops are becoming increasingly popular in India in recent years. Azospirillum is a rhizosphere bacterium colonizing the roots of crop plants making use of root exudates and fixes substantial amount of atmospheric nitrogen. They exert beneficial effects on growth and yieldof many economically important crops (Okon and Vanderleyden, 1997).

The maintenance of soil organic matter is the problem in tropical countries like India, hence the application of organic residues is essential for the maintanence of fertility level. Soil organic matter plays an important role in ecosystem services (Loveland and Webb 2003) and in agronomic yields (Tiessen et al. 1994). Although the world is facing the challenge of climate change because of rapidly increasing CO2 in the atmosphere, accumulation of soil organic matter and hence C sequestration (Schlesinger 2000) have received attention since 1990s as a climate change mitigation option at global (FAO 2001) and regional scales (Smith 2004). Indeed, soil C sequestration is an important option not only to mitigate climate change but also to enhance soil fertility and all the productivity of agro-ecosystem (Dawea et al. 2003; Janzen 2006; Manlay et al. 2007).

FYM is being used as a major source of organic manure in field crops. Limited availability of this manure is, however an important constraint in its use as a source of nutrients. Farm yard manure refers to the decomposition mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle. FYM is rich in organic matter and is a good source of plant nutrients. Poor nutrient economy of light textured soil necessitates the need for supplementing fertilizer with FYM. Organic matter increases water holding capacity. Improvement in physical properties of soil, organic carbon and available nitrogen, phosphorus and potassium due to long term application of FYM and fertilizer has been documented by Babulkar et al., (2000). It is a store house of essential plant nutrients, affects soil physical, chemical and biological properties; provides energy material for the soil organisms; and plays a vital role for sustainable crop productivity. It also act as a sink for greenhouse gases between land surface and the atmosphere (Swarup, 2008).

Vermicompost has been advocated as good organic manure for use in integrated nutrient management practices in field crops. Now-a-days vermicompost is gaining more and

more importance as a substitute of other organic manure due to its comparatively higher nutrient concentration with quick, release of nutrients and which are available mostly to the current crop. It also take part in improving the physical condition of the soil. Vermicompost is an eco-friendly and an effective way to recycle agriculture and kitchen waste. It can also be called as biological manure and its application not only adds plant nutrients and growth regulators but also increases soil water retention, nutrient content and organic carbon content of the soil.

1.1 Objective

Indicate the objective of research study

Formatted: Outline numbered + Level: 2 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Indent: Left: 0.5"

2.0 MATERIALS AND METHODS

2.1 SITE SELECTION

A field experiment was conducted during kharif season of 2021, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25^{o} 24' 42" N latitude, 81^{o} 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of Bio fertilizer and Organic manure on growth and yield of Pearl millet (*Pennisetum glaucum* L.). The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Each treatment net plot size is 3m × 3m. The treatment are categorized as with recommended dose of nitrogen through urea and potash through Muriate of Potash, in addition with Phosphorus and zinc when applied in combinations as follows, T1 – Rhizobium @ 10 g/kg + FYM @ 5 t/ha, T2 – Rhizobium @ 10 g/kg + Vermicompost @ 5 t/ha, T3 – Rhizobium @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, T4 – VAM @ 10 g/kg + FYM @ 5 t/ha, T5 – VAM @ 10 g/kg + Vermicompost @ 5 t/ha, T6 – VAM @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, T7 – Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 5 t/ha, T8 - Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha, T9 – Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha.

2.2: Data Collection

The pearl millet crop was harvested treatment wise at harvesting maturity stage. Growth parameters viz. plant height (cm), dry matter accumulation g plant^{-1} were recorded manually on five randomly selected representative plants from each plot of each replication

separately and after harvesting, seeds were separated from each net plot and were dried under sun for three days. Later winnowed, cleaned and grain yield per ha was computed and expressed in tonnes per hectare. After complete drying under sun for 10 days stover yield from each net plot was recorded and expressed in kgs per hectare.

2.3: Data Analysis

The data was computed and analysed by following statistical method of Gomez and Gomez ~~(1984).~~ The benefit: cost ratio was worked out after price value of seed with straw and total cost included in crop cultivation.

Comment [FK4]: Too old reference please use most recent

RESULTS AND DISCUSSION

Comment [FK5]: In this section the researcher must include the propability tha was used in data analysis

Plant height (cm)

It is evident from Table-1 that plant height measured increased with advancement in crop growth. At harvest maximum plant height 201.20 cm was recorded with treatment *Rhizobium* @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. However, treatment Rhizobium @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, *Rhizobium* @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha are statistically at par to the treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. *Rhizobium* inoculation significantly enhanced the plant height, which could be attributed to increase in uptake of nutrients more specifically nitrogen. Availability of N increased the vegetative growth due to rapid cell multiplication. VAM has been related to increased uptake of nutrients, especially Phosphorus leading to increase in plant height. Increased availability of nutrients through vermicompost and FYM in the soil through mineralization of organic sources could have triggered cell elongation and multiplication resulting in higher growth rate of shoots in turn plant height of pearl millet in organic. Combinations of organics and inorganics ensured ready availability of nutrients at initial stages of crop due to improved soil properties and prolonged nutrient availability through organics also helped increase plant height. Similar findings were also reported by Narolia et al., (2011), Sharma et al., (2000), Kumar ajd Khangarot (2002).

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Dry matter accumulation

At Harvest plant dry weight (50.05 g/hill) was found to be significantly maximum in the treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha (49.49 g/hill). However, treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha was found to be statistically at par to the Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. Rhizobium and VAM significantly enhanced the plant dry weight, which could be attributed to increase in uptake of nutrients more specifically nitrogen. Availability of N increased the vegetative growth due to rapid cell multiplication, while phosphorus fertilization through VAM improved the root system which in turn helped more assimilation of nutrients resulting in increased plant dry weight. The improved physico -chemical properties due to Vermicompost and FYM increased availability of nutrients at a slow rate for a longer period with the use of organics might be responsible for more tillers, maximum leaf area and increased photosynthesis leading to accumulation of significantly higher dry matter. Similar findings were also reported by Narolia et al., (2011), Sharma et al., (2000), Kumar and Khangarot (2002).

Table 1. Effect of Bio fertilizer and Organic manure on growth parameters of pearl millet

S.No	Treatments	Plant height (cm)	Dry matter accumulation (g plant^{-1})
1.	Rhizobium @ 10 g/kg + FYM @ 5 t/ha	178.67	39.83
2.	Rhizobium @ 10 g/kg + Vermicompost @ 5 t/ha	183.57	40.93
3.	Rhizobium @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha	193.10	43.81
4.	VAM @ 10 g/kg + FYM @ 5 t/ha	176.70	38.14
5.	VAM @ 10 g/kg + Vermicompost @ 5 t/ha	180.63	41.55
6.	VAM @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha	190.20	42.86
7.	Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 5 t/ha	186.90	41.95
8.	Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha	196.17	46.93
9.	Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha	201.20	50.05
	SEm (±)	3.45	1.29
	CD (P 0.05)	10.33	3.86

Yield and Yield Attributes:

Number of ears/hill

Significant effect was observed by the statistical analysis of ear head length. Treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha resulted in significantly higher number of ears/hill (2.43). However, Rhizobium @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, VAM @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 5 t/ha, Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha were found to be statistically on par with Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. Increase in number of ears/hill was due to Rhizobium and VAM may be attributed to reason that Rhizobium enhanced nitrogen utilization efficiency along with enzymatic attributes, while VAM enhanced efficiency of nutrients absorption and release of growth substances which increased Number of ears/hill and Number of grains/ear. Vermicompost and FYM is cumulative effect of growth and vigor of plants which leads to increased supply of metabolites which have significant effect on growth character and yield attributes and also higher rate of photosynthesis as well as higher translocation of photosynthates from source to sink for the development. Similar results were also reported by Choudhary and Gautam (2007), Kumar et al., (2014), Anil kumar *et al.*, (2016).

Number of grains/ear head

Significant effect was observed by the statistical analysis of number of grains/ear. Treatment Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha recorded significant and highest number of grains/ear (2157.33). However, Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha recorded statistical parity with Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. Increase in number of grains per ear was due to Rhizobium and VAM may be attributed to reason that Rhizobium enhanced nitrogen utilization efficiency along with enzymatic attributes, while VAM enhanced efficiency of nutrients absorption and release of growth substances which increased Number of grains/ear. Vermicompost and FYM is cumulative effect of growth and vigour of plants which leads to increased supply of metabolites which have significant effect on growth character and yield attributes and also higher rate of photosynthesis as well as higher translocation of photosynthates

from source to sink for the development. Similar results were also reported by Choudhary and Gautam (2007), Kumar et al., (2014), Anil kumar *et al.*, (2016).

Grain yield

The grain yield showed increasing trend with the application of Bio fertilizer and Organic manure in pearl millet. Significant and highest grain yield (1973 kg/ha) was observed under Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. However, Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha was found to be statistically on par with Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. Application of Bio fertilizers like Rhizobium and VAM along with Organic manures like FYM and Vermicompost increased the soil fertility and availability of nutrients which might have resulted in increased translocation and production of photosynthates at the source. This production of photosynthates might have been utilized by the plants to increase yield. The increase amount of nutrients uptake might have promoted root enabling them to absorb more nutrients, thereby enhancing grain yield. Application of FYM and vermicompost released the macro and micro nutrient during the course of microbial decomposition. The increased yield in organic treatment through vermicompost can be attributed improved physical conditions of the soil apart from slow release of nutrients during entire crop growth period. The gradual release and steady supply of nutrients from vermicompost throughout the growth and development of plants could have maintained the photosynthetic efficiency and production of metabolites at higher level and later on the translocation of photosynthates to various sinks resulting into higher grain yield. Similar results were also reported by Choudhary and Gautam (2007), Kumar et al., (2014), Anil kumar *et al.*, (2016).

Stover yield

The straw yield of pearl millet was also influenced by the application of Bio fertilizer and Organic manure. Highest straw yield (3920 kg/ha) was recorded with Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, however, Rhizobium @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha, VAM @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha and Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha were found to be statistically on par with Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha. Application of Bio fertilizers like Rhizobium and VAM along with Organic manures like FYM and Vermicompost increased the soil fertility and availability of

nutrients which might have resulted in increased translocation and production of photosynthates at the source. This production of photosynthates might have been utilized by the plants to increase yield. The increase amount of nutrients uptake might have promoted root enabling them to absorb more nutrients, thereby enhancing straw yield. Application of FYM and vermicompost released the macro and micro nutrient during the course of microbial decomposition. The increased yield in organic treatment through vermicompost can be attributed improved physical conditions of the soil apart from slow release of nutrients during entire crop growth period. The gradual release and steady supply of nutrients from vermicompost throughout the growth and development of plants could have maintained the photosynthetic efficiency and production of metabolites at higher level and later on the translocation of photosynthates to various sinks resulting into higher straw yield. Similar results were also reported by Choudhary and Gautam (2007), Kumar et al., (2014), Anil kumar *et al.*, (2016).

Table 2. Effect of Bio fertilizer and Organic manure on yield and yield attributing characters of pearl millet

S. No	Treatments	Ear head length (cm)	No. of grains/ear head	Grain Yield (Kg ha^{-1})	Stover Yield (Kg ha^{-1})
1	Rhizobium @ 10 g/kg + FYM @ 5 t/ha	1.43	1848.00	1543.33	3530
2	Rhizobium @ 10 g/kg + Vermicompost @ 5 t/ha	1.77	1929.33	1669.67	3575
3	Rhizobium @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha	2.23	2019.33	1796.67	3761
4	VAM @ 10 g/kg + FYM @ 5 t/ha	1.20	1797.00	1505.00	3474
5	VAM @ 10 g/kg + Vermicompost @ 5 t/ha	1.67	1893.67	1633.33	3550
6	VAM @ 10 g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha	2.00	1985.33	1746.33	3726
7	Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 5 t/ha	1.90	1970.00	1700.67	3629
8	Rhizobium @ 5 g/kg + VAM @ 5g/kg + Vermicompost @ 5 t/ha	2.33	2115.00	1817.00	3850
9	Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha	2.43	2157.33	1973.00	3920
	SEm (±)	0.21	44.59	16.58	68.71
	CD (P 0.05)	0.63	133.68	49.71	205.98

CONCLUSION

Based on the findings of the investigation it may be concluded that treatment with Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha 25 kg N/ha + 50 kg P/ha performed exceptionally in all growth and yield parameters and in obtaining maximum grain yield of pearl millet. Hence, Rhizobium @ 5 g/kg + VAM @ 5g/kg + FYM @ 2.5 t/ha + Vermicompost @ 2.5 t/ha 25 kg N/ha + 50 kg P/ha may be more preferable and can be recommended to the farmers.

AUTHORS' CONTRIBUTIONS

ACKNOWLEDGMENT

COMPETING INTEREST

.

REFERENCES

Comment [FK6]: Include all the references and number them

Anil Kumar, L K Chugha, Dev Vart Yadav, R S Malika and L C Manoj Kumar (2016). Effect of farmyard manure, organic manure and balanced fertilizers application on the productivity and soil fertility in pearl millet (*Pennisetum glaucum*)- mustard. *Journal of Agricultural Sciences* **86** (2): 220–6.

Balachandar D and Nagarajan P (1999). Dual inoculation of vesicular arbuscular mycorrhiza and Rhizobium in green gram. *Legume Research* **22**(3): 177-180.

Bagla, G., Singh, L., Yadav, S.K. and Kumar, P. (2008). Effect of organic and inorganic sources of nutrient supply on growth and yield parameters of pearl millet. *Nantnl. J. Pl. Improv.* **10**(1): 37-39.

Bairwa, K., Dahiya, R., Kumar, P and Phogat, V.K. (2013). Effect of long term integrated nutrient management on soil properties, soil fertility, nutrient uptake and crop yields under pearl millet -wheat cropping system. *Research on Crops*. **14** (3):762-768.

Bana, R.S., Gautam, R.C and Rana, K.S. (2012). Effect of different organic sources on productivity and quality of pearl millet (Pennisetum glaucum) and their residual effect on wheat (Triticum aestivum). *Annals of Agricultural Research*. **33** (3):126-130.

Bandyopadhyay, K.K., Ghosh, P.K., Hati, K.M. and Misra, A.K. (2009). Effcient utilization of limited available water in wheat through proper irrigation scheduling and integrated nutrient management under different cropping system in a vertisols. *Journal of Indian Society of Soil Science* **57**(2), 121-128.

Behera, U.K., Pradhan, S. and Sharma, A.K. (2007). Effect of integrated nutrient management practices on productivity of duram wheat (triticum durum) in the vertisols of central India. *Annals of Plant and Soil Research* **9**(1), 21-24.

Choudhary, R., Yadav, L.R. and Parihar, S. (2015). Effect of vermicompost and fertility levels on growth and yield of pearl millet (Pennisetum glaucum L.). *Ann. of arid zone* **54** (1&2): 59-61.

Choudhary, R.S. and Gautam, R.C. (2007). Effect of nutrient-management practices on growth and yield of pearl millet (Pennisetum glaucum). *Indian J. of Agron.* **52**(1): 64-66.

Dubey, S.K., Tripathi, S.K. and Singh, B. (2013). Effect of sulphur and zinc levels on growth, yield and quality of mustard (Brassica juncea L.). *Journal of Crop Science and Technology* **2**(1):1-10.

Gopal, K., Kurothe, R.S., Brajendra., Vishwakarma, A.K., Rao, B.K and Pande V.C. (2014). Effect of farmyard manure and fertilizer application on crop yield, runoff and soil erosion and soil organic carbon under rainfed pearl millet (Pennisetum glaucum). *Indian Journal of Agriculture Sciences.* **84**(7):816-823.

Gupta, A.K. and Jain, N.K. 2008. Sulphur fertilization in a pearl millet (Pennisetum glaucum)- Indian mustard (Brassica juncea) cropping system. *Archives of Agronomy and Soil Science* **54**(5):533-539.

Jakhar, S.R., Singh, M. and Balai, C.M. (2006). Effect of Farmyard manure, phosphorus and zinc levels on growth, yield, quality and economics of pearl millet (Pennisetum glaucum). *Indian Journal of Agriculture Science*, **76**(1):58-61.

Kajila, M., Thakral, S.K. and Pahuja, S.S. (2006). Yield attributes and yield of wheat as affected by organic and inorganic sources of nutrition. *Haryana Journal of Agronomy*, **22**(1):85-87.

Kavimani R, Annadurai K, Vijayabaskaran S and Rangaraju G, (2001). Effect of farm yard manure and nitrogen on growth and yield of pearl millet under rainfed alfisol, *Madras Agricultural Journal*, **87**, 10-12, 713-714.

Khan, M.U., Qasim, M. and Khan, I.U. (2007). Effect of integrated nutrient management on crop yield in Rice-Wheat cropping system. *Sarhad Journal of Agriculture* **23**(4), 1019-1025.

Kumar, A. and Kumar, S. 2011. Production potential and economic analysis of Indian mustard var. Vardhan under different levels of nitrogen and sulphur. *Indian Journal of Agriculture Research* **45**(1): 65-70.

Kumar, G., Kurothe, R.S., Brajendra, V.A., Rao, B.K., and Pande, V.C. (2014). Effect of farmyard manure and fertilizer application on crop yield, runoff and soil erosion and soil organic carbon under rainfed pearl millet (Pennisetum glaucum). *Indian Journal of Agricultural Sciences* **84**(7),816-823.

Kumari, S., Singh, V., Choudhary, N., and Choudhary, p. (2017). Effect of organic and Inorganic sources of nitrogen and growth and yield of kharif pearl millet. *International Journal of Current Microbiology and Applied Sciences* 8, 769-782.

Kumawat P D and Khangarot S S (2002). Response of sulphur, phosphorus and Rhizobium inoculation on growth and yield of cluster bean [Cyamopsis trtragonoloba (L.)]. *Legume Research* **25**(4):276-278.

Maman, N. and Mason, S. (2013). Poultry manure and inorganic fertilizer to improve pearl millet yield in Niger. *African Journal of Plant Science* **7**(5), 162-169.

Nagaraju R, Haripriya K, Rajalingam G V, Sriramachandrasekharan V and Kader Mohideen M 2000. Effect of VAM on growth and yield of aggregatum onion (Allium cepa L.). *South Indian Horticulture* **48**(1-6):40-45.

Narolia, R.S., Poonia, B.L. and Yadav, R.S. (2009). Effect of vermicompost and inorganic fertilizers on productivity of pearl millet (Pennisetum glaucum). *Indian Journal of Agriculture Science*, **79**: 506-509.

Narolia, R.S. and Poonia, B.L. (2011). Growth dynamics, yield and economics of pearl millet (Pennisetum glaucum L.) as influenced by vermicompost and fertilizers. *Annals of Arid Zone* **50**(2), 145-149.

Neeraj and Verma A (1994). Cyamposis, vesicular arbuscular mycorrhizae and Rhizobium interaction studies. Mycorrhuzae: biofertilizers for the future. Proceedings of Third National Conference Mycorrhiza pp. 220-223.

Patel, P.R., Patel, B.J., Vyas, K.G and Yadav, B.G. (2014). Effect of integrated nitrogen management and bio – fertilizer in kharif pearl millet (Pennisetum glaucum L.). *Advance Research Journal of Crop Improvement.* **5**(2):122-125.

Patidar, M. and Mali, A.L (2004). Residual effect of farmyard manure, fertility levels and inoculation on growth, yield and quality of sorghum (Sorghum bicolor). *Indian Journal of Agronomy*, **49**: 117-120.

Pradeep, K., Rakesh S., Singh, A., Dinesh P and Sushil K. (2014). Integrated nutrient management in peral miller – Wheat cropping sequence in semi arid condition of India. *International Journal of Agriculture.***10**(1):96-1-1.

Pradeep Kumar, RajeevKumar, S.K. Singh and Anil Kumar (2014). Effect of fertility on growth yield attributes of pearl millet (Pennisetumglaucum L.) under rainfed condition. *Agri ways* **2**(2):89-93.

Rajput, S.C. (2008). Effect of integrated nutrient management of productivity and monetary returns of pearl millet (Pennisetum glaucum). *Research on Crops*, **9**(2): 248-250.

Ravi S., Channal, H.T., Hebsur, N.S., Patil, B.N. and Dharmatti, P.R. 2008. Effect of sulphur, zinc and iron nutrition on growth, yield, nutrient uptake and quality of safflower (Carthamus tinctorius L.). *Karnataka Journal of Agricultural Sciences* **21**(3):382-385.

Sattar, A., Mumtaz, A., Cheema, M.A., Wahid, M.F., Saleem and Hassan, M. 2011. Interactive effect of sulphur and nitrogen on growth, yield and quality of canola. *Crop and Environment* **2**(1):32-37.

Shailesh K, Mishra and Solanki R B 1996. Effect of Rhizobium inoculation, nitrogen and phosphorus on growth and seed yield of cowpea (Vigna Sinesis). *Indian Journal of Horticulture* **53**(3):220-224.

Sharma S, Upadhyay R G and Sharma C R 2000. Effect of Rhizobium inoculation and nitrogen on growth, dry matter accumulation and yield of black gram. *Legume Research* **23**(1):64-66.

Shilpashree, V.M., Chidanandappa, H.M., Jayprakash, R., and Punitha, B.C. (2012). Influence of integrated nutrient management practices and productivity of maize crop. **2**(1), 45-50.

Singh, B. (2003). Response of pearl millet [Pennisetum glaucum (L.) R. Br. Emend stunt] to vermicompost and fertilizer levels. M.Sc. (Ag.) Thesis, submitted to Rajasthan Agricultural University, Bikaner, Campus-Jobner.

Singh A P, Sumit Chaturvedi, Tripathi M K and Singh S (2004). Growth and yield of green gram (Vigna radiate L.) as influenced by bio fertilizer and phosphorus application. *Annals of Biology 20* (2):227-232.

Singh, G., Sekhon, H.S., and Kaur, H. (2012). Effect of farmyard manure, vermicompost and chemical nutrients on growth and yield of chickpea (Cicer arietinum L.). *International Journal of Agricultural Research* **7**(2), 93-99.

Srivastava T R and Ahlawat I P S (1995). Response of pea to phosphorus, molybdenum and bio fertilizers. *Indian Journal of Agronomy*, **40**(4):630-635.

Subbiah G and Rao P S S (1998). Effect of varying levels of phosphorus and nitrogen in combination with Rhizobium on post rainy season pigeon pea (Cajanus cajan L.). *The Andhra Agricultural Journal* **45**(1&2):61-64.

Tanwar S P S, Sharma G L and Chahar M S (2003). Effect of phosphorus and bio fertilizers on yield, nutrient content and uptake by blackgram. *Legume Research* 2691:39-41.

Thakur R N, Arya P S and Thakur S k (1999). Response of French bean varieties to fertilizer levels, Rhizobium inoculation and their residual effect on onion in mid hills on North-Western Himalayas. *Indian Journal of Agricultural Sciences* **69**(6); 416-418.

Wadile, S.C., Girase, P.P., Sonawane, P.D. and Chitodkar, S.S. (2009). Effect of different fertilizer levels on peral millet (Pennisetum glaucum L.) under rainfed conditions. *Bioinfolet* **6**(4): 334-335.

Yadav, N.D. and Beniwal, R.K. (2004). Response of pearl millet to N and FYM under rainfed condition. In human impact of desert evnvironment (Edited by Narain et al.) *Arid Zone research Association of India*, Jodhpur, pp. 276-279.