

**EFFECT OF FYM AND NITROGEN ON YIELD  
AND NUTRIENT STOICHIOMETRY OF PEARL  
MILLET (*Pennisetum glaucum* L.) UNDER *BAEL*  
(*Aegle marmelos* L.) BASED AGRI-HORTI SYSTEM**



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REQUIREMENTS FOR THE AWARD TO THE DEGREE OF  
**Master of Science (Agriculture)**  
in  
**Agroforestry**

Submitted by  
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## CERTIFICATE

To,

The Registrar  
Banaras Hindu University,  
Varanasi (UP) - 221005 (India).

Through: The Head, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi- 221005.

Dear Sir,

I have great pleasure in forwarding the thesis entitled “**Effect of FYM and nitrogen on yield and nutrient stoichiometry of pearl millet under bael based agri-horti system**” submitted by **Miss Rashmi Sweta Hembrom, I.D. No. AGF-15212, Enrolment No. 375667** in partial fulfillment of the requirements for the degree **Master of Science (Agriculture)** in **Agroforestry**.

I certified that the work has been carried out under my guidance and the data forming on the basis of this thesis, to the best of our knowledge are original and genuine and no part of the work has been submitted for any other degree or dissertation.

Thanking you.

Yours faithfully

Forwarded By

(Dr. S. K. Prasad)  
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HEAD

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*By*

*Rashmi Sweta Hembrom*

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---

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## **ABBREVIATIONS AND SYMBOLS USED**

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|                        |   |                                |
|------------------------|---|--------------------------------|
| <b>@</b>               | : | at the rate of                 |
| <b>°C</b>              | : | degree Celsius                 |
| <b>C</b>               | : | Carbon                         |
| <b>cm</b>              | : | Centimeter                     |
| <b>CD</b>              | : | Critical difference            |
| <b>Cv.</b>             | : | Cultivar                       |
| <b>d.f.</b>            | : | degree of freedom              |
| <b>DAS</b>             | : | Days After Sowing              |
| <b>dS/m</b>            | : | Deci Siemens/meter             |
| <b><i>et al.</i></b>   | : | and others                     |
| <b>Fig.</b>            | : | Figure                         |
| <b>g</b>               | : | Gram                           |
| <b>ha</b>              | : | Hectare                        |
| <b>i.e</b>             | : | that is                        |
| <b>K</b>               | : | Potassium                      |
| <b>kg</b>              | : | Kilogram                       |
| <b>m</b>               | : | Meter                          |
| <b>Max.</b>            | : | Maximum                        |
| <b>Mg</b>              | : | Milligram                      |
| <b>Mha</b>             | : | million hectares               |
| <b>Min.</b>            | : | Minimum                        |
| <b>mm</b>              | : | Milimeter                      |
| <b>N</b>               | : | Nitrogen                       |
| <b>NS</b>              | : | Non Significant                |
| <b>P</b>               | : | Phosphorus                     |
| <b>RDF</b>             | : | Recommended dose of fertilizer |
| <b>SE<sub>m</sub>±</b> | : | Standard error Mean            |
| <b>SMW</b>             | : | Standard meteorological week   |
| <b>t</b>               | : | Tonnes                         |
| <b>Viz.</b>            | : | Namely                         |

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## INTRODUCTION

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The declining trend in size of holding poses a serious challenge to the sustainability and profitability of the farming. The availability of land declined from 0.5 ha in 1950-51 to 0.15 ha by in turn of the century and projected a further decline to less than 0.1 ha by 2020 (Kachroo *et al.*, 2015). Under such alarming situations, the agroforestry, a land use systems is most suitable option to sustain and improve yield and income of farmers. The latest findings were in the favour of this system that has resulted drastic and produces quality based food and also enhanced quality crops and also improves soil conditions. Agri-horti , is an agroforestry system that provides an efficient land use and better economic return than the corresponding sole crop during the early phase of orchard establishment, and the interaction between the component is an complementary in nature and advantageous under rainfed condition. In agri-horti system, the short duration crops are intercropped with perennial fruit trees to make its best use of resources.

*Aegle marmelos* (L.) Corr. commonly known as Bael, belonging to the family Rutaceae, is a moderate-sized, slender, aromatic and indigenous tree of India. It contains eugenol, lupeol, citronellal, cuminaldehyde, marmelosin, psoralen, luvengetin, aurapten and marmelide as phytoconstituents. Among the other parts of bael tree, fruit is reported to be a valuable ayurvedic medicine for the chronic diarrhea and dysentery, tonic for a heart and brain, anti-viral activity and significant results against the parasites and antiproliferative activity. The leaves and twigs are lopped for the fodder. The bael fruit tree is a sub-tropical species. It grows well in swampy, alkaline or stony soils and grows luxuriantly in the soil having pH range from 5 to 8. In the semi-arid regions of India the main benefit of the alley cropping is fodder production during the dry season because mulching in alleys with hedgerow pruning does not consistently increase the crop production (Singh *et al.*, 1989).

The economic survival of a farming community of district Mirzapur (Vindhyan region) depends on the cultivation of short duration *kharif* crops under rainfed condition. Pearl millet is popularly grown in the region and also the fruit trees like guava and custard apple have been found promising under situation of Vindhyan region. Agri-horticultural system having a fruit crop tolerant to these stress conditions opens up an opportunity for the farmer to get more assured income. (ICAR Annual report 2008-09).

Pearl millet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz.] is an important millet crop and considered to be a poor man's food. *India* is the largest producer of the *pearl millet*, both in terms of area (~8.5 million ha) and production (~9.0 million tonnes) during 2009–10 to 2013–14 (*Agriculture Statistics*, GOI. 2014). It is the important food crop in areas with low rainfall and shallow soils, due to its short duration, and most drought-tolerant nature and widely grown in the arid and semi-arid regions of the world (Bhagavatula *et al.*, 2013). It is an imperative drought escaping cereal crop and often cultivated under the harsh condition such as frequent drought, high temperature, low and erratic rainfall and in fertile soils with the poor water holding capacity. Under erratic rainfall, moisture conservation practices plays a significant role in increasing the pearl millet productivity by economizing the use of rain water as well as boosting the use of nutrients and water. In rainfed areas, farmers usually apply low quantity of chemical fertilizers. Among the various reasons, less fertilization is also the main reasons for low productivity of pearl millet under rainfed condition.

Farmyard manure (FYM) is a decomposed mixture of dung and urine of farm animals along with their litter and the left over material from roughages or fodder fed to the cattle. It is considered as the organic source of nutrient. They are also a rich in micronutrients besides having plant growth promoting substances *viz.*, hormones, enzymes and humus forming beneficial microbes. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity which promote the growth and development of plants (Idan *et al.*, 2014)

Nitrogen is an essential element required for successful plant growth. Although inorganic nitrogen compounds (*i.e.*,  $\text{NH}_4^+$ ,  $\text{NO}_2^-$ , and  $\text{NO}_3^-$ ) account for less than 5% of the total nitrogen in soil (Brady *et al.*, 2008), they are the main form of the element absorbed by most plants. It promotes large leaf area index, long duration of photosynthesis, high nutrient uptake, and ultimately high crop productivity. Application of the nitrogen fertilizer provides a greater and prolonged availability of the nutrients to the crop (Bhuva *et al.*, 2015), (Lal *et al.*, 1993). Along with N, phosphorous (P) is another vital mineral nutrient influencing plant photosynthesis assimilation and biomass production (Ye *et al.*, 2014).

Inorganic and organic fertilizers are applied to maintain the nutritional condition of different cropping systems. For an organic agricultural system, continuous application of manure increases the nitrogen (N), phosphorus (P), potassium (K), calcium, and magnesium content in soil (Watts *et al.*, 2010). Once organic fertilizers are applied to soils and mineralization begins, inorganic nitrogen is released and absorbed by plants. However, the rate of mineralization is controlled by several factors, including agricultural management, microorganism, soil properties, temperature, and water content (Dessureault-Romppe, 2010), as well as the type of organic fertilizer. Many models have been developed to predict the release of the nitrogen in applied organic fertilizers (Dessureault-Romppe, 2010).

C, N and P are strongly coupled in their biochemical functioning and their balance generally affects crop production and food-web dynamics. To a date, C:N:P: stoichiometry has been widely applied in diverse ecological processes, and successfully incorporated into explain many phenomena at all levels of biology, from genes and molecules to whole organisms and even to the ecosystems and the biosphere. Some measurements have already been made on the spatio-temporal variations, biological regulation mechanisms and the ecological implications of C:N:P stoichiometric ratios in soil, plant and litter at different trophic levels on a regional, national and even global scale. So the elucidating changes in C:N:P ratios during a plant growth could be useful in calibrating the plant mechanistic models and in developing terrestrial biogeochemical models (Ye *et al.*, 2014).

The nature of interactions between the two components can be described on the basis of observable net effect of one component on another in a system, if the tree and crop components help each other, by creating favourable conditions for their growth in such a way that the agroforestry systems provides an efficient land use and better economic returns than the corresponding sole crops during early phase of orchard establishment, then the interaction between the components may be complementary in nature and advantageous. Under the rainfed condition and in poor water holding capacity of Vindhyan region soils, growing of short duration arable crops during *kharif* is the only option for most of the farmers.

Keeping these facts into consideration, the present investigation entitled "Effect of FYM and nitrogen on yield and nutrient stoichiometry of pearl millet under bael based agri-horti system and open field." was conducted with following objectives:

1. To study the effect of FYM and nitrogen levels on growth and yield of pearl millet under bael based agri-horti system and open field.
2. To study the effect of FYM and nitrogen levels on nutrient stoichiometry of pearl millet under bael based agri-horti system and open field.
3. To work out the economics of the treatments.



## **REVIEW OF LITERATURE**

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In this chapter, an effort has been made to present a concise and coherent picture on the advances made so far on various aspects related to the present investigation "Effect of FYM and nitrogen on yield and nutrient stoichiometry of pearl millet under bael based agri-horti system and open system." An attempt has been made in this chapter to review the literature embracing the relevant references related to different aspects of FYM and nitrogen fertilizer on pearl millet. This information is mostly from Indian situation in which the experiment was conducted. However, some foreign literatures have also been cited in order to get useful information regarding the present investigation under the appropriate heads.

### **2.1 Effect of FYM**

#### **2.1.1 Growth parameters**

Abd *et al.* (2011) observed that the five combination inorganic and organic fertilizers viz. T<sub>1</sub> (recommended NPK; 180:55:60 kg ha<sup>-1</sup>), T<sub>2</sub> (20 tons FYM ha<sup>-1</sup>), T<sub>3</sub> (25% of NPK + 15 tons FYM ha<sup>-1</sup>), T<sub>4</sub> (50% of NPK +10 tons FYM ha<sup>-1</sup>) and T<sub>5</sub> (75% of NPK + 5 tons FYM ha<sup>-1</sup>) were assigned to sub plots. Its results revealed that growth parameters and forage yield were significantly affected by the sowing dates and fertilization treatments. The interaction of sowing dates and fertilization treatments significantly affected on number of tillers plant<sup>-1</sup>, LA and green and dry forage yields ha<sup>-1</sup>. Pearl millet sown at 15-May (D<sub>2</sub>) and application of 75% of NPK + 5 tons FYM ha<sup>-1</sup> (T<sub>5</sub>) gave the highest values of green and dry forage yields ha<sup>-1</sup>, while the lowest were found for D<sub>3</sub>T<sub>2</sub>. Thus, a sowing date at mid-May with integrated use of mineral and organic fertilizers (75% of NPK + 5 tons FYM ha<sup>-1</sup>) is recommended with this study.

Narolia *et al.* (2011) observed the growth dynamics, yield and economics of pearl millet (*Pennisetum glaucum* (L.) R.Br. Emend Stunz) as influenced by vermicompost and fertilizers. The results revealed that plant height, dry matter accumulation, total

number of tillers at 40 DAS, yield attributes, physiological parameters, seed and stover yield, harvest index, nutrient uptake, net returns and B:C ratio increased significantly due to drilling of vermicompost @ 2 t ha<sup>-1</sup> over control, where as its drilling @ 1 t ha<sup>-1</sup> remained statistically at par with soil incorporation @ 2 t ha<sup>-1</sup>. Maximum and significantly higher growth parameters, yield attributes, physiological parameters, yield, HI, nutrient uptake, net return and B:C ratio were recorded due to application of 90 kg N + 45 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> as compared to control (N<sub>0</sub> P<sub>0</sub>).

Khandelwal *et al.* (2017) studied the effect of integrated nutrient management [100 % farmyard manure (T<sub>1</sub>), 100 % poultry manure (T<sub>2</sub>), 100 % vermi-compost (T<sub>3</sub>), 100 % RDF (T<sub>4</sub>), 50 % RDF + 50 % FYM (T<sub>5</sub>), 50 % RDF + 50 % Poultry Manure (T<sub>6</sub>), 50 % RDF + 50% Vermicompost (T<sub>7</sub>) and control (T<sub>8</sub>)] on growth and yield of pearl millet. It is seems to that, integrated nutrient management have better response and exhibited higher growth, yield attribute and yield of pearl millet over control treatment under guava based agri-horti system. Significantly highest plant height (205.67 cm), number of tillers plant<sup>-1</sup> (3.80), dry matter accumulation plant<sup>-1</sup> (159.77 g) were reflected with the application of under 50 % RDF + 50 % Poultry Manure (T<sub>6</sub>). This might be due to better nutrient supply.

### 2.1.2 Yield attributes and yield

Abd (2011) found that sowing of pearl millet on 15 May and 15 June, and application of 75% of NPK + 5 tons FYM ha<sup>-1</sup> (T<sub>5</sub>) gave the highest values of green and dry forage yields ha<sup>-1</sup>, over the rest of the treatment. Thus, a sowing date at mid-May with integrated use of mineral and organic fertilizers (75% of NPK + 5 tons FYM ha<sup>-1</sup>) is recommended for forage pearl millet under the conditions of this study.

Parihar *et al.* (2009) studied on crop productivity, quality and nutrient uptake of pearl millet and observed that integrated application of nutrients (30 kg N + 20 kg P<sub>2</sub>O<sub>5</sub> + farmyard manure@ 6 tonnes ha<sup>-1</sup>) significantly enhanced the grain and stover yield and total N and P uptake of pearl millet over the control, 30 kg N + 20kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and sole application of farmyard manure@ 6 tonnes ha<sup>-1</sup> and remained at par with 60 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through urea and single superphosphate in both the seasons.

Khandelwal *et al.* (2017) studied the effect of integrated nutrient management and found that, integrated nutrient management have better response and exhibited higher growth, yield attribute and yield of pearl millet over control treatment under guava based agri-horti system. Yield attributes such as diameter of the ear (6.99 cm), ear perimeter (10.92 cm), length of ear (24.63 cm), 1000-seed weight (9.43 g) and grain yield ( $22.40 \text{ q ha}^{-1}$ ), stover yield ( $56.71 \text{ q ha}^{-1}$ ) were recorded highest under 50 % RDF + 50 % Poultry Manure ( $T_6$ ) while, harvest index (31.48 %) was maximum in control ( $T_8$ ) and minimum (26.60%) in 100% vermicompost ( $T_3$ ). This might be due to release of essential nutrients by poultry manure and increase in availability of nutrients and moisture. Net return (Rs 50340.17) and B:C ratio (2.99) were higher in 50 % RDF + 50 % Poultry Manure ( $T_6$ ). Minimum net return was recorded with control (Rs 40756.67) and B:C ratio (1.63) was lower in 100 % vermi-compost under guava agri-horti system.

Husain *et al.* (2017) observed the suitable organic source for enriching soil health, increasing grain yield of pearl millet and residual effect of applied organic sources on chickpea yield under pearl millet-chickpea cropping system. eight organic sources. The application of  $7.5 \text{ t FYM ha}^{-1}$  gave significantly higher grain yield of pearl millet ( $1912 \text{ kg ha}^{-1}$ ). The lowest grain yield of pearl millet exhibited at control ( $1204 \text{ kg ha}^{-1}$ ). Significantly maximum seed yield of chickpea was recorded under residual effect of  $7.5 \text{ t FYM ha}^{-1}$  by  $1376 \text{ kg ha}^{-1}$ , while lowest yield noted at control ( $703 \text{ kg ha}^{-1}$ ). Application of  $7.5 \text{ t FYM ha}^{-1}$  gave higher pearl millet equivalent yield ( $6161 \text{ kg ha}^{-1}$ ), net return (Rs.  $31971 \text{ ha}^{-1}$ ) and BCR (1:4.48) in comparison to other tested source of organic manure.

### 2.1.3 Nutrient uptake

Parihar *et al.* (2009) observed that integrated application of nutrients ( $30 \text{ kg N} + 20 \text{ kg P}_2\text{O}_5 + \text{farmyard manure } 6 \text{ tonnes ha}^{-1}$ ) significantly enhanced the grain and stover yield and total N and P uptake of pearl millet over the control,  $30 \text{ kg N} + 20 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$  and sole application of farmyard manure  $6 \text{ tonnes ha}^{-1}$  and remained at par with  $60 \text{ kg N} + 40 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$  through urea and single superphosphate in both the seasons and recorded 33.5% higher mean grain yield over control.

Singh *et al.*, (2013) studied the effect of integrated nitrogen management nutrient uptake, quality, economics and soil fertility of pearl millet under rainfed conditions. Applications of 50% RDN through FYM + 50% through urea, 80% RDN through vermicompost + 20% through urea and 25% RDN through FYM + 75% through urea were found the most superior and equally effective treatments in terms of total uptake of nitrogen, phosphorus and potassium, protein content in grain, grain yield, net returns and B:C ratio. Significantly, higher total uptake of nitrogen ( $66.73 \text{ kg ha}^{-1}$ ), phosphorus ( $14.48 \text{ kg ha}^{-1}$ ) and potassium ( $97.16 \text{ kg ha}^{-1}$ ), protein content in grain (11.83%), grain yield ( $2.22 \text{ t ha}^{-1}$ ) net returns ( $11169 \text{ ha}^{-1}$ ) and B:C ratio (1.95) were recorded where 50% RDN through FYM + 50% through urea was applied. Whereas, application of 100% RDN through FYM was proved most superior treatment for improvement in post experiment soil fertility by increased soil organic carbon, N, P and K content.

#### 2.1.4 Nutrient stoichiometry of pearl millet

Gupta *et al.* (1996) studied the application of farm yard manure (FYM) is known to maintain soil productivity longer than inorganic fertilizers (Flaig, 1975). Farm yard manure contains all the macro- and micronutrients required for plant growth (Hesse, 1984), but its main effect is due to nitrogen, phosphorus, and potassium (Heck, 1931). Maintenance of organic matter in soil is important for the improving nutrient and structural status of soils, particularly under tropical conditions as in India (Acharya *et al.*, 1988; Gattani *et al.*, 1976). Apart from its nutritional role, FYM controls the dynamics of all the macro and micronutrients (Katyal, 1977; Stevenson, 1982). Therefore, a long-term field experiment was initiated in October, 1967 to study the savings in fertilizer N with the use of FYM in pearl millet-wheat cropping sequence.

Sadras (2006) observed the relationship between N uptake ( $N_u$ ) and P uptake ( $P_u$ ) for crops achieving maximum yield in each experiment was markedly non-linear. Functions of the form  $N_u = N_{\max} P_u / (P_u + P_u)$  described the way in which N:P stoichiometry scaled with grain yield. Maximum uptake of nitrogen ( $N_{\max}$ ) was similar for all three crop types ( $\approx 240 \text{ kg N ha}^{-1}$ ), but it was achieved via different avenues, i.e. high yield and low grain protein concentration for cereals compared to

lower yield and higher grain protein concentration in oilseed and legume crops. Phosphorus uptake at half  $N_{\max}$  ( $P_u$ ) ranged from 27 kg P ha<sup>-1</sup> for oilseeds to 14 kg P ha<sup>-1</sup> for legumes. The N:P ratio at was 4.5 for oilseed crops, 5.6 for cereals and 8.7 for legumes. For cereals and oilseeds, over 40% of crops attaining maximum yield had N:P ratios in a relatively narrow range between 4 and 6. Variation in grain protein concentration was a major source of instability in N:P ratios of legumes. Being at the base of agro-ecological food webs, the N:P stoichiometry of crops has implications for both decomposers and consumers, and stoichiometric concepts might be of interest in fertiliser management and modelling. Variability in N:P stoichiometry related to plant storage products, however, restricts its application.

Srivatsava *et al.* (2014) studied the fertilizer effect on pearl millet–wheat yield and plant-soil nutrients. The treatments differed significantly in influencing soil-plant nutrients and grain and straw yields of both crops. Grain yield had significant correlation with soil-plant N, P, K, S, and zinc (Zn) nutrients. The study indicated superiority of  $T_{11}$  for attaining maximum pearl millet grain yield (2885 kg ha<sup>-1</sup>) and straw yield (7185 kg ha<sup>-1</sup>); amounts of N (48.9 kg ha<sup>-1</sup>), P (8.8 kg ha<sup>-1</sup>), K (26.3 kg ha<sup>-1</sup>), S (20.6 kg ha<sup>-1</sup>), and Zn (0.09 kg ha<sup>-1</sup>) taken up; and amounts of soil N (187.7 kg ha<sup>-1</sup>), P (13.7 kg ha<sup>-1</sup>), K (242.5 kg ha<sup>-1</sup>), S (10.1 kg ha<sup>-1</sup>), and Zn (0.70 kg ha<sup>-1</sup>). Based on the study, 100% NPK + FYM at 10 tha<sup>-1</sup> + Zn at 25 kg ha<sup>-1</sup> + S at 25 kg ha<sup>-1</sup> could be recommended for attaining maximum returns of pearl millet–wheat under semi-arid Inceptisols.

## **2.2 Effect of Nitrogen**

### **2.2.1 Growth parameters**

Lakhana and Gupta (2005) studied the response of pearl millet to different levels of nitrogen (0, 30, 60 and 90 kg N ha<sup>-1</sup>) and thiourea application (control, seed soaking (500 ppm), foliar spray (1000 ppm), seed soaking plus foliar spray and foliar spray of urea (1000 ppm) and concluded that dry matter accumulation significantly increased with the application of 90 kg N ha<sup>-1</sup>, over the lower levels.

Verma *et al.* (2006) conducted a field experiment to evaluate the effects of different nitrogen (20, 40, 60 and 80 kg ha<sup>-1</sup>) and mulching treatments (dust mulch, mustard straw at 5 t ha<sup>-1</sup> and tephrosia straw at 5 t ha<sup>-1</sup>) on the growth and yield of pearl millet and revealed that application of N at 60 or 80 kg ha<sup>-1</sup> along with mulching of tephrosia straw recorded the highest values for the different growth (plant height, dry matter accumulation and number of tillers plant<sup>-1</sup>).

Alkaff *et al.*, (2007) reported that application of nitrogen fertilizer gave a significant increment on growth and yield attributes of Pearl millet (length, diameter and weight of spike, weight of grains spike<sup>-1</sup>, biological yield by plant and hectare grain yield plant<sup>-1</sup>, grain yield ha<sup>-1</sup>). Fertilizer application with 60 kg N ha<sup>-1</sup> gave the highest values, followed by 45 kg N ha<sup>-1</sup>. Both treatments did not significantly differ from each other. Application of biofertilizers and 45 kg N ha<sup>-1</sup> gave the highest mean values for most of the studied characteristics. Applying biofertilizers as Halex2 to pearl millet plants was reduced by approximately 25-50 % from the used N fertilizers.

Neto *et al.* (2010) conducted an experiment four nitrogenous manuring levels (0, 30, 60 and 120 kg ha<sup>-1</sup>) and different spacings (0.25, 0.35, 0.45 and 0.65 m) on plant size, biomass and dry mass in the production of millet (*Pennisetum glaucum* L.). They reported that biomass and dry mass production recorded maximum with highest nitrogen level (120 kg ha<sup>-1</sup>).

Ayub *et al.* (2009) observed the parameters like dry matter and crude fibre contents, plant height, forage yield, stem diameter, number of leaves and leaf area plant<sup>-1</sup> of pearl millet (*Pennisetum americanum* L.) were consistently increased up to final harvest. Higher yield of Pearl millet may be due to fertilization at the rate of 180 kg N ha<sup>-1</sup> and harvest it 60 days after sowing.

Silva *et al.* (2012) conducted an experiment with pearl millet (*Pennisetum glaucum*) cv. ADR-300 under nitrogen doses (0, 50, 100 and 150 kg ha<sup>-1</sup>) at two residual height cuts (0.20 and 0.25 m) and reported that the dry matter production (DMP) differed (P<0.05) among the N doses and cuts. Dry matter (DM) content decreased as N doses increased.

### 2.2.2 Yield attributes

Singh *et al.* (2006) conducted an experiment to determine the effect of levels (0 (control), 60, 120 and 180 kg ha<sup>-1</sup>) and time of nitrogen application on pearl millet hybrid HHB 94. The study revealed that the application of nitrogen significantly improved grain, stover and protein yields of pearl millet hybrid HHB 94. Split application of nitrogen played a significant role in increasing the grain and stover yields of pearl millet.

Verma *et al.* (2006) conducted a field experiment to evaluate the effects of different nitrogen (20, 40, 60 and 80 kg ha<sup>-1</sup>) and mulching on the growth and yield of pearl millet and reported that application of N at 60 or 80 kg ha<sup>-1</sup> and mulching with tephrosia straw reflected the highest values for yield attributes (number of effective tillers per 1 m row length, ear head length, grain weight and test weight) of pearl millet.

Singh *et al.* (2006) conducted a field experiment was conducted to study the effect of N levels on grain yield and nitrogen uptake and found significant improvement in the grain and stover yield with increasing levels of N application.

Khafi *et al.* (2007) conducted a field experiment with three nitrogen levels i.e. 60, 90 and 120 kg N ha<sup>-1</sup> and reported that fertilizing the summer pearl millet with 120 kg N ha<sup>-1</sup> exhibited beneficial effect on yield attributes and ultimately high productivity of summer pearl millet. He reported that application of 120 kg N ha<sup>-1</sup> produced significantly highest grain yield 4284 kg ha<sup>-1</sup> as well as fodder yield of 8151 kg ha<sup>-1</sup>.

Singh *et al.* (2009) conducted an experiment under different combinations of irrigation water and nitrogen fertilizer and reported that 1000 grain weight increased significantly with successive N levels, but the increment was pronounced only up to 40 kg N ha<sup>-1</sup> in rainfed and up to 120 kg N ha<sup>-1</sup> in irrigated treatment.

Yakadri and Reddy (2009) conducted a two years experiment to find the effects of different planting pattern and nitrogen levels on pearl millet. Among different levels of nitrogen, 80 kg ha<sup>-1</sup> was optimum as it gave significantly higher grain and stover

yield compared to 40, 60 kg N ha<sup>-1</sup> and at par yield with 100 kg N ha<sup>-1</sup> in both the years.

Singh *et al.* (2009) conducted an experiment under different combinations of irrigation water and nitrogen fertilizer and reported grain yield significantly varied with nitrogen application rates as compared to those plots that received no N. Mean yield in irrigated plots was also significantly higher than the unirrigated plots.

Jakhar *et al.* (2011) reported that with increasing levels of nitrogen up to 120 kg N ha<sup>-1</sup> grain and stover yield were increased and application of N as 50% basal+25% top dressing at 30 DAS+25% foliar spray at 45 DAS showed an increase in grains and stover yield as compared to other treatments except 50% basal+25% top dressing at 30 DAS+25% foliar spray at 60 DAS.

### 2.2.3 Economics

Khinchi *et al.* (2017) observed the treatments consist of five nitrogen levels viz. 0, 30, 60, 90 and 120 kg N ha<sup>-1</sup> and four zinc levels viz. 0, 15, 30 and 45 kg ZnSO<sub>4</sub> ha<sup>-1</sup>. The experiment was laid out in randomized block design (Factorial) with three replications. The results showed that maximum green fodder (196.61 and 184.21 q ha<sup>-1</sup>) and dry matter (33.36 and 29.33 q ha<sup>-1</sup>) yield of fodder pearl millet at first and second cut, respectively; and economics viz. net return (Rs. 57,117 ha<sup>-1</sup>) and B:C ratio (4.02) were recorded with 120 kg N ha<sup>-1</sup>. Further, Significant increase in green fodder (347.21 q ha<sup>-1</sup>) and dry matter (55.46 q ha<sup>-1</sup>) yields; and economics viz. net return (Rs. 50,700 ha<sup>-1</sup>) and B:C ratio (3.69) were obtained when the crop was fertilized with 30 kg ZnSO<sub>4</sub> ha<sup>-1</sup> compared with control and 15 ZnSO<sub>4</sub> kg ha<sup>-1</sup>.

Narolia *et al.* (2011) reported that growth dynamics, yield and economics of pearl millet (*Pennisetum glaucum* (L.) R.Br. Emend Stunz) as influenced by vermicompost and fertilizers. The maximum and significantly higher growth parameters, yield attributes, physiological parameters, yield, HI, nutrient uptake, net return and B:C ratio were recorded due to application of 90 kg N + 45 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> as compared to control (N<sub>0</sub>P<sub>0</sub>).

Reddy *et al.* (2016) conducted a field experiment was carried out with an objective to study the effect of nitrogen and potassium on yield and quality of pearl millet during kharif season. It was concluded that for higher production with good quality grain, pearl millet crop has to be supplied with  $100 \text{ kg N ha}^{-1} + 30 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1} + 40 \text{ kg K}_2\text{O ha}^{-1}$  (T<sub>7</sub>). However, for optimum and economic production, pearl millet has to be supplied with  $100 \text{ kg N ha}^{-1} + 30 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1} + 20 \text{ kg K}_2\text{O ha}^{-1}$  (T<sub>4</sub>).

#### 2.2.4 Nutrient concentration and uptake.

Swamy *et al.* (1993) conducted a field trial on two hybrid varieties of pearl millet (ICMH 451 and Visakha Composite) with nitrogen levels and reported that N uptake was increased with increasing N rate.

Heringer and Moojen (2002) investigated different levels of nitrogen (0, 250, 300, 450 and 600 kg ha<sup>-1</sup>) on pearl millet and reported that crude protein of stem and dead material showed positive linear relations with nitrogen levels from top to base of pasture and for leaf blade until 30 cm height.

Jakhar *et al.* (2003) observed that the application of  $120 \text{ kg N ha}^{-1}$  significantly increased the crude protein and crude fibre content in fodder pearl millet (*Pennisetum glaucum*) at both cuttings as compared to 60 and 90 kg N ha<sup>-1</sup> and he also reported that increasing levels of nitrogen upto  $120 \text{ kg ha}^{-1}$  increased the N content of fodder at both cuttings as well as total N uptake significantly.

Dalal *et al.* (2005) conducted an field experiment to determine the effects of cultivars and nitrogen rates on the nutrient content and uptake of pearl millet with five hybrid cultivars (MP 411, MP 413, Pusa 383, HHB 67, and HHB 117) and four N rates (0 (control), 30, 60 and 90 kg ha<sup>-1</sup>) under rainfed condition and found that increasing levels of nitrogen resulted in corresponding significant increase the NPK contents both in grain and stover and their total uptake by crop. The highest protein content (9.12%) in grain and protein yield ( $367.56 \text{ kg ha}^{-1}$ ) was observed at  $90 \text{ kg N ha}^{-1}$ .

Lakhana and Gupta (2005) studied the response of pearl millet to different levels of nitrogen (0, 30, 60 and 90 kg N ha<sup>-1</sup>) and thiourea application [(control, seed soaking

(500 ppm), foliar spray (1000 ppm), seed soaking plus foliar spray and foliar spray of urea (1000 ppm)] and found that nitrogen content in grain and total uptake of nitrogen increased up to 60 kg N ha<sup>-1</sup>.

A field experiment was conducted to study the effect of N levels on grain yield and nitrogen uptake he found that increasing levels of N application brought about significant improvement N content and its uptake by rainfed pearl millet. (Singh *et al.* 2006)

A field experiment was conducted to find the effect of farm yard manure and nitrogen levels on forage yield and quality of bajra napier hybrid (*Pennisetum purpureum*) with three levels of farmyard manure (FYM; 0, 15 and 30 t ha<sup>-1</sup> as basal every year) and three N levels (50, 75 and 100 kg ha<sup>-1</sup> after each cut). The result revealed that successive increase in N application from 50 to 75 and 100 kg N ha<sup>-1</sup> after each cut significantly increased crude protein yields. (Patel *et al.* 2008)

Silva *et al.* (2012) reported that addition of N doses promoted a rise of crude protein (CP) content at all the cuts of pearl millet.

## **2.2.5 Effect of N on nutrient stoichiometry of Pearl millet.**

Agren (2008) observed Stoichiometric relations in plants, with emphasis on C:N:P, are reviewed. Both theoretically and empirically it is found for whole plants as well as for different tissues that nitrogen concentrations increase slower than phosphorus concentrations. A lack of data prevents the establishment of relations between nitrogen and other elements. Optimal element ratios where elements are simultaneously limiting growth can be established. There is a considerable variability around these optimal ratios in observed values.

Ye *et al.* (2014) investigated the seasonal changes of C, N and P concentrations, accumulation, partitioning, and C:N:P stoichiometric ratios in different plant tissues (root, stem-leaf, and panicle) of late-season rice under two irrigation regimes (continuous flooding, CF; alternate wetting and drying, AWD) and four N managements (control, N<sub>0</sub>; conventional urea at 240 kg N ha<sup>-1</sup>, UREA; controlled-

release bulk blending fertilizer at 240 kg N ha<sup>-1</sup>, BBF; polymer-coated urea at 240 kg N ha<sup>-1</sup>, PCU). They found that water and N treatments had remarkable effects on the measured parameters in different plant tissues after transplanting, but the water and N interactions had insignificant effects. The root and stem-leaf C:N:P and panicle C:N ratios showed overall uptrends with a peak at harvest whereas the panicle N:P and C:P ratios decreased from filling to harvest. The AWD treatment did not affect the concentrations and accumulation of tissue C and N, but greatly decreased those of P, resulting in enhanced N:P and C:P ratios. N fertilization significantly increased tissue N concentration, slightly enhanced tissue P concentration, but did not affect tissue C concentration, leading to a significant increase in tissue N:P ratio but a decrease in C:N and C:P ratios. Our results suggested that the growth of rice in the Taihu Lake region was co-limited by N and P.

## 2.3 Interaction between crops and tree component

### 2.3.1 Competition for light

Chauhan *et al.* (2013) studied an agri-horti-silvicultural model involving poplar (*Populus deltoids* Bartr. Ex Marsh.) as timber tree component, fruit trees and agronomic crops viz, turmeric (*Curcuma longa* L.) and moong (*Vigna radiata* L.) were evaluated for yield. Net photosynthesis, stomatal conductance and transpiration in both crops were higher in open areas than in shaded ones. Agronomic crops showed initially better performance under partial shade in yield and yield contributing parameters, and decreased as poplar canopy advanced in age. The transpiration (E) rate of crops was lowest under shade conditions irrespective of the crop used in the experiment leading to more water use efficiency in the shade conditions than in open. There was gradual reduction in crop yield with advancement of age but the economic benefits of intercropping were two to three times higher than traditional crop rotation. It is suggested that to minimize resource competition and improve physiological processes of crops, canopy management is essential to ensure better yield under poplar-based agri-horti-silvicultural system.

Mayus (1998) studied a model was developed to simulate the effects of competition for soil water and radiation between windbreaks and pearl millet crops in the Sahel. These effects on millet (*Pennisetum glaucum* (L.) R. Br.) growth were simultaneously

simulated for each millet row parallel to the windbreak with small time steps for soil water processes, radiation availability and crop assimilation. The crop routine of the model was based on an existing semi-deterministic model. The soil-water flow was simulated in two dimensions to account for horizontal gradients. Competition for water was expressed by distributing the available soil water between trees and millet in proportion to its uptake rates in a non-competitive situation. Competition for light was incorporated as light reduction through a two-dimensional (windbreak) barrier with time-increasing height and density. Global radiation intensities and soil water contents were simulated satisfactorily as a function of time and the distance from the windbreak. Hence, the model is appropriate to analyse competition for light and water between windbreaks and crops.

### **2.3.2 Competition for nutrient**

There are innumerable studies indicating how competition for nutrients can reduce crop yields. In most cases, the case of the agricultural crops is the criterion by which the merit of an agroforestry system is assessed. Yield depressions of this component therefore receive more attention than those of the associated trees species. Further since the crop is usually the smaller component (when compared individually), its root system will usually be confined to the soil horizons that are also available to the roots of the trees, but the tree can exploit soil volume beyond reach of the crop. Therefore the effect of nutrient competition will probably be more severe for the crop components.

Gao *et al.* (2013) studied the agroforestry practices which may lead to competition between crops and trees for underground soil moisture and nutrients, and the trees on the canopy layer may also lead to shortage of light for crops. In order to minimize interspecific competition and maximize the benefits of tree-based intercropping systems, we studied photosynthesis, growth and yield of soybean (*Glycine max* L. Merr.) and peanut (*Arachis hypogaea* L.) by measuring photosynthetically active radiation, net photosynthetic rate, soil moisture and soil nutrients in a plantation of apple (*Malus pumila* M.) at a spacing of 4 m × 5 m on the Loess Plateau of China. The results showed that for both intercropping systems in the study region, soil moisture was the primary factor affecting the crop yields followed by light.

Deficiency of the soil nutrients also had a significant impact on crop yields. Compared with soybean, peanut was more suitable for intercropping with apple trees to obtain economic benefits in the region. However, the distance between crops and tree rows should be adjusted to minimize interspecies competition. Agronomic measures such as regular canopy pruning, root barriers, additional irrigation and fertilization also should be applied in the intercropping systems.

Rao *et al.* (2004) investigated that the management of below-ground interactions was most important in systems where trees and crops were grown in close proximity with the objective of producing multiple products, and where soil resources (water, nutrients) were limiting, as in seasonally dry climates, the semi-arid tropics and on infertile soils.

### **2.3.3 Competition for water**

Malik and Sharma (1990) reported that the reduction of yield over 30% for the crops growing at a distance of less than 10 m from the tree line. Thus, despite the use of drought adapted plants, water competition is likely to play a major role in the productivity of agroforestry system, especially in dry areas.

### **2.3.4 Relative economics**

Bhatt and Mishra (2003) reported that the guava and Assam lemon based agroforestry system exhibited, respectively, 2.96 and 1.98 fold higher net return as compared to control.

Osman *et al.* (2011) in agroforestry systems, crop yields under trees are often low compared to outside and studied that crop management under trees for improved production and income for farmers. Cowpea (*Vigna unguiculata*) and pearl millet (*Pennisetum glaucum*) sole and intercrops were grown under and outside the shade of six randomly selected *Parkia* *globosa* trees during one season in south-central Burkina Faso. Results indicate that intercropping could improve the system's productivity, increase the income for farmers, and compensate losses in pearl millet under the canopy.

Rajput and Bhardwaj (2010) reported that the valley ecosystem, orchard + vegetable land use system situated at 1600-1900 mean above sea level displayed net profit of 10,23,430 ha<sup>-1</sup> yr<sup>-1</sup> at all the four altitudinal gradients. Benefit-cost ratio in the valley ecosystems was maximum (3.3) in pure fruit tree (apple and plum) based land use system situated at 1600-1900 mean above sea level.

Kumar *et al.* (2013) observed that aonla fruit production was not influenced with intercropping of fodder crops under rainfed and produced fruit yield of 13.65 t ha<sup>-1</sup>. Pearl millet (multicut) + cowpea produced significantly higher yield 21.6 t of green fodder as compared to 18.4 t green fodder obtained from Pearl millet (single cut) + cowpea. Fodder production in association with tree was also higher (20.75 t green fodder) as compared to sole crop. Higher B: C ratio of 2.48:1 and 4.02:1 respectively of aonla based fodder production was recorded in 1st year and 2<sup>nd</sup> year when aonla trees were intercropped with Pearl millet (multicut) + cowpea. The soil nutrient build up was also noticed in fodder intercropped in association with aonla tree.



## **MATERIALS AND METHODS**

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The present investigation entitled “Effect of FYM and nitrogen levels on yield and nutrient stoichiometry of pearl millet under bael based agri-horti system and open system” was conducted during rainy (*kharif*) season of 2016 - 17 at Agricultural research farm of Rajiv Gandhi South Campus, Barkachha (BHU), Mirzapur, Uttar Pradesh. The materials and techniques implemented in conducting the experiment with edaphic and climatic condition of experimental plot has been presented in this chapter.

### **3.1. Experimental site**

The experiment was carried out at the agricultural research farm of Rajiv Gandhi South Campus, Barkachha (BHU), Mirzapur. The experimental area is situated in *Vindhyan* region of the district Mirzapur at (25° 10' N latitude , 82° 37' E longitude and altitude of 80 meters above mean sea level). The Soil of Barkachha is red lateritic comes under rainfed condition with invariably poor fertility status. This region comes under Agro-climatic zone III A (semi-arid eastern plain zone).

### **3.2. Climate and weather**

The climatic condition of Barkachha is typically semi-arid to sub- humid climate, characterized by extremes of temperature both in summer and winter with low rainfall and moderate humidity. Maximum temperature in summer is as high at 45° C and minimum temperature in winter falls below 10 °C. The annual rainfall of Barkachha was 1046.59 mm of which nearly 90 percent is contributed by south-west monsoon) between July to September. Winter showers are often experienced in between the month of December to mid of February. However, March to May is generally dry. On an average, out of the total annual rainfall major fraction (75 percent) is received during June to September. The winter months are cool whereas summer is hot and dry. The coldest and hottest month is January and May, respectively. The temperature begins to rise from the month of February and reaches its maximum in May.

### **3.3. Weather condition during the crop season**

The data on the weather condition during the crop season of present investigation with respect to maximum and minimum temperature, rainfall, relative humidity, sunshine duration and evaporation recorded at meteorological observatory of Krishi Bhawan, Mirzapur which are presented in Table 3.1 and graphically presented in Fig. 3.1

The total rainfall during the period of investigation in the year 2016 (2 Sept to 3 Dec, 2016 ) was 1629.5 mm. Major part of rainfall was received in the month of September during the experimentation. The maximum rainfall of 345.2 mm was recorded during 37th standard week of 2016 while the minimum was 16.2mm in 47th standard week of 2016. The weekly maximum and minimum temperature during the experimentation ranged from 35<sup>0</sup>C to 24°C and 32<sup>0</sup>C to 23°C, respectively. The weekly maximum relative humidity ranged between 77 to 68 percent and minimum relative humidity varied from 54 to 49 percent during the period of experimentation. The evaporation data obtained from weather bureau class A Pan Evaporimeter. The average evaporation during the crop period was measured as 3.52 mm day<sup>-1</sup>.

### **3.4. Soil characteristics of experimental field**

The soil of the experimental field was sandy loam in texture with low drainage. It was acidic in reaction, poor in nitrogen as well as phosphorus and moderate in potash. Composite soil samples prior to commencement of the experiment were collected to determine mechanical composition and physio-chemical properties of the soil and the data has been presented in table 3.2.

### **3.5. Cropping history of experimental field**

The crop sequences followed in the experimental field during the last three years have been presented in table 3.3. The cropping history of the Agri- horti system experimental site clearly indicates that the field was not cropped continuously and kept fallow mostly during *Rabi* season. The field was ideally suitable for the experiment. The presented crop sequence (table 3.3a & b) indicated that the field was ideally suitable for the experiment.

**Table 3.1. Mean Weekly Meteorological Data during Crop Season *Kharif*, 2016.**

| Week No. | Months    | Date  | Rainfall (mm) | Temperature (°C) |      | R.H. (%) |      | Evapo-ration (mm) |
|----------|-----------|-------|---------------|------------------|------|----------|------|-------------------|
|          |           |       |               | Max.             | Min. | Max.     | Min. |                   |
| 37       |           | 28-03 | 345.2         | 35.5             | 27   | 75       | 65   | 5.6               |
| 38       | September | 04-10 | 287           | 34               | 26   | 74       | 65   | 5                 |
| 39       |           | 11-17 | 246.6         | 34.3             | 26   | 76       | 67   | 4.2               |
| 40       |           | 18-24 | 217.5         | 35               | 25   | 77       | 68   | 4.2               |
| 41       |           | 25-01 | 184.3         | 34.5             | 26   | 74       | 65   | 4                 |
| 42       | October   | 02-08 | 123           | 34               | 25   | 66       | 57   | 3.8               |
| 43       |           | 09-15 | 56.4          | 35.8             | 23   | 58       | 49   | 3.2               |
| 44       |           | 16-22 | 18.7          | 33               | 21   | 56       | 47   | 2                 |
| 45       |           | 23-29 | 26.3          | 33.2             | 20   | 58       | 47   | 3                 |
| 46       |           | 30-05 | 30.4          | 32.8             | 18   | 57       | 46   | 3.1               |
| 47       | November  | 06-12 | 16.2          | 31.4             | 15   | 58       | 48   | 2.8               |
| 48       |           | 13-19 | 28.3          | 30.2             | 14   | 54       | 49   | 2.6               |
| 49       |           | 20-26 | 19.4          | 29               | 13   | 55       | 48   | 3.3               |
| 50       |           | 27-03 | 30.2          | 26               | 13   | 56       | 47   | 2.5               |

Source: Meteorological Observatory of Krishi Bhawan, Mirzapur

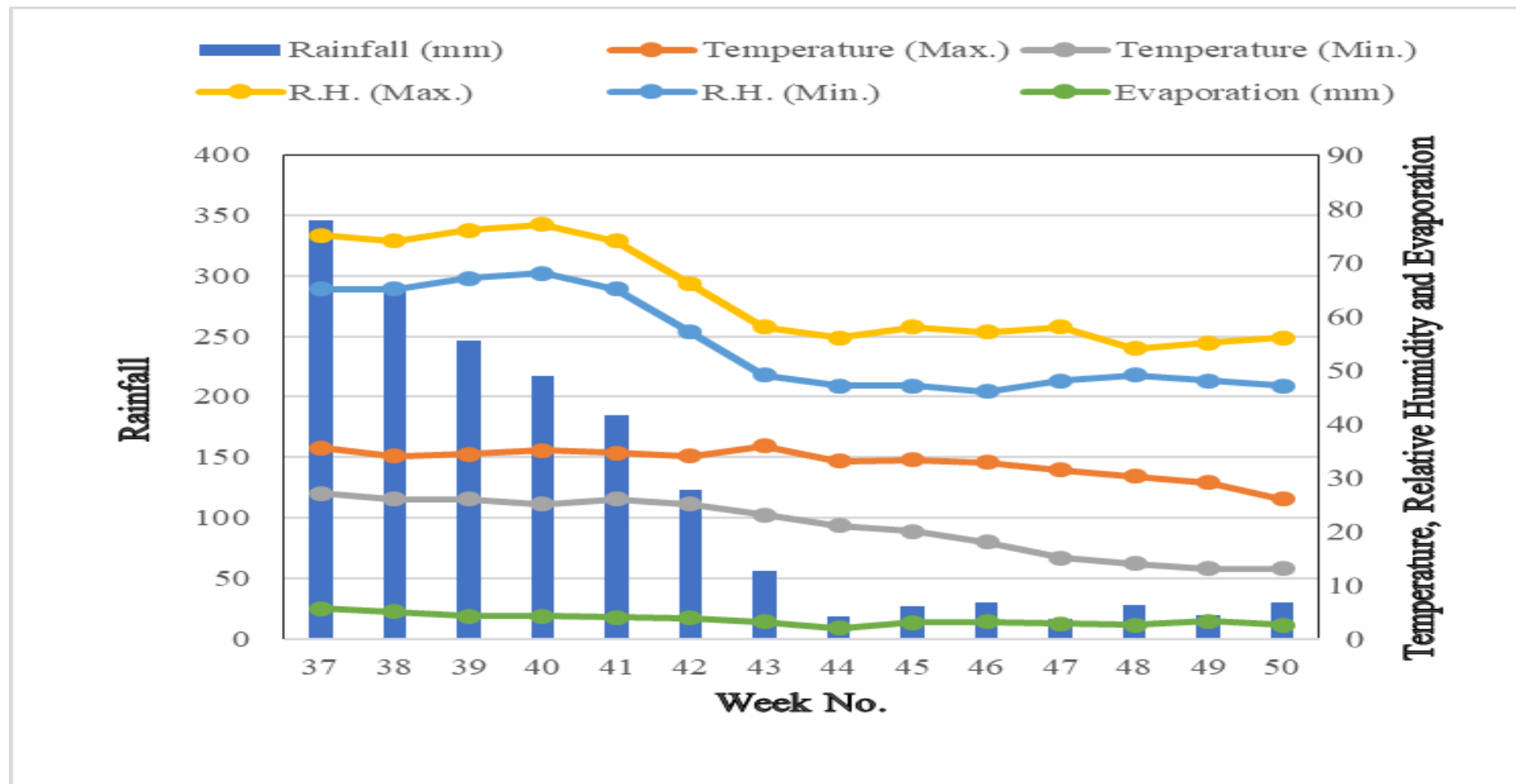


Fig. 3.1 Mean week- wise meteorological data during crop season *Kharif*, 2016

**Table 3.2. Initial soil characteristics of the experimental field.**

| Soil properties                                                       | Values          | Method employed                                        |
|-----------------------------------------------------------------------|-----------------|--------------------------------------------------------|
| <b>A. Mechanical analysis</b>                                         |                 |                                                        |
| Coarse sand (%)                                                       | 9.04            | International pipette method (Piper, 1950)             |
| Fine sand (%)                                                         | 49.36           |                                                        |
| Silt (%)                                                              | 18.71           |                                                        |
| Clay (%)                                                              | 22.89           |                                                        |
| Textural class                                                        | Sandy clay loam |                                                        |
| <b>B. Physical analysis</b>                                           |                 |                                                        |
| Bulk density ( $\text{g cc}^{-1}$ )                                   | 1.53            | Core sampler (Piper, 1966)                             |
| True density ( $\text{g cc}^{-1}$ )                                   | 2.59            | Chopra and Kanwar (1986)                               |
| <b>C. Chemical analysis</b>                                           |                 |                                                        |
| Organic carbon (%)                                                    | 0.28            | Walkley & Black rapid titration method (Jackson, 1973) |
| Available nitrogen ( $\text{kg ha}^{-1}$ )                            | 176.20          | Alkaline permanganate method (Subbiah and Asija, 1956) |
| Available phosphorus ( $\text{kg ha}^{-1}$ )                          | 11.15           | Bray and Kurtz method (1945)                           |
| Available potassium ( $\text{kg ha}^{-1}$ )                           | 185.5           | Flame photometer method (Jackson, 1973)                |
| Soil reaction (pH)                                                    | 5.8             | Glass electrode pH meter (Jackson, 1973)               |
| Electrical conductivity ( $\text{dSm}^{-1}$ at $25^{\circ}\text{C}$ ) | 0.28            | Electrical conductivity meter (Jackson, 1973)          |

**Table 3.3: Cropping history of experimental field****(A) System field**

| <b>Year</b> | <b>Season</b>                |                             |
|-------------|------------------------------|-----------------------------|
|             | <b>Rainy (<i>kharif</i>)</b> | <b>Winter (<i>rabi</i>)</b> |
| 2012-13     | Pearl Millet                 | Fallow                      |
| 2013-14     | Mungbean                     | Fallow                      |
| 2014-15     | Mungbean                     | Fallow                      |
| 2015-16     | Experimental crop            | -                           |

**(B) Open field**

| <b>Year</b> | <b>Season</b>                |                             |
|-------------|------------------------------|-----------------------------|
|             | <b>Rainy (<i>kharif</i>)</b> | <b>Winter (<i>rabi</i>)</b> |
| 2012-13     | Pearl Millet                 | Mustard                     |
| 2013-14     | Mungbean                     | Wheat                       |
| 2014-15     | Mungbean                     | Wheat                       |
| 2015-16     | Experimental crop            | -                           |

### 3.6. Experimental details

The field experiment was laid out during *kharif* season of 2016 in open field and 9 year old bael orchard which was planted in August 2006 at a spacing of 7 x 7 meter.

#### 3.6.1. Test variety

The pearl millet hybrid, Pioneer 86M86 was taken as experimental crop. This variety matures in 90-100 days, maximum plant height is 230 cm. The grain is red in colour and have bold for high grain and fodder yield under good management practices.

#### 3.6.2. Details of layout of the experiment

The experiment was laid out in Randomized block design (factorial) with combination of FYM and nitrogen. The details of the layout plan of the experimental design showing the allocation of treatment to different plots have been presented in fig 3.2.

**Table 3.4: The layout plan of experimental field system and open is as follows**

|                         |                                         |
|-------------------------|-----------------------------------------|
| Experimental design     | : Randomized block design (factorial)   |
| Number of treatment     | : 12                                    |
| Number of replication   | : 3                                     |
| Total number of plots   | : 36                                    |
| Gross plot size         | : 4 m x 3 m = 12 m <sup>2</sup>         |
| Net plot size           | : 2.20 m x 2.40 m = 5.28 m <sup>2</sup> |
| Plot border             | : 50 cm                                 |
| Row to row distance     | : 45 cm                                 |
| Plant to plant distance | : 15 cm                                 |

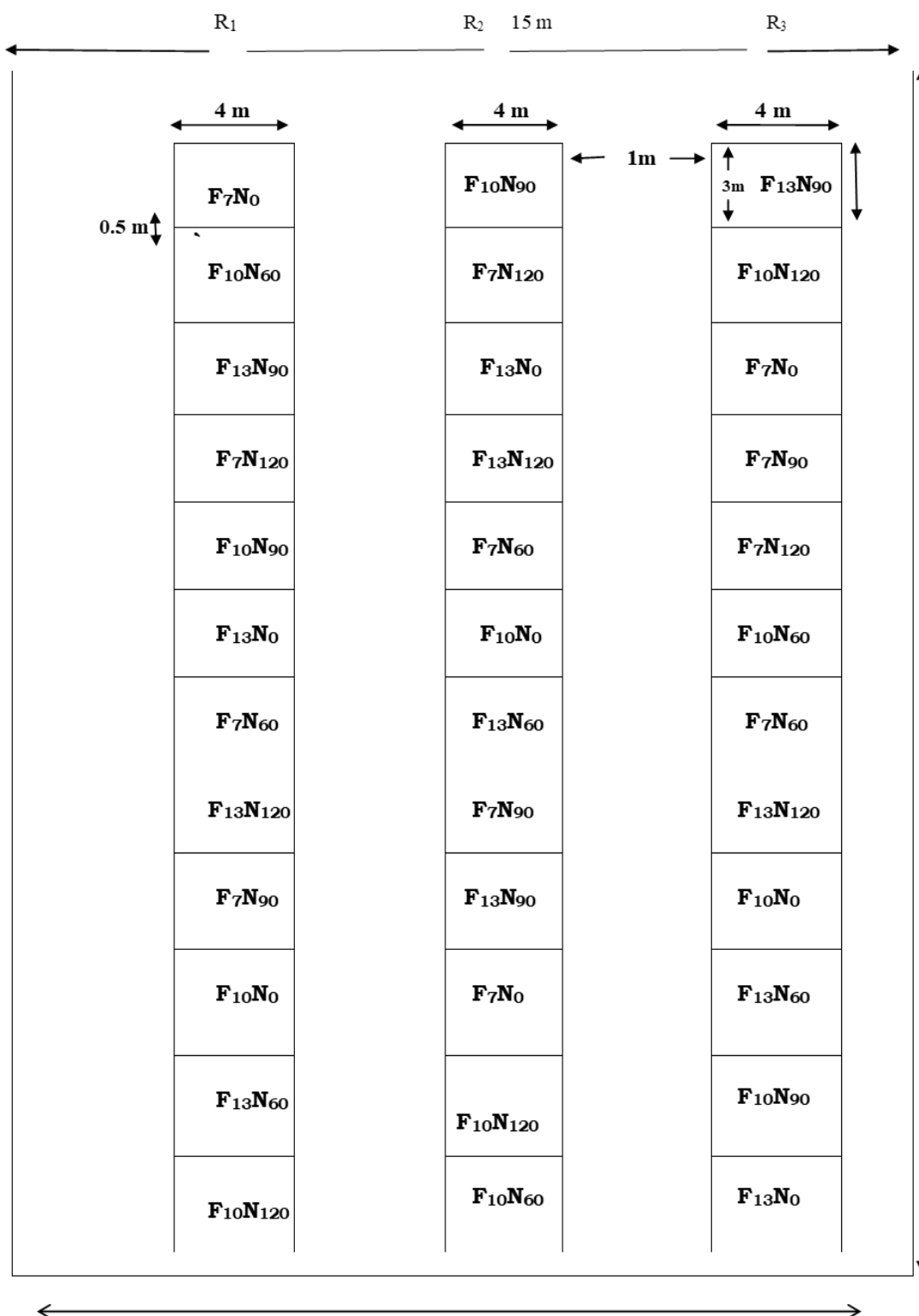
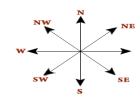
**Table 3.5: Treatment details**

The treatment was consisting with three FYM and four nitrogen levels.

| S.No.     | Treatment                                    | Symbol           |
|-----------|----------------------------------------------|------------------|
| <b>A.</b> | <b>Farm Yard Manure FYM (tonnes)</b>         |                  |
| 1.        | 7                                            | F <sub>7</sub>   |
| 2.        | 10                                           | F <sub>10</sub>  |
| 3.        | 13                                           | F <sub>13</sub>  |
| <b>B.</b> | <b>Nitrogen levels ( kg ha<sup>-1</sup>)</b> |                  |
| 1.        | 0                                            | N <sub>0</sub>   |
| 2.        | 60                                           | N <sub>60</sub>  |
| 3.        | 90                                           | N <sub>90</sub>  |
| 4.        | 120                                          | N <sub>120</sub> |



Fig. 3.2. Layout plan for the experimental field.



### **3.7 Schedule of field operation**

The various cultural operations done during the period of investigation are given in table.3.6.

#### **3.7.1. Land preparation**

At workable condition, field was ploughed with the help of disc plough and harrowing was done followed by planking. Thereafter, the experiment was laid out as per plan and design.

#### **3.7.2. Fertilizer and manure application**

The FYM and nitrogen application was done according to the treatments. The sources of N, P and K were Urea, SSP and MOP.

#### **3.7.3. Seed rate and sowing**

After fertilizer application the seed were sown manually in the furrow opened by *kudal* at a row distance of 45 cm as per treatment. Relatively higher seed rate 5 kg ha<sup>-1</sup> was used for proper maintenance of plant population. A plant spacing of 15 cm within the row was maintained by thinning which was done about 21 days after sowing.

#### **3.7.4. Thinning and intercultural operation**

Gap filling and thinning were done 21 days after sowing to maintain optimum plant stand. Intercultural operations such as weeding and hoeing were carried out 20 and 45 days after sowing.

#### **3.7.5. Harvesting and threshing**

The crop was harvested when the panicles was nearly dry and entire plants showed physiological maturity (yellowing). First the panicles were removed from the standing crops and the stalk was harvested later. The harvested panicles were kept in separate gunny bags for each plot and dried in the sun before selling. Before selling, the grains

**Table 3.6: Schedule of operational detail**

| S.No.     | Operations                                  | Dates             |            |
|-----------|---------------------------------------------|-------------------|------------|
|           |                                             | Agri-horti system | Open field |
| <b>A.</b> | <b>Pre sowing operations</b>                |                   |            |
|           | <b>1. Land preparation</b>                  |                   |            |
|           | <b>a. Ploughing</b>                         | 2.09.2016         | 2.09.2016  |
|           | <b>b. Levelling</b>                         | 3.09.2016         | 3.09.2016  |
|           | <b>2. Layout and experiment</b>             | 4.09.2016         | 4.09.2016  |
| <b>B.</b> | <b>Sowing operation</b>                     |                   |            |
|           | <b>1. Fertilizer application and sowing</b> | 4.09.2016         | 4.09.2016  |
| <b>C.</b> | <b>Post sowing operations</b>               |                   |            |
|           | <b>1. Thinning</b>                          | 26.09.2016        | 26.09.2016 |
|           | <b>2. Weeding and hoeing</b>                | 24.09.2016        | 25.09.2016 |
|           |                                             | 19.10.2016        | 20.10.2016 |
|           | <b>3. Harvesting</b>                        | 30.11.2016        | 1.12.2016  |
|           | <b>4. Threshing</b>                         | 15.12.2016        | 15.12.2016 |

were dried in the sun to bring the moisture content to 15 percent and then the final weights were recorded. The stalk was also bundled separately for each plot and dried thoroughly in the sun before taking the final weight. Harvesting of panicles done at 30<sup>th</sup> November, 2016 and 1<sup>st</sup> December, 2016.

The panicles were dried well before threshing was done by beating the panicles with sticks. The separated grains were cleaned, dried in sun to bring down the content to 12%.

### **3.8. Biometric observations**

Five plants from each plot were randomly selected and tagged for recording the biometric observations at different growth stages. The observations on growth attributes were recorded at an interval of 20 days i.e. 20<sup>th</sup>, 40<sup>th</sup>, 60<sup>th</sup> days after sowing and at maturity. Yield attributes and yield were studied before and after harvesting as per investigation required.

#### **3.8.1. Growth attributes**

##### **3.8.1.1. Plant height(cm)**

Height of randomly selected and marked plants from each plot was measured from base of the plants up to growing tip of leaves. The average plant height was calculated by taking the mean of five observations and expressed in cm.

##### **3.8.1.2. Tillers no. plant<sup>-1</sup>**

The tillers of five selected plants from each plot were counted carefully and averaged to obtain the number of tiller plant<sup>-1</sup>.

##### **3.8.1.3. Leaf count (no. plant<sup>-1</sup>)**

The number of green leaves plant of pearl millet was counted at different intervals of the crop growth from the entire representative randomly selected plants plot<sup>-1</sup> and mean of five observations were computed.

**3.8.1.4. Internodal count (no. plant<sup>-1</sup>)**

Internode is the space between two nodes in the pearl millet crop was counted and mean of five observations were computed.

**3.8.1.5. Internodal length (cm)**

The length of internode was measured by tape of five selected plants from each plot and obtained the average of internode's length plant<sup>-1</sup>.

**3.8.1.6. Number of tillers per running meter**

Total and effective number of tillers in each plot within a running meter row length from three randomly selected spots of one meter row (marked with wooden sticks) in each plot were recorded at 20, 40, 60 days after sowing and at harvest.

**3.8.1.7. Dry matter accumulation (g plant<sup>-1</sup>)**

For recording dry matter accumulation, 5 plants from each plot were cut from the ground level of border rows of pearl millet. Sampled plants were sun dried first then dried in an oven at 70°C for 24 hours to get constant dry weight. Thereafter, the average dry weight was recorded in gram plant<sup>-1</sup>.

**3.8.1.8. Crop growth rate (g day<sup>-1</sup>)**

The crop growth rate (CGR) at different growth stages were recorded by the following formula.

$$CGR (g day^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,  $W_2$  and  $W_1$  are dry matter weight of plants at time  $t_2$  and  $t_1$  respectively.

**3.8.2. Yield attributing characters**

The following observations on yield attributes and yield studies were recorded during the experimentation:

**3.8.2.1. Number of panicle (no. plant<sup>-1</sup>)**

Total number of panicle on the tagged plants was counted and average number of panicle plant<sup>-1</sup> was recorded.

**3.8.2.2. Number of panicle (no. ha<sup>-1</sup>)**

Total number of panicle on the tagged plants was counted and average number of panicle plant<sup>-1</sup> was recorded.

**3.8.2.3. Length of panicle (cm)**

Length of five randomly selected ears was measured from five tagged plants and average was worked out to get the panicle length of crop.

**3.8.2.4. Girth of panicle (cm)**

Width of five randomly selected panicles was measured from five tagged plants and average was worked out to get the panicle girth.

**3.8.2.5. Number of grain panicle<sup>-1</sup>**

The five randomly selected panicles from each five tagged plants plot<sup>1</sup> were taken out and total number of seeds was counted. Average number of seeds panicle<sup>-1</sup> were then calculated and recorded.

**3.8.2.6. Test weight (g)**

Randomly selected 1000-seed from the seed yield samples of the crop were counted from each plot and their combined weight was recorded to get the test weight of 1000 seeds.

**3.8.2.7. Grain yield (kg ha<sup>-1</sup>)**

The grain yield of net plot after cleaning and proper drying was recorded in gram and converted to Kg ha<sup>-1</sup> by multiplying with appropriate conversion factor.

#### **3.8.2.8. Stover yield (kg ha<sup>-1</sup>)**

After threshing, stem and chaff weight plot<sup>-1</sup> were recorded and added treatment wise. Then these were converted to Kg ha<sup>-1</sup> by multiplying with appropriate conversion factor.

#### **3.8.2.9. Harvest index (%)**

The harvest index was calculated by dividing the economic yield by the biological yield and multiplying by 100. (Donald and Hamblin, 1976)

$$\text{Harvest index} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Where, Economic yield = seed yield (Kg ha<sup>-1</sup>)

Biological yield = seed yield + stover yield (kg ha<sup>-1</sup>)

#### **3.8.3. Soil studies**

The soil samples (from 0-15 cm. depth) were collected from each plot before sowing and after harvesting and were analyzed for the available nitrogen, phosphorus, potassium and organic carbon.

#### **3.8.4. Nutrient analysis**

Plant material was chopped, dried in an oven and grinded in Willey mill<sup>TM</sup> to pass through a 30 mesh sieve and stored in a sealed and labelled container for chemical analysis. The methodology followed is presented in Table 3.2.

Oven dried grain and stover samples weighed 0.2 and 0.5 g, respectively were digested in diacid mixture of H<sub>2</sub>SO<sub>4</sub> and HClO<sub>4</sub> in the ratio of 9:1 for nutrient (N, P and K) estimation. After digestion, a known volume was made with glass distilled water and stored in well washed plastic bottles after filtration through Whatman filter paper No. 42. Nitrogen content in digested plant's material was determined by the

modified Kjeldhal method (Jackson, 1973). Phosphorus and potassium content were determined by Vanadomolybdo phosphoric acid yellow colour method (Jackson, 1973) and flame photometric method (Jackson, 1973), respectively. Uptake of each nutrient (N, P and K) was computed as below:

$$\text{Nutrient uptake by grain (kg ha}^{-1}\text{)} = \frac{\text{Percent nutrient content in grain} \times \text{grain yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nutrient uptake by straw (kg ha}^{-1}\text{)} = \frac{\text{Percent nutrient content in straw} \times \text{straw yield (kg ha}^{-1}\text{)}}{100}$$

The total uptake of nitrogen, phosphorus and potassium at harvest was computed by summing up the nutrient uptake by grain and straw.

#### **3.8.4.1a Nitrogen content (%)**

Nitrogen content was estimated using the modified Kjeldhal method (Jackson, 1973).

#### **3.8.4.1b Nitrogen uptake (kg ha<sup>-1</sup>)**

Nitrogen uptake in grain and straw of pearl millet crop was calculated in kg ha<sup>-1</sup> in relation to dry matter production ha<sup>-1</sup> by using the formula.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nitrogen content (\%)} \times \text{Yield (Grain/ Straw in kg /ha)}}{100}$$

Nitrogen uptake by grain and straw was added to get the total nutrient uptake by the crop.

#### **3.8.4.2a Potassium content (%)**

Potassium content was estimated using the flame photometric method (Jackson, 1973).

**3.8.4.2b Potassium uptake (kg ha<sup>-1</sup>)**

Potassium uptake in grain and straw of pearl millet crop was calculated in kg ha<sup>-1</sup> in relation to dry matter production ha<sup>-1</sup> by using the formula.

$$\text{Potassium uptake (kg ha}^{-1}\text{)} = \frac{\text{Potassium content (\%)} \times \text{Yield (Grain/ Straw in kg /ha)}}{100}$$

Potassium uptake by grain and straw was added to get the total nutrient uptake by the crop.

**3.8.4.3a Phosphorus content (%)**

Phosphorus content was estimated using the Vanadomolybdo phosphoric acid yellow colour method (Jackson, 1973).

**3.8.4.3b Phosphorus uptake (kg ha<sup>-1</sup>)**

Phosphorus uptake in grain and straw of pearl millet crop was calculated in kg ha<sup>-1</sup> in relation to dry matter production ha<sup>-1</sup> by using the formula.

$$\text{Phosphorus uptake (kg ha}^{-1}\text{)} = \frac{\text{Phosphorus content (\%)} \times \text{Yield (Grain/ Straw in kg /ha)}}{100}$$

Phosphorus uptake by grain and straw was added to get the total nutrient uptake by the crop.

**3.8.4.4a Carbon content (%)**

Carbon content was estimated using the estimation of Total Ash through Muffle furnace. The method currently recommended by USDA (Soil Taxonomy, USDA, 1999) is based upon dry combustion (muffle furnace), and measures the percent of

total carbon. The content of organic carbon is determined by subtracting the amount of carbon contributed by carbonates from total carbon data.

#### **3.8.4.5 Protein content (%) and protein yield (kg ha<sup>-1</sup>)**

Protein content in grain was worked out by multiplying the nitrogen content in grain with a conversation factor 5.75, as suggested by (A.O.A.C., 1970). Protein yield was determined by multiplying the protein content in grain and straw with their respective yield and then both were added to give the total protein yield. The protein yield was calculated using following formula:

$$\text{Protein content (\%)} = \text{Nitrogen content in grain (\%)} \times 5.75$$

$$\text{Protein yield (kg ha}^{-1}\text{)} = \text{Protein content in grain (\%)} \times \text{Grain yield (kg ha}^{-1}\text{)}$$

### **3.9. C:N:P:K stoichiometry ratio**

Plant C:N:P stoichiometry determines plant community composition and structure (resource allocation), trophic dynamics, and nutrient limitation [Sternner *et al.* (2002), Sardans *et al.* (2012), Zhang *et al.* (2008)]. Accumulation of C, N and P in root, stem, leaf, and panicle at various growth stages was calculated from the element concentration multiplied by the dry matter. The element accumulation rate (kg ha<sup>-1</sup> day<sup>-1</sup>) at each growth stage was obtained from the element accumulation divided by the number of days of the growth stage. Stoichiometric ratios of C:N, N:P, C:K, P:K, N:K and C:P in plant tissues were calculated on mass basis.

### **3.10. Economics**

The cost of cultivation, gross return, net return and benefit: cost ratio of different treatments was worked out on the basis of prevailing market prices. Power and labour for different operations *i.e.* ploughing, harrowing, sowing, weeding, harvesting etc. were calculated ha<sup>-1</sup> as per normal rates prevalent at the research farm, B.H.U. Varanasi. The cost of fertilizers and seeds were considered as market price. Net return (₹ ha<sup>-1</sup>) and benefit: cost ratio, were computed with the help of following formula.

Net return (₹ ha<sup>-1</sup>) = Gross return (₹ ha<sup>-1</sup>) — Cost of cultivation (₹ ha<sup>-1</sup>)

Benefit: cost ratio = Gross return (₹ ha<sup>-1</sup>) / Total cost of cultivation (₹ ha<sup>-1</sup>)

### **3.11. Distinguishing Features of the Fruit Tree *Bael***

#### **3.11.1 *Bael* (Variety- *Narendra Bael-5*)**

*Narendra Bael-5* is a tree that grows from 2.4 to 4.6 meters (8 to 15 feet) tall with a dense spiny growth. The fruit is 5 to 10 centimeters (2 to 4 inches) in diameter, green, gray or yellowish, and full of seeds. The Bael fruit has a smooth, woody shell and takes about 11 months to ripen on the tree. This variety of Bael is characterized by moderate size with better quality in terms of thin skull, less fiber content, low number of seeds per fruit and highest soluble solids, ascorbic acid and total sugars in pulp.

#### **3.11.2. Observation on fruit tree**

The following growth parameters and yield of fruit trees were taken which was situated at border of the plot.

##### **3.11.2.1. Height (m)**

The height of fruit trees (*Bael*) were measured from base of the plant up to growing tip of main stem. The average plant height was calculated by taking the mean of five observations and expressed in meter.

##### **3.11.2.2. Branches per tree (No.)**

The numbers of branches were counted as per visualization.

##### **3.11.2.3. Diameter (cm)**

The diameter of each fruit tree was recorded with the help of measuring tape.

**3.11.2.4. Shading area (m)**

File shading area of the fruit tree was recorded with the help of meter tape. The shading area was calculated as width and length in meter.

**3.11.2.5. Average fruit per tree (No.)**

Numbers of fruits per tree was counted on the basis of visualization and then average numbers of fruits was calculated and expressed as number of fruits per tree.

**3.11.2.6. Average fruit weight (g) and fruit yield (kg ha<sup>-1</sup>)**

Total fruit weight was recorded by measuring it on balance and then average was calculated.

**3.11.2.7. Canopy diameter (m)**

The canopy area of Bael was recorded with the help of meter tape and it was recorded from the highest canopy diameter in meter.

**3.11.2.8. Stem girth (cm)**

The stem girth of Bael was recorded from base of the plant in cm which was situated at the plot of the crops.

**3.12. Statistical analysis**

For determining the significance between the treatment means and to draw valid conclusion, statistical analysis was made. Data obtained from various observations were subjected to statistical analysis by adopting appropriate method of "Analysis of Variance". The significance of the treatment effect was judged with the help of 'F' test (Variance ratio). The difference of the treatments mean was tested using critical difference (CD) at 5% level of probability (Gomez and Gomez, 1976).

If the variance ratio (F test) was found significant at 5% level of significance, the standard error of mean (S.E.m.±) and critical differences (CD) were calculated for

further comparison.

$$S.E.m.\pm = \sqrt{\frac{V_E(a)}{r \times C}}$$

C.D. at 5% = S.E.m. $\pm$  x  $\sqrt{2}$  x t value at value at 5% of error (a) d.f.

### **3.13. Presentation of experimental data**

The trend of crop response under various treatments is described with the help of tables and illustrated by graphs at appropriate places. The significant mean table values are described in detail.



## **EXPERIMENTAL FINDINGS**

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An endeavour has been made in this chapter to assess "Effect of FYM and nitrogen levels on yield and nutrient stoichiometry of pearl millet under agri- horti system". The results obtained during the course of investigation in 2016 was subjected to statistical analysis and the inferences drawn along with suitable interpretation have been presented and elucidated through tables and graphs whenever required in succeeding pages.

### **4.1 Growth attributes**

#### **4.1.1 Plant height (cm)**

The data pertaining to the plant height (cm) recorded at successive growth stages are presented in the table 4.1.1. In general plant height increase with advancement of crop growth stages and reached to maximum at harvest, irrespective of experimental variability.

#### **Agri-horti system**

**FYM:** In agri-horti system the plant height increased with the advancement of the age and recorded maximum at harvest. The maximum plant height (188.57 cm) was recorded with application of FYM @ 13 t ha<sup>-1</sup> which was significantly higher than other FYM treated plot at harvest.

**Nitrogen levels:** Nitrogen levels significantly influence the plant height and recorded maximum plant height (197.23 cm) at harvest with N<sub>90</sub>. However, it was statistically at par with N<sub>20</sub> but significantly superior to other nitrogen levels.

**Interaction:** Significant effect of plant height was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>120</sub> (120 kg ha<sup>-1</sup>) interacted with each other and produced the maximum height. F<sub>13</sub>N<sub>120</sub> treatment combination recorded maximum height of (208.60).

**Table 4.1.1 Effect of FYM and nitrogen levels on plant height (cm) at different periods of growth under agri-horti system.**

| Treatments                                  | Plant height (cm) |        |        |            |
|---------------------------------------------|-------------------|--------|--------|------------|
|                                             | 20 DAS            | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                   |        |        |            |
| F <sub>7</sub>                              | 57.84             | 134.65 | 177.32 | 178.58     |
| F <sub>10</sub>                             | 56.79             | 145.07 | 182.43 | 186.12     |
| F <sub>13</sub>                             | 59.28             | 119.03 | 186.56 | 188.57     |
| S.Em.(±)                                    | 1.46              | 0.94   | 0.94   | 0.72       |
| CD at 5%                                    | NS                | 2.76   | 2.75   | 2.11       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                   |        |        |            |
| N <sub>0</sub>                              | 43.01             | 86.58  | 151.89 | 154.71     |
| N <sub>60</sub>                             | 64.01             | 127.24 | 187.34 | 190.14     |
| N <sub>90</sub>                             | 62.69             | 163.66 | 194.72 | 197.23     |
| N <sub>120</sub>                            | 62.18             | 154.19 | 194.12 | 195.60     |
| S.Em.(±)                                    | 1.69              | 1.09   | 1.08   | 0.83       |
| CD at 5%                                    | 4.95              | 3.19   | 3.17   | 2.44       |
| F × N                                       | NS                | S      | S      | S          |

**Table 4.1.1 Effect of FYM and nitrogen levels on plant height (cm) at different periods of growth under open field.**

| Treatments                                  | Plant height (cm) |        |        |            |
|---------------------------------------------|-------------------|--------|--------|------------|
|                                             | 20 DAS            | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                   |        |        |            |
| F <sub>7</sub>                              | 57.98             | 151.98 | 178.58 | 182.23     |
| F <sub>10</sub>                             | 55.65             | 164.09 | 186.12 | 188.51     |
| F <sub>13</sub>                             | 59.18             | 166.85 | 188.57 | 191.31     |
| S.Em.(±)                                    | 1.26              | 1.45   | 0.94   | 0.89       |
| CD at 5%                                    | NS                | 4.25   | 2.75   | 2.62       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                   |        |        |            |
| N <sub>0</sub>                              | 42.46             | 127.36 | 154.71 | 158.41     |
| N <sub>60</sub>                             | 63.11             | 170.38 | 190.14 | 193.44     |
| N <sub>90</sub>                             | 62.79             | 175.01 | 197.23 | 198.97     |
| N <sub>120</sub>                            | 62.07             | 171.16 | 195.60 | 198.57     |
| S.Em.(±)                                    | 1.45              | 1.67   | 1.08   | 1.03       |
| CD at 5%                                    | 4.25              | 4.91   | 3.17   | 3.02       |
| F × N                                       | NS                | S      | S      | S          |

Table 4.1.1.1. Integrated effect of FYM and nitrogen on plant height (cm).

| Treatment   | Plant height at 40 DAS in open field |               |               |                            |               | Plant height at 40 DAS in agri-horti system |               |               |                            |               |
|-------------|--------------------------------------|---------------|---------------|----------------------------|---------------|---------------------------------------------|---------------|---------------|----------------------------|---------------|
|             | Nitrogen levels                      |               |               |                            | Mean          | Nitrogen levels                             |               |               |                            | Mean          |
| FYM levels  | N0                                   | N60           | N90           | N120                       |               | N0                                          | N60           | N90           | N120                       |               |
| <b>F7</b>   | 114.53                               | 161.70        | 179.63        | 152.07                     | <b>151.98</b> | 95.07                                       | 138.83        | 160.30        | 144.40                     | <b>134.65</b> |
| <b>F10</b>  | 130.40                               | 169.43        | 179.13        | 177.40                     | <b>164.09</b> | 78.17                                       | 162.70        | 173.70        | 165.70                     | <b>145.07</b> |
| <b>F13</b>  | 137.13                               | 180.00        | 166.27        | 184.00                     | <b>166.85</b> | 86.50                                       | 80.20         | 156.97        | 152.47                     | <b>119.03</b> |
| <b>Mean</b> | <b>127.36</b>                        | <b>170.38</b> | <b>175.01</b> | <b>171.16</b>              | <b>160.98</b> | <b>86.58</b>                                | <b>127.24</b> | <b>163.66</b> | <b>154.19</b>              | <b>132.92</b> |
|             | <b>S.Em.(±) = 2.90</b>               |               |               | <b>CD (P= 0.05) = 8.49</b> |               | <b>S.Em.(±) = 1.88</b>                      |               |               | <b>CD (P= 0.05) = 5.52</b> |               |

**Open system**

**FYM:** In open system maximum plant height (191.31cm) was recorded at harvest with 13 tonne FYM ha<sup>-1</sup> which was significantly higher than other nitrogen treated plot at harvest.

**Nitrogen levels:** 90 kg N ha<sup>-1</sup> level produced the highest plant height (198.97cm) in open system.

**Interaction:** Significant effect of plant height was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>120</sub> (120 kg ha<sup>-1</sup>) interacted with each other and produced the maximum height. F<sub>13</sub>N<sub>120</sub> treatment combination exhibited maximum height of (208.60).

**4.1.2 Number of tillers plant<sup>-1</sup>**

Data pertaining to the number of tillers per plant were recorded at successive growth stages are presented in the table 4.1.2. In general number of tillers per plant increase with advancement of crop growth stages and reached to maximum at 60 DAS after that it decreased, irrespective of experimental variability.

**Agri-horti system**

**FYM:** There was significant influence on the tillers plant<sup>-1</sup> due to FYM application. The maximum number of tillers plant<sup>-1</sup> (3.28 plant<sup>-1</sup>) was recorded at 40 DAS with F<sub>13</sub> level (13 tonnes ha<sup>-1</sup>) in agri- horti system.

**Nitrogen levels:** The maximum number of tillers plant<sup>-1</sup> was recorded at 40 DAS (3.51 plant<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> in agri- horti system.

**Interaction:** FYM and Nitrogen levels showed an interaction with each other that reflected increasing of number of tillers plant<sup>-1</sup> at 20 DAS and at harvest in the agri-horti system.

### Open system

**FYM:** In the open system the higher number of tillers plant observed was ( $3.25 \text{ plant}^{-1}$ ) which was statistically higher to their lower FYM levels. Thereafter, the number of tillers maintained till 60 DAS and decreased unto the time of harvest.

**Nitrogen levels:** As the dose of nitrogen was increased from  $0 \text{ kg N ha}^{-1}$  to  $120 \text{ kg N ha}^{-1}$ , the number of tillers increased significantly up to  $120 \text{ kg N ha}^{-1}$ , the number of tillers observed was ( $3.40 \text{ plant}^{-1}$ ) in open system. However, it was statistically at par with  $90 \text{ kg N ha}^{-1}$  during 40 DAS.

**Interaction:** FYM and Nitrogen levels showed an interaction with each other in increasing the number of tillers  $\text{plant}^{-1}$  at 20 DAS and at harvest in open system also.

#### 4.1.3 Leaf count (no. $\text{plant}^{-1}$ )

Data pertaining to the number of leaves  $\text{plant}^{-1}$  were recorded at successive growth stages are presented in the table 4.1.3. In general number of leaves  $\text{plant}^{-1}$  increase with advancement of crop growth stages and reached to maximum at 40 DAS after that it decreased, irrespective of experimental variability.

### Agri-horti system

**FYM:** There was significant influence on the leaf count (no.  $\text{plant}^{-1}$ ) due to FYM application. The higher number of leaves ( $22.43 \text{ plant}^{-1}$ ) was recorded at 40 DAS with  $13 \text{ t FYM ha}^{-1}$  in agri-horti system.

**Nitrogen levels:** Nitrogen level improved the leaf count (no.  $\text{plant}^{-1}$ ) significantly and as the dose of nitrogen was increased from  $0 \text{ kg N ha}^{-1}$  to  $N_{120}$  level ( $120 \text{ kg N ha}^{-1}$ ), the number of leaves increased significantly up to  $120 \text{ kg N ha}^{-1}$  hence the maximum number of leaf count (no.  $\text{plant}^{-1}$ ) was observed ( $24.33 \text{ plant}^{-1}$ ).

**Interaction:** FYM and Nitrogen levels interacted with each other in increasing the number of leaves  $\text{plants}^{-1}$  at 60 DAS with the dose of  $F_{13}$  and  $N_{120}$  and their combination  $F_{13}N_{120}$  produced the maximum height of ( $25.27 \text{ plant}^{-1}$ ) in agri-horti system.

**Table 4.1.2. Effect of FYM and nitrogen levels on number of tillers (plant<sup>-1</sup>) at different periods of growth under agri-horti system.**

| Treatments                                  | Number of tillers (plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                   | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                          |        |        |            |
| F <sub>7</sub>                              | 1.15                                     | 2.95   | 2.95   | 1.70       |
| F <sub>10</sub>                             | 0.94                                     | 3.25   | 3.25   | 2.13       |
| F <sub>13</sub>                             | 1.62                                     | 3.28   | 3.28   | 2.48       |
| S.Em.(±)                                    | 0.08                                     | 0.06   | 0.06   | 0.11       |
| CD at 5%                                    | 0.23                                     | 0.19   | 0.19   | 0.33       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                          |        |        |            |
| N <sub>0</sub>                              | 0.44                                     | 2.62   | 2.62   | 1.82       |
| N <sub>60</sub>                             | 1.06                                     | 3.11   | 3.11   | 2.11       |
| N <sub>90</sub>                             | 1.84                                     | 3.40   | 3.40   | 2.11       |
| N <sub>120</sub>                            | 1.60                                     | 3.51   | 3.51   | 2.38       |
| S.Em.(±)                                    | 0.09                                     | 0.07   | 0.07   | 0.13       |
| CD at 5%                                    | 0.26                                     | 0.21   | 0.21   | 0.29       |
| F × N                                       | S                                        | NS     | NS     | NS         |

**Table 4.1.2. Effect of FYM and nitrogen levels on number of tillers (plant<sup>-1</sup>) at different periods of growth under open field.**

| Treatments                                  | Number of tillers (plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                   | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                          |        |        |            |
| F <sub>7</sub>                              | 1.07                                     | 2.97   | 2.97   | 1.62       |
| F <sub>10</sub>                             | 0.79                                     | 3.20   | 3.20   | 1.87       |
| F <sub>13</sub>                             | 1.52                                     | 3.25   | 3.25   | 2.43       |
| S.Em.(±)                                    | 0.07                                     | 0.04   | 0.04   | 0.10       |
| CD at 5%                                    | 0.21                                     | 0.13   | 0.13   | 0.30       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                          |        |        |            |
| N <sub>0</sub>                              | 0.44                                     | 2.64   | 2.64   | 1.80       |
| N <sub>60</sub>                             | 1.06                                     | 3.13   | 3.13   | 2.02       |
| N <sub>90</sub>                             | 1.73                                     | 3.38   | 3.38   | 2.00       |
| N <sub>120</sub>                            | 1.27                                     | 3.40   | 3.40   | 2.07       |
| S.Em.(±)                                    | 0.08                                     | 0.05   | 0.05   | 0.12       |
| CD at 5%                                    | 0.25                                     | 0.15   | 0.15   | 0.34       |
| F × N                                       | S                                        | NS     | NS     | NS         |

Table 4.1.2.1. Integrated effect of FYM and nitrogen on number of tillers (plant<sup>-1</sup>).

| Treatment   | Number of tillers (plant <sup>-1</sup> ) at 20 DAS in open field |             |             |             |                     | Number of tillers (plant <sup>-1</sup> ) at 20 DAS in agri-horti system |             |             |             |                     |
|-------------|------------------------------------------------------------------|-------------|-------------|-------------|---------------------|-------------------------------------------------------------------------|-------------|-------------|-------------|---------------------|
|             | Nitrogen levels                                                  |             |             |             | Mean                | Nitrogen levels                                                         |             |             |             | Mean                |
| FYM levels  | N0                                                               | N60         | N90         | N120        |                     | N0                                                                      | N60         | N90         | N120        |                     |
| <b>F7</b>   | 1.87                                                             | 1.33        | 1.53        | 1.73        | <b>1.62</b>         | 1.93                                                                    | 1.40        | 1.60        | 1.87        | <b>1.70</b>         |
| <b>F10</b>  | 1.87                                                             | 2.47        | 1.80        | 1.33        | <b>1.87</b>         | 1.93                                                                    | 2.60        | 1.87        | 2.13        | <b>2.13</b>         |
| <b>F13</b>  | 1.67                                                             | 2.27        | 2.67        | 3.13        | <b>2.43</b>         | 1.60                                                                    | 2.33        | 2.87        | 3.13        | <b>2.48</b>         |
| <b>Mean</b> | <b>1.80</b>                                                      | <b>2.02</b> | <b>2.00</b> | <b>2.07</b> | <b>1.97</b>         | <b>1.82</b>                                                             | <b>2.11</b> | <b>2.11</b> | <b>2.38</b> | <b>2.11</b>         |
|             | S.Em.(±) = 0.20                                                  |             |             |             | CD (P= 0.05) = 0.60 | S.Em.(±) = 0.23                                                         |             |             |             | CD (P= 0.05) = 0.66 |

**Open system**

**FYM:** No. of leaves ( $22.33 \text{ plant}^{-1}$ ) was observed in open system with the dose of  $F_{13}$  at 40 DAS. Thereafter, the number of leaves decreased up to the time of harvest.

**Nitrogen levels:** The maximum no. of leaves ( $24.12 \text{ plant}^{-1}$ ) at 40 DAS with the dose of  $120 \text{ kg N ha}^{-1}$  was observed in open system. Thereafter, the number of leaves decreased up to the time of harvest. The minimum number of leaves was recorded with  $0 \text{ kg N ha}^{-1}$ .

**Interaction:** FYM and Nitrogen levels interacted with each other in increasing the number of leaves  $\text{plants}^{-1}$  at 60 DAS with the dose of  $F_{13}$  and  $N_{120}$  and their combination  $F_{13}N_{120}$  produced the maximum height of ( $24.97 \text{ plant}^{-1}$ ) in open system.

**4.1.4 Internodes count (no.  $\text{plant}^{-1}$ )**

Data pertaining to the number of internodes  $\text{plant}^{-1}$  were recorded at successive growth stages at 20, 40, 60 DAS and at maturity are presented in the table 4.1.4. In general number of internodes  $\text{plant}^{-1}$  increase with advancement of crop growth stages and reached to maximum at maturity, irrespective of experimental variability.

**Agri-horti system**

**FYM:** : In the case of FYM levels it showed a significant effect on final internodes count ( $\text{no. plant}^{-1}$ ) except at 20 DAS. The internodes count ( $8.74 \text{ plant}^{-1}$ ) was recorded at the time of harvest with  $10 \text{ t FYM ha}^{-1}$  from agri-horti system.

**Nitrogen levels:** There was a significant effect of nitrogen on internodes count ( $\text{no. plant}^{-1}$ ) except 20 DAS. The maximum internodes ( $9.10 \text{ plant}^{-1}$ ) was recorded at the time of harvest with  $60 \text{ kg N ha}^{-1}$  from agri-horti system.

**Interaction:** Significant effect of internodal count was observed due to FYM and Nitrogen levels  $F_{10}$  ( $10 \text{ tonnes ha}^{-1}$ ) and  $N_{120}$  ( $120 \text{ kg ha}^{-1}$ ) interacted with each other

and produced the maximum number of internodal count plant<sup>-1</sup>. F<sub>10</sub>N<sub>60</sub> treatment combination recorded maximum no. of internodal count (9.27 plant<sup>-1</sup>) at 60 DAS in agri-horti system.

### **Open system**

**FYM:** The internode count with respect to other levels was (8.66 plant<sup>-1</sup>) recorded at harvest with 10 t FYM ha<sup>-1</sup> in open system.

**Nitrogen levels:** The higher internode count with respect to other levels was (8.96 plant<sup>-1</sup>) was recorded at harvest with 120 kg N ha<sup>-1</sup> in open system.

**Interaction:** Significant effect of internodal count was observed due to FYM and Nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>120</sub> (120 kg ha<sup>-1</sup>), F<sub>10</sub> (10 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg ha<sup>-1</sup>) interacted with each other and produced the internodal count plant<sup>-1</sup>. F<sub>13</sub>N<sub>120</sub> and F<sub>10</sub>N<sub>60</sub> treatment combination recorded maximum no. of internodal count (9.13 plant<sup>-1</sup>) at 60 DAS in open system.

#### **4.1.5 Internodal length (cm)**

Data pertaining to the internodal length plant<sup>-1</sup> were recorded at successive growth stages at 20, 40, 60 DAS and at maturity are presented in the table 4.1.5 and illustrated in fig 4.1.5. In general internodal length plant<sup>-1</sup> increase with advancement of crop growth stages and reached to maximum at maturity, irrespective of experimental variability.

### **Agri-horti system**

**FYM:** There was significant influence on the internodal length (cm) due to FYM application. The internodal length (21.53 cm) was recorded at harvest with 7 t FYM ha<sup>-1</sup> from agri-horti system.

**Table 4.1.3. Effect of FYM and nitrogen levels on leaf count (no. of plant<sup>-1</sup>) at different period of growth under agri-horti system.**

| Treatments                                  | Leaf count (no. of plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                   | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                          |        |        |            |
| F <sub>7</sub>                              | 13.33                                    | 20.99  | 18.59  | 15.84      |
| F <sub>10</sub>                             | 15.45                                    | 21.68  | 19.68  | 15.65      |
| F <sub>13</sub>                             | 16.78                                    | 22.43  | 19.87  | 16.08      |
| S.Em.(±)                                    | 0.22                                     | 0.16   | 0.35   | 0.41       |
| CD at 5%                                    | 0.65                                     | 0.46   | 1.02   | 1.20       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                          |        |        |            |
| N <sub>0</sub>                              | 11.76                                    | 19.27  | 15.37  | 11.89      |
| N <sub>60</sub>                             | 14.84                                    | 20.39  | 18.81  | 16.53      |
| N <sub>90</sub>                             | 15.96                                    | 22.81  | 20.14  | 17.13      |
| N <sub>120</sub>                            | 18.20                                    | 24.33  | 23.20  | 17.87      |
| S.Em.(±)                                    | 0.26                                     | 0.18   | 0.40   | 0.47       |
| CD at 5%                                    | 0.75                                     | 0.53   | 1.18   | 1.38       |
| F × N                                       | NS                                       | S      | S      | S          |

**Table 4.1.3. Effect of FYM and nitrogen levels on leaf count (no. of plant<sup>-1</sup>) at different period of growth under open field.**

| Treatments                                  | Leaf count (no. of plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                   | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                          |        |        |            |
| F <sub>7</sub>                              | 12.88                                    | 20.67  | 18.27  | 15.13      |
| F <sub>10</sub>                             | 14.97                                    | 21.23  | 19.16  | 15.32      |
| F <sub>13</sub>                             | 16.39                                    | 22.33  | 19.58  | 15.66      |
| S.Em.(±)                                    | 0.23                                     | 0.15   | 0.29   | 0.41       |
| CD at 5%                                    | 0.69                                     | 0.43   | 0.84   | 1.21       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                          |        |        |            |
| N <sub>0</sub>                              | 11.22                                    | 18.88  | 15.01  | 11.29      |
| N <sub>60</sub>                             | 14.30                                    | 20.03  | 18.40  | 15.93      |
| N <sub>90</sub>                             | 15.67                                    | 22.60  | 19.72  | 16.69      |
| N <sub>120</sub>                            | 17.79                                    | 24.12  | 22.88  | 17.56      |
| S.Em.(±)                                    | 0.27                                     | 0.17   | 0.33   | 0.48       |
| CD at 5%                                    | 0.79                                     | 0.50   | 0.97   | 1.39       |
| F × N                                       | NS                                       | NS     | S      | S          |

Table 4.1.3.1. Integrated effect of FYM and nitrogen on leaf count (no. of plant<sup>-1</sup>).

| Treatment   | Leaf count (no. of plant <sup>-1</sup> ) at 60 DAS in open field |              |              |                            |              | Leaf count (no. of plant <sup>-1</sup> ) at 60 DAS in agri-horti system |              |              |                            |              |
|-------------|------------------------------------------------------------------|--------------|--------------|----------------------------|--------------|-------------------------------------------------------------------------|--------------|--------------|----------------------------|--------------|
|             | Nitrogen levels                                                  |              |              |                            | Mean         | Nitrogen levels                                                         |              |              |                            | Mean         |
| FYM levels  | N0                                                               | N60          | N90          | N120                       |              | N0                                                                      | N60          | N90          | N120                       |              |
| <b>F7</b>   | 15.30                                                            | 17.90        | 18.80        | 21.07                      | <b>18.27</b> | 15.80                                                                   | 18.00        | 19.17        | 21.40                      | <b>18.59</b> |
| <b>F10</b>  | 15.43                                                            | 18.80        | 19.80        | 22.60                      | <b>19.16</b> | 16.23                                                                   | 19.03        | 20.53        | 22.93                      | <b>19.68</b> |
| <b>F13</b>  | 14.30                                                            | 18.50        | 20.57        | 24.97                      | <b>19.58</b> | 14.07                                                                   | 19.40        | 20.73        | 25.27                      | <b>19.87</b> |
| <b>Mean</b> | <b>15.01</b>                                                     | <b>18.40</b> | <b>19.72</b> | <b>22.88</b>               | <b>19.00</b> | <b>15.37</b>                                                            | <b>18.81</b> | <b>20.14</b> | <b>23.20</b>               | <b>19.38</b> |
|             | <b>S.Em.(±) = 0.58</b>                                           |              |              | <b>CD (P= 0.05) = 1.69</b> |              | <b>S.Em.(±) = 0.70</b>                                                  |              |              | <b>CD (P= 0.05) = 2.04</b> |              |

**Nitrogen levels:** Nitrogen level improved the internodal length (cm) at all the stages of growth. As the dose of nitrogen was increased from 0 kg N ha<sup>-1</sup> to 120 kg N ha<sup>-1</sup>, thus the internodal length (cm) increased significantly. The maximum internodal length (23.30 cm) was recorded at harvest with 60 kg N ha<sup>-1</sup> from agri-horti system.

**Interaction:** Significant effect of internodal length was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>90</sub> (90 kg ha<sup>-1</sup>) interacted with each other and produced the maximum number of internodal length plant<sup>-1</sup>. F<sub>13</sub>N<sub>90</sub> treatment combination recorded maximum no. of internodal length (9.13 cm) at 20 DAS in agri-horti system.

### **Open system**

**FYM:** The internodal length (21.28 cm) with both 7 t FYM ha<sup>-1</sup> was observed in open system which was statistically at par with 13 t FYM ha<sup>-1</sup>.

**Nitrogen levels:** The internodal length (23.09 cm) was recorded from open system at harvest with dose of 60 kg N ha<sup>-1</sup> which was statistically higher to their other nitrogen levels.

**Interaction:** F<sub>7</sub>N<sub>60</sub> treatment combination showed a significant effect on the no. of internodal length (8.71 cm) observed at 20 DAS in agri-horti system.

**Table 4.1.4. Effect of FYM and nitrogen levels on internodal count (no. of plant<sup>-1</sup>) at different periods of growth under agri-horti system.**

| Treatments                                  | Internodal count (No. of plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|------------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                         | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                                |        |        |            |
| F <sub>7</sub>                              | 0.48                                           | 5.37   | 7.89   | 8.36       |
| F <sub>10</sub>                             | 0.80                                           | 5.63   | 8.46   | 8.74       |
| F <sub>13</sub>                             | 1.00                                           | 6.43   | 8.38   | 8.68       |
| S.Em.(±)                                    | 0.09                                           | 0.04   | 0.08   | 0.05       |
| CD at 5%                                    | 0.27                                           | 0.11   | 0.25   | 0.16       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                                |        |        |            |
| N <sub>0</sub>                              | 0.00                                           | 4.59   | 6.90   | 7.32       |
| N <sub>60</sub>                             | 0.66                                           | 5.97   | 8.80   | 9.10       |
| N <sub>90</sub>                             | 0.77                                           | 5.82   | 8.60   | 8.87       |
| N <sub>120</sub>                            | 1.62                                           | 6.86   | 8.67   | 9.09       |
| S.Em.(±)                                    | 0.10                                           | 0.04   | 0.10   | 0.06       |
| CD at 5%                                    | 0.31                                           | 0.13   | 0.29   | 0.18       |
| F × N                                       | NS                                             | S      | S      | S          |

**Table 4.1.4. Effect of FYM and nitrogen levels on internodal count (no. of plant<sup>-1</sup>) at different periods of growth under open field.**

| Treatments                                  | Internodal count (no. of plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|------------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                         | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                                |        |        |            |
| F <sub>7</sub>                              | 0.37                                           | 4.93   | 7.85   | 7.86       |
| F <sub>10</sub>                             | 0.77                                           | 5.17   | 8.38   | 8.66       |
| F <sub>13</sub>                             | 0.95                                           | 5.48   | 8.30   | 8.57       |
| S.Em.(±)                                    | 0.11                                           | 0.06   | 0.07   | 0.07       |
| CD at 5%                                    | 0.32                                           | 0.19   | 0.22   | 0.19       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                                |        |        |            |
| N <sub>0</sub>                              | 0.00                                           | 3.36   | 6.83   | 7.20       |
| N <sub>60</sub>                             | 0.56                                           | 5.57   | 8.71   | 8.75       |
| N <sub>90</sub>                             | 0.73                                           | 5.46   | 8.54   | 8.76       |
| N <sub>120</sub>                            | 1.49                                           | 6.39   | 8.62   | 8.96       |
| S.Em.(±)                                    | 0.12                                           | 0.07   | 0.09   | 0.08       |
| CD at 5%                                    | 0.36                                           | 0.22   | 0.25   | 0.22       |
| F × N                                       | NS                                             | NS     | S      | S          |

**Table 4.1.4.1. Integrated effect of FYM and nitrogen on internodal count (no. of plant<sup>-1</sup>).**

| Treatment   | Internodal count (no. of plant <sup>-1</sup> ) at 60 DAS in open field |             |                        |             |             | Internodal count (no. of plant <sup>-1</sup> ) at 60 DAS in agri-horti system |             |                     |             |             |
|-------------|------------------------------------------------------------------------|-------------|------------------------|-------------|-------------|-------------------------------------------------------------------------------|-------------|---------------------|-------------|-------------|
|             | Nitrogen levels                                                        |             |                        |             | Mean        | Nitrogen levels                                                               |             |                     |             | Mean        |
| FYM levels  | N0                                                                     | N60         | N90                    | N120        |             | N0                                                                            | N60         | N90                 | N120        |             |
| <b>F7</b>   | 6.30                                                                   | 8.30        | 9.10                   | 7.70        | <b>7.85</b> | 6.30                                                                          | 8.37        | 9.13                | 7.77        | <b>7.89</b> |
| <b>F10</b>  | 7.07                                                                   | 9.13        | 8.30                   | 9.03        | <b>8.38</b> | 7.13                                                                          | 9.27        | 8.37                | 9.07        | <b>8.46</b> |
| <b>F13</b>  | 7.13                                                                   | 8.70        | 8.23                   | 9.13        | <b>8.30</b> | 7.27                                                                          | 8.77        | 8.30                | 9.17        | <b>8.38</b> |
| <b>Mean</b> | <b>6.83</b>                                                            | <b>8.71</b> | <b>8.54</b>            | <b>8.62</b> | <b>8.18</b> | <b>6.90</b>                                                                   | <b>8.80</b> | <b>8.60</b>         | <b>8.67</b> | <b>8.24</b> |
|             | S.Em.(±) = 0.15                                                        |             | CD at (P= 0.05) = 0.43 |             |             | S.Em.(±) = 0.17                                                               |             | CD (P= 0.05) = 0.49 |             |             |

**Table 4.1.5. Effect of FYM and nitrogen levels on internodal length (cm) at different periods of growth under agri-horti system.**

| Treatments                                  | Internodal length (cm) |        |        |            |
|---------------------------------------------|------------------------|--------|--------|------------|
|                                             | 20 DAS                 | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                        |        |        |            |
| F <sub>7</sub>                              | 6.96                   | 16.13  | 20.20  | 21.53      |
| F <sub>10</sub>                             | 7.45                   | 16.20  | 19.01  | 21.50      |
| F <sub>13</sub>                             | 8.64                   | 18.95  | 20.78  | 21.48      |
| S.Em.(±)                                    | 0.04                   | 0.03   | 0.06   | 0.11       |
| CD at 5%                                    | 0.13                   | 0.09   | 0.16   | 1.19       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                        |        |        |            |
| N <sub>0</sub>                              | 5.87                   | 14.93  | 16.09  | 17.39      |
| N <sub>60</sub>                             | 7.03                   | 15.91  | 21.42  | 23.30      |
| N <sub>90</sub>                             | 8.00                   | 17.31  | 21.72  | 23.01      |
| N <sub>120</sub>                            | 7.17                   | 18.89  | 20.76  | 22.32      |
| S.Em.(±)                                    | 0.05                   | 0.04   | 0.06   | 0.12       |
| CD at 5%                                    | 0.15                   | 0.11   | 0.19   | 0.36       |
| F × N                                       | S                      | S      | S      | S          |

**Table 4.1.5. Effect of FYM and nitrogen levels on internodal length (cm) at different periods of growth under open field.**

| Treatments                                  | Internodal length (cm) |        |        |            |
|---------------------------------------------|------------------------|--------|--------|------------|
|                                             | 20 DAS                 | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                        |        |        |            |
| F <sub>7</sub>                              | 6.19                   | 15.75  | 19.73  | 21.28      |
| F <sub>10</sub>                             | 6.21                   | 15.97  | 18.59  | 21.19      |
| F <sub>13</sub>                             | 8.30                   | 18.76  | 20.29  | 21.28      |
| S.Em.(±)                                    | 0.07                   | 0.06   | 0.21   | 0.10       |
| CD at 5%                                    | 0.22                   | 0.19   | 0.63   | 1.41       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                        |        |        |            |
| N <sub>0</sub>                              | 6.00                   | 14.37  | 16.12  | 17.21      |
| N <sub>60</sub>                             | 6.60                   | 15.71  | 20.72  | 23.09      |
| N <sub>90</sub>                             | 7.63                   | 17.29  | 20.94  | 22.70      |
| N <sub>120</sub>                            | 6.98                   | 18.60  | 20.36  | 22.00      |
| S.Em.(±)                                    | 0.09                   | 0.07   | 0.25   | 0.12       |
| CD at 5%                                    | 0.25                   | 0.22   | 0.72   | 0.35       |
| F × N                                       | S                      | S      | S      | S          |

Table 4.1.5.1. Integrated effect of FYM and nitrogen on internodal length (cm).

| Treatment   | Internodal length (cm) at 20 DAS in open field |             |             |                     |             | Internodal length (cm) at 20 DAS in agri-horti system |             |             |                     |             |
|-------------|------------------------------------------------|-------------|-------------|---------------------|-------------|-------------------------------------------------------|-------------|-------------|---------------------|-------------|
|             | Nitrogen levels                                |             |             |                     | Mean        | Nitrogen levels                                       |             |             |                     | Mean        |
| FYM levels  | N0                                             | N60         | N90         | N120                |             | N0                                                    | N60         | N90         | N120                |             |
| <b>F7</b>   | 4.73                                           | 8.71        | 7.90        | 5.00                | <b>6.59</b> | 4.67                                                  | 8.80        | 8.13        | 5.17                | <b>6.69</b> |
| <b>F10</b>  | 5.20                                           | 5.53        | 6.70        | 7.43                | <b>6.22</b> | 5.60                                                  | 5.73        | 6.73        | 7.73                | <b>6.45</b> |
| <b>F13</b>  | 8.07                                           | 8.33        | 8.30        | 8.52                | <b>8.30</b> | 8.30                                                  | 8.53        | 9.13        | 8.60                | <b>8.64</b> |
| <b>Mean</b> | <b>6.00</b>                                    | <b>7.52</b> | <b>7.63</b> | <b>6.98</b>         | <b>7.04</b> | <b>6.19</b>                                           | <b>7.69</b> | <b>8.00</b> | <b>7.17</b>         | <b>7.26</b> |
|             | S.Em.(±) = 0.15                                |             |             | CD (P= 0.05) = 0.44 |             | S.Em.(±) = 0.09                                       |             |             | CD (P= 0.05) = 0.25 |             |

#### 4.1.6 Crop dry matter accumulation (g plant<sup>-1</sup>)

It is evident from the data table 4.1.6. revealed that crop dry matter accumulation increased with the advancement of crop growth.

##### **Agri-horti system**

**FYM:** There was a significant effect of FYM on crop dry matter accumulation (g plant<sup>-1</sup>) except 20 and 40 DAS. However, the maximum crop dry matter accumulation (59.65 g) was recorded at the time of harvest with 13 t FYM ha<sup>-1</sup> from agri-horti system.

**Nitrogen levels:** The highest crop dry matter (61.76 g) was recorded with 120 kg N ha<sup>-1</sup> at the harvest from agri-horti system.

**Interaction:** Significant effect of crop dry matter accumulation was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>0</sub> (0 kg ha<sup>-1</sup>) interacted with each other and produced the highest crop dry matter. F<sub>13</sub>N<sub>0</sub> treatment combination recorded the maximum (62.77 g).

##### **Open system**

**FYM:** The crop dry matter accumulation (58.81 g) was observed at harvest with 13 t FYM ha<sup>-1</sup> in open system.

**Nitrogen levels:** While (61.33g) with 120 kg N ha<sup>-1</sup> at harvest was recorded from open system and which was superior over all nitrogen lower levels. The minimum crop dry matter was recorded with 0 kg N ha<sup>-1</sup> at all the growth stages.

**Interaction:** Significant effect of crop dry matter accumulation was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>0</sub> (0 kg ha<sup>-1</sup>) interacted with each other and produced the higher crop dry matter. F<sub>13</sub>N<sub>0</sub> treatment combination recorded (61.67 g).

#### 4.1.7 Crop growth rate ( $\text{g day}^{-1}$ )

It is evident from the data table 4.1.7. revealed crop growth rate ( $\text{g day}^{-1}$ ) that increased with the advancement with crop growth.

##### **Agri-horti system**

**FYM:** The crop growth rate ( $1.78 \text{ g}$ ) was recorded at 40 DAS with  $13 \text{ t FYM ha}^{-1}$  from agri-horti system.

**Nitrogen levels:** The highest crop growth rate was ( $1.97 \text{ g day}^{-1}$ ) recorded with  $120 \text{ kg N ha}^{-1}$  at 40 DAS from agri-horti system.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

##### **Open system**

**FYM:** the crop growth rate ( $1.55 \text{ g}$ ) was recorded at 40 DAS with  $13 \text{ t FYM ha}^{-1}$  from open system.

**Nitrogen levels:** The crop growth rate ( $1.69 \text{ g day}^{-1}$ ) was recorded with  $120 \text{ kg N ha}^{-1}$  at 40 DAS from open system.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**Table 4.1.6. Effect of FYM and nitrogen levels on crop dry matter accumulation (g plant<sup>-1</sup>) at different periods of growth under agri-horti system.**

| Treatments                                  | Crop dry matter ( g plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|-------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                    | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                           |        |        |            |
| F <sub>7</sub>                              | 0.83                                      | 31.60  | 34.11  | 54.24      |
| F <sub>10</sub>                             | 0.88                                      | 28.43  | 35.18  | 54.05      |
| F <sub>13</sub>                             | 1.07                                      | 36.63  | 47.19  | 59.65      |
| S.Em.(±)                                    | 0.14                                      | 2.48   | 0.53   | 0.53       |
| CD at 5%                                    | NS                                        | NS     | 1.55   | 1.54       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                           |        |        |            |
| N <sub>0</sub>                              | 0.44                                      | 17.93  | 35.46  | 42.03      |
| N <sub>60</sub>                             | 1.08                                      | 35.12  | 42.09  | 59.69      |
| N <sub>90</sub>                             | 0.87                                      | 35.03  | 37.14  | 60.44      |
| N <sub>120</sub>                            | 1.30                                      | 40.79  | 40.62  | 61.76      |
| S.Em.(±)                                    | 0.16                                      | 2.87   | 0.61   | 0.61       |
| CD at 5%                                    | 0.48                                      | 8.41   | 1.79   | 1.78       |
| F × N                                       | NS                                        | NS     | S      | S          |

**Table 4.1.6. Effect of FYM and nitrogen levels on crop dry matter accumulation (g plant<sup>-1</sup>) at different periods of growth under open field.**

| Treatments                                  | Crop dry matter ( g plant <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|-------------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                    | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                           |        |        |            |
| F <sub>7</sub>                              | 0.71                                      | 29.45  | 34.98  | 54.13      |
| F <sub>10</sub>                             | 0.78                                      | 25.97  | 35.24  | 53.47      |
| F <sub>13</sub>                             | 0.94                                      | 32.03  | 46.59  | 58.81      |
| S.Em.(±)                                    | 0.14                                      | 3.15   | 0.28   | 0.25       |
| CD at 5%                                    | NS                                        | NS     | 0.82   | 0.72       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                           |        |        |            |
| N <sub>0</sub>                              | 0.44                                      | 16.11  | 35.19  | 41.93      |
| N <sub>60</sub>                             | 0.90                                      | 31.93  | 42.14  | 60.20      |
| N <sub>90</sub>                             | 0.81                                      | 33.69  | 37.54  | 58.40      |
| N <sub>120</sub>                            | 1.08                                      | 34.87  | 40.87  | 61.33      |
| S.Em.(±)                                    | 0.16                                      | 3.64   | 0.32   | 0.28       |
| CD at 5%                                    | NS                                        | 10.66  | 0.95   | 0.83       |
| F × N                                       | NS                                        | NS     | S      | S          |

**Table 4.1.6.1. Integrated effect of FYM and nitrogen on crop dry matter accumulation (g plant<sup>-1</sup>).**

| Treatment   | Crop dry matter (g plant <sup>-1</sup> ) at 60 DAS in open field |              |                     |              |              | Crop dry matter (g plant <sup>-1</sup> ) at 60 DAS in agri-horti system |              |                     |              |              |
|-------------|------------------------------------------------------------------|--------------|---------------------|--------------|--------------|-------------------------------------------------------------------------|--------------|---------------------|--------------|--------------|
|             | Nitrogen levels                                                  |              |                     |              | Mean         | Nitrogen levels                                                         |              |                     |              | Mean         |
| FYM levels  | N0                                                               | N60          | N90                 | N120         |              | N0                                                                      | N60          | N90                 | N120         |              |
| <b>F7</b>   | 26.30                                                            | 36.33        | 40.63               | 36.63        | <b>34.98</b> | 25.80                                                                   | 36.03        | 38.23               | 36.37        | <b>34.11</b> |
| <b>F10</b>  | 17.60                                                            | 60.60        | 36.47               | 26.30        | <b>35.24</b> | 17.80                                                                   | 60.03        | 36.67               | 26.23        | <b>35.18</b> |
| <b>F13</b>  | 61.67                                                            | 29.50        | 35.53               | 59.67        | <b>46.59</b> | 62.77                                                                   | 30.20        | 36.53               | 59.27        | <b>47.19</b> |
| <b>Mean</b> | <b>35.19</b>                                                     | <b>42.14</b> | <b>37.54</b>        | <b>40.87</b> | <b>38.94</b> | <b>35.46</b>                                                            | <b>42.09</b> | <b>37.14</b>        | <b>40.62</b> | <b>38.83</b> |
|             | S.Em.(±) = 0.56                                                  |              | CD (P= 0.05) = 1.64 |              |              | S.Em.(±) = 1.06                                                         |              | CD (P= 0.05) = 3.10 |              |              |

**Table 4.1.7. Effect of FYM and nitrogen levels on crop growth rate (g day<sup>-1</sup>) at different periods of growth under agri-horti system.**

| Treatments                                  | Crop growth rate (g day <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|-----------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                  | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                         |        |        |            |
| F <sub>7</sub>                              | 0.04                                    | 1.54   | 0.12   | 0.32       |
| F <sub>10</sub>                             | 0.04                                    | 1.38   | 0.14   | 0.23       |
| F <sub>13</sub>                             | 0.05                                    | 1.78   | 0.37   | 0.18       |
| S.Em.(±)                                    | 0.01                                    | 0.13   | 0.28   | 0.36       |
| CD at 5%                                    | 0.02                                    | 0.37   | 0.83   | 1.06       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                         |        |        |            |
| N <sub>0</sub>                              | 0.02                                    | 0.87   | 0.11   | 0.09       |
| N <sub>60</sub>                             | 0.05                                    | 1.70   | 0.39   | 0.15       |
| N <sub>90</sub>                             | 0.04                                    | 1.71   | 0.35   | 0.39       |
| N <sub>120</sub>                            | 0.07                                    | 1.97   | 0.01   | 0.34       |
| S.Em.(±)                                    | 0.01                                    | 0.14   | 0.33   | 0.42       |
| CD at 5%                                    | 0.02                                    | 0.42   | 0.96   | 1.23       |
| F × N                                       | NS                                      | NS     | NS     | NS         |

**Table 4.1.7. Effect of FYM and nitrogen levels on crop growth rate (g day<sup>-1</sup>) at different periods of growth under open field.**

| Treatments                                  | Crop growth rate (g day <sup>-1</sup> ) |        |        |            |
|---------------------------------------------|-----------------------------------------|--------|--------|------------|
|                                             | 20 DAS                                  | 40 DAS | 60 DAS | At harvest |
| <b>FYM levels (tonnes ha<sup>-1</sup>)</b>  |                                         |        |        |            |
| F <sub>7</sub>                              | 0.04                                    | 1.44   | 0.28   | 0.96       |
| F <sub>10</sub>                             | 0.04                                    | 1.26   | 0.46   | 0.91       |
| F <sub>13</sub>                             | 0.05                                    | 1.55   | 0.73   | 0.61       |
| S.Em.(±)                                    | 0.01                                    | 0.16   | 0.16   | 0.02       |
| CD at 5%                                    | 0.02                                    | 0.46   | 0.46   | 0.05       |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                         |        |        |            |
| N <sub>0</sub>                              | 0.02                                    | 0.78   | 0.95   | 0.34       |
| N <sub>60</sub>                             | 0.05                                    | 1.55   | 0.51   | 0.90       |
| N <sub>90</sub>                             | 0.04                                    | 1.64   | 0.19   | 1.04       |
| N <sub>120</sub>                            | 0.05                                    | 1.69   | 0.30   | 1.02       |
| S.Em.(±)                                    | 0.01                                    | 0.18   | 0.18   | 0.02       |
| CD at 5%                                    | 0.02                                    | 0.53   | 0.53   | 0.06       |
| F × N                                       | NS                                      | NS     | NS     | NS         |

## 4.2 Yield attributes

### 4.2.1 Number of panicle plant<sup>-1</sup>

Data pertaining to the number of panicle as affected by FYM and nitrogen levels are present in table 4.2.1a. and 4.2.1b., figure 4.2.1a. and 4.2.1b.

#### Agri-horti system

**FYM:** There was a significant influence on the number of panicle plant<sup>-1</sup> due to FYM fertilization. The maximum number of panicle plant<sup>-1</sup> (1.34 plant<sup>-1</sup>) was recorded with 13 tonnes FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with open system.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the number of panicle plant<sup>-1</sup>. The number of panicle plant<sup>-1</sup> was found to be significantly maximum (1.40 plant<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> from agri-horti system.

**Interaction:** Significant effect on No. of panicle plant<sup>-1</sup> was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg ha<sup>-1</sup>) interacted with each other and produced the maximum no. of panicle plant<sup>-1</sup>. F<sub>13</sub>N<sub>60</sub> treatment combination recorded maximum of (1.47 plant<sup>-1</sup>) from agri-horti system.

#### Open system

**FYM:** The number of panicle plant<sup>-1</sup> (1.33 plant<sup>-1</sup>) was recorded with 13 tonnes FYM ha<sup>-1</sup> from open system which was statistically at par with agri-horti system.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the number of panicle plant<sup>-1</sup>. The number of panicle plant<sup>-1</sup> was found to be significantly maximum (1.40 plant<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> from open system with was also found at par with agri- horti system.

**Interaction:** Significant effect on No. of panicle plant<sup>-1</sup> was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg ha<sup>-1</sup>) interacted with each other. F<sub>13</sub>N<sub>60</sub> treatment combination recorded (1.45 plant<sup>-1</sup>) from system.

#### 4.2.2 Number of panicle ( $\text{ha}^{-1}$ )

Data pertaining to the number of panicle as affected by FYM and nitrogen levels are present in table 4.2.1a. and 4.2.1b., figure 4.2.1a. and 4.2.1b.

##### **Agri-horti system**

**FYM:** There was significant influence on the number of panicle  $\text{ha}^{-1}$  due to FYM fertilization. and minimum number of panicle  $\text{ha}^{-1}$  was recorded with 7 tonnes FYM  $\text{ha}^{-1}$ . The number of panicle  $\text{ha}^{-1}$  (40548.98  $\text{ha}^{-1}$ ) was recorded with 13 tonnes FYM  $\text{ha}^{-1}$  from agri-horti system.

**Nitrogen levels:** The number of panicle  $\text{ha}^{-1}$  was found to be significantly superior with 120 kg N  $\text{ha}^{-1}$  and minimum number of panicle was recorded with 0 kg N  $\text{ha}^{-1}$ . Which produced the higher number of panicle (42487.87  $\text{ha}^{-1}$ ) from agri-horti system.

**Interaction:** Significant effect of no. of panicle  $\text{ha}^{-1}$  was observed due to FYM and nitrogen levels  $F_{13}$  (13 tonne) and  $N_{120}$  (120 kg  $\text{ha}^{-1}$ ) interacted with each other and produced the maximum No. of panicle  $\text{ha}^{-1}$  from agri-horti system.  $F_{13}N_{120}$  treatment combination recorded maximum (46389.82  $\text{ha}^{-1}$ ).

##### **Open system**

**FYM:** The number of panicle  $\text{ha}^{-1}$  (40457.31  $\text{ha}^{-1}$ ) was recorded with 13 tonnes FYM  $\text{ha}^{-1}$  from open system.

**Nitrogen levels:** While ( 42431.76  $\text{ha}^{-1}$ ) with 120 kg N  $\text{ha}^{-1}$  was observed from open system.

**Interaction:** Significant effect of no. of panicle  $\text{ha}^{-1}$  was observed due to FYM and nitrogen levels  $F_{13}$  (13 tonne) and  $N_{120}$  (120 kg  $\text{ha}^{-1}$ ) interacted with each other and it also produced the maximum no. of panicle  $\text{ha}^{-1}$  in open system.  $F_{13}N_{120}$  treatment combination recorded maximum of (46389.82  $\text{ha}^{-1}$ ).

### 4.2.3 Length of Panicle (cm)

Data pertaining to the length of panicle (cm) as affected by FYM and nitrogen levels are present in table 4.2.1a. and 4.2.1b., figure 4.2.1a. and 4.2.1b.

#### Agri-horti system

**FYM:** There was a significant influence on the length of particle (cm) due to FYM fertilization. The maximum length of panicle (25.95 cm) was recorded with 13 tonnes FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with the produce from open system from same level of FYM.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the length of particle (cm). The minimum panicle length was recorded with 0 kg N ha<sup>-1</sup>. The length of panicle (cm) with 90 kg N ha<sup>-1</sup> recorded panicle length (25.42 cm) from agri-horti system.

**Interaction:** Significant effect of length of panicle was observed due to FYM and nitrogen levels F<sub>10</sub> (10 tonnes ha<sup>-1</sup>) and N<sub>0</sub> (0 kg ha<sup>-1</sup>) interacted with each other. F<sub>10</sub>N<sub>0</sub> treatment combination recorded (27.57 cm) from agri-horti system.

#### Open system

**FYM:** The length of panicle (25.86 cm) was recorded with 13 tonnes FYM ha<sup>-1</sup> from open system.

**Nitrogen levels:** While the length of panicle (24.99 cm) with 60 kg N ha<sup>-1</sup> was recorded from open system.

**Interaction:** Significant effect of length of panicle was observed due to FYM and nitrogen levels F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (90 kg ha<sup>-1</sup>) interacted with each other. F<sub>13</sub>N<sub>60</sub> treatment combination recorded maximum of (26.96 cm) from open system.

#### 4.2.4 Girth of panicle (cm)

Data pertaining to the girth of panicle (cm) as affected by FYM and nitrogen levels are present in table 4.2.1a. and 4.2.1b.

##### **Agri-horti system**

**FYM:** There was a significant effect on the girth of panicle (cm) due to FYM fertilization. Maximum girth of panicle (9.32 cm) was recorded with 10 tonnes FYM ha<sup>-1</sup> from agri- horti system which was statistically at par with the open system.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the girth of panicle (cm) and was found to be significant. The girth of panicle (cm) was found to be significantly superior at 60 kg N ha<sup>-1</sup> and produced the maximum girth of panicle (9.35 cm) from agri- horti system.

**Interaction:** Significant effect of girth of panicle (cm) was observed due to FYM and nitrogen levels F<sub>10</sub> (10 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg ha<sup>-1</sup>) interacted with each other. F<sub>10</sub>N<sub>60</sub> treatment combination recorded (10.71 cm) from agri- horti system.

##### **Open system**

**FYM:** The girth of panicle (9.31 cm) was observed with the dose of 10 tonnes FYM ha<sup>-1</sup> from open system.

**Nitrogen levels:** While girth of panicle (9.25 cm) with 60 kg N ha<sup>-1</sup> was recorded in open system and minimum girth of panicle was recorded with 0 kg N ha<sup>-1</sup>.

**Interaction:** Significant effect of girth of panicle (cm) was observed due to FYM and nitrogen levels F<sub>10</sub> (10 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg ha<sup>-1</sup>) interacted with each other. F<sub>10</sub>N<sub>60</sub> treatment combination recorded (10.66 cm) from open system.

**Table 4.2.1a. Effect of FYM and nitrogen levels on yield attributes under agri-horti system.**

| Treatments                                  | Number of panicle plant <sup>-1</sup> | Number of panicle (ha <sup>-1</sup> ) | Length of panicle (cm) | Girth of panicle (cm) | Number of grain panicle <sup>-1</sup> |
|---------------------------------------------|---------------------------------------|---------------------------------------|------------------------|-----------------------|---------------------------------------|
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                                       |                                       |                        |                       |                                       |
| F <sub>7</sub>                              | 1.19                                  | 37634.41                              | 23.96                  | 8.10                  | 1431.22                               |
| F <sub>10</sub>                             | 1.24                                  | 38102.52                              | 25.03                  | 9.32                  | 1919.50                               |
| F <sub>13</sub>                             | 1.34                                  | 40548.98                              | 25.95                  | 9.00                  | 1948.70                               |
| S.Em.(±)                                    | 0.02                                  | 76.76                                 | 0.15                   | 0.05                  | 47.49                                 |
| CD at 5%                                    | 0.07                                  | 225.13                                | 0.43                   | 0.14                  | 139.28                                |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                       |                                       |                        |                       |                                       |
| N <sub>0</sub>                              | 1.05                                  | 32587.78                              | 24.82                  | 8.06                  | 1164.63                               |
| N <sub>60</sub>                             | 1.24                                  | 39820.68                              | 24.60                  | 9.35                  | 1953.66                               |
| N <sub>90</sub>                             | 1.34                                  | 40151.54                              | 25.42                  | 9.03                  | 1899.28                               |
| N <sub>120</sub>                            | 1.40                                  | 42487.87                              | 25.09                  | 8.79                  | 2048.32                               |
| S.Em.(±)                                    | 0.03                                  | 88.63                                 | 0.17                   | 0.06                  | 54.84                                 |
| CD at 5%                                    | 0.08                                  | 259.96                                | 0.49                   | 0.17                  | 160.83                                |
| F × N                                       | S                                     | S                                     | S                      | S                     | S                                     |

**Table 4.2.1b. Effect of FYM and nitrogen levels on yield attributes under open field.**

| Treatments                                  | Number of panicle plant <sup>-1</sup> | Number of panicle (ha <sup>-1</sup> ) | Length of panicle (cm) | Girth of panicle (cm) | Number of grain panicle <sup>-1</sup> |
|---------------------------------------------|---------------------------------------|---------------------------------------|------------------------|-----------------------|---------------------------------------|
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                                       |                                       |                        |                       |                                       |
| F <sub>7</sub>                              | 1.19                                  | 37475.66                              | 24.00                  | 8.15                  | 1420.39                               |
| F <sub>10</sub>                             | 1.24                                  | 37994.18                              | 24.61                  | 9.31                  | 1906.16                               |
| F <sub>13</sub>                             | 1.33                                  | 40457.31                              | 25.86                  | 8.87                  | 1946.45                               |
| S.Em.(±)                                    | 0.02                                  | 84.70                                 | 0.18                   | 0.05                  | 46.58                                 |
| CD at 5%                                    | 0.07                                  | 248.43                                | 0.54                   | 0.14                  | 136.62                                |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                       |                                       |                        |                       |                                       |
| N <sub>0</sub>                              | 1.05                                  | 32465.56                              | 24.73                  | 8.07                  | 1178.30                               |
| N <sub>60</sub>                             | 1.23                                  | 39698.46                              | 24.99                  | 9.25                  | 1938.10                               |
| N <sub>90</sub>                             | 1.35                                  | 39973.77                              | 24.75                  | 9.01                  | 1889.28                               |
| N <sub>120</sub>                            | 1.40                                  | 42431.76                              | 24.82                  | 8.78                  | 2024.98                               |
| S.Em.(±)                                    | 0.03                                  | 97.81                                 | 0.21                   | 0.05                  | 53.79                                 |
| CD at 5%                                    | 0.08                                  | 286.86                                | 0.62                   | 0.16                  | 157.76                                |
| F × N                                       | S                                     | S                                     | S                      | S                     | S                                     |

**Fig. 4.2.1a. Effect of FYM and nitrogen levels on yield attributes under agri-horti system.**

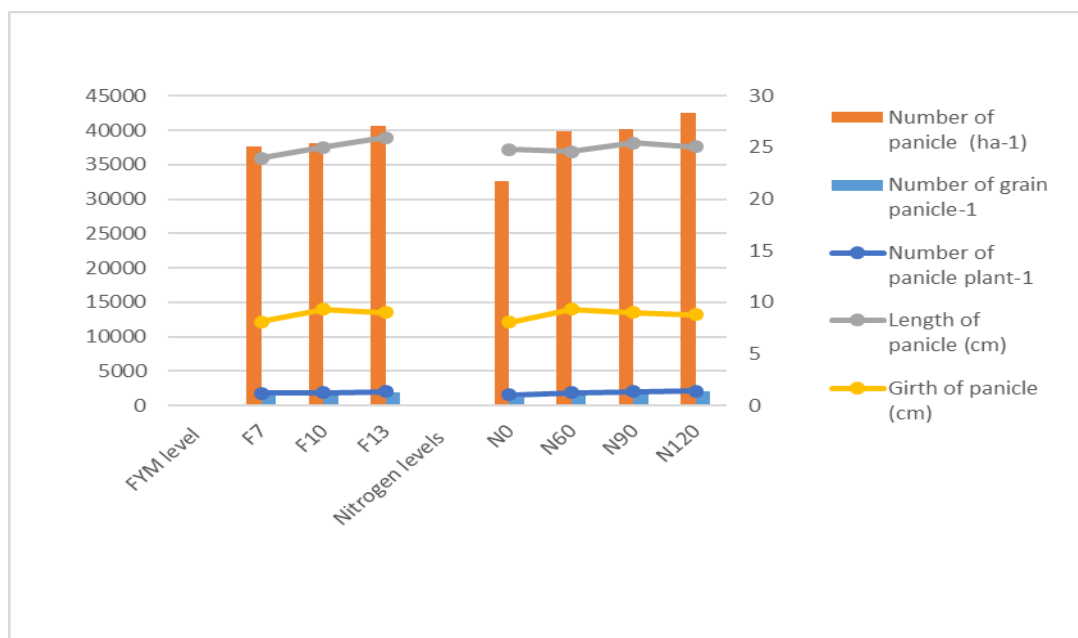


**Fig. 4.2.1b. Effect of FYM and nitrogen levels on yield attributes under open field.**

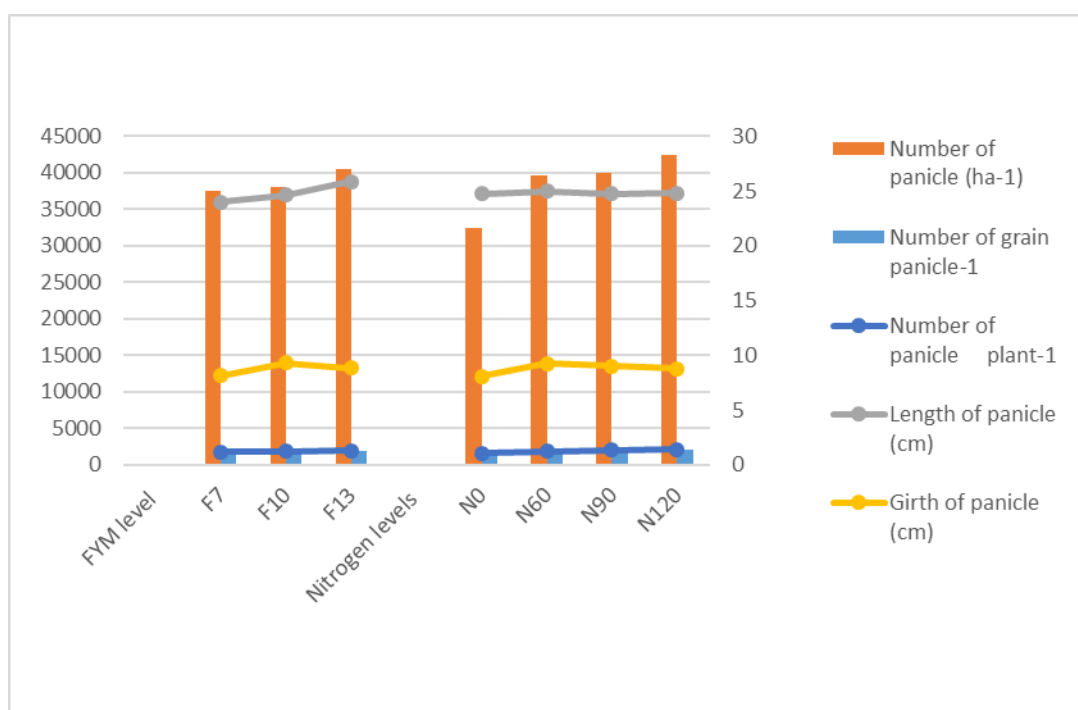


Table 4.2.1.1. Integrated effect of FYM and nitrogen on number of panicle (no. plant<sup>-1</sup>)

| Treatment       | Number of panicle (plant <sup>-1</sup> ) in open field |                 |                 |                  |                     | Number of panicle (plant <sup>-1</sup> ) in agri-horti system |                 |                 |                  |                     |
|-----------------|--------------------------------------------------------|-----------------|-----------------|------------------|---------------------|---------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                                        |                 |                 |                  | Mean                | Nitrogen levels                                               |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                                         | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                                | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 1.00                                                   | 1.12            | 1.32            | 1.34             | <b>1.19</b>         | 1.00                                                          | 1.12            | 1.32            | 1.34             | <b>1.19</b>         |
| F <sub>10</sub> | 1.07                                                   | 1.14            | 1.35            | 1.42             | <b>1.24</b>         | 1.07                                                          | 1.14            | 1.35            | 1.42             | <b>1.24</b>         |
| F <sub>13</sub> | 1.07                                                   | 1.45            | 1.37            | 1.44             | <b>1.33</b>         | 1.07                                                          | 1.47            | 1.36            | 1.45             | <b>1.34</b>         |
| Mean            | <b>1.05</b>                                            | <b>1.23</b>     | <b>1.35</b>     | <b>1.40</b>      | <b>1.26</b>         | <b>1.05</b>                                                   | <b>1.24</b>     | <b>1.34</b>     | <b>1.40</b>      | <b>1.26</b>         |
|                 | S.Em.(±) = 0.04                                        |                 |                 |                  | CD (P= 0.05) = 0.13 | S.Em.(±) = 0.05                                               |                 |                 |                  | CD (P= 0.05) = 0.14 |

Table 4.2.2.1. Integrated effect of FYM and nitrogen on number of panicle (no. ha<sup>-1</sup>)

| Treatment       | Number of panicle (ha <sup>-1</sup> ) in open field |                 |                 |                  |                       | Number of panicle (ha <sup>-1</sup> ) in agri-horti system |                 |                 |                  |                       |
|-----------------|-----------------------------------------------------|-----------------|-----------------|------------------|-----------------------|------------------------------------------------------------|-----------------|-----------------|------------------|-----------------------|
|                 | Nitrogen levels                                     |                 |                 |                  | Mean                  | Nitrogen levels                                            |                 |                 |                  | Mean                  |
| FYM levels      | N <sub>0</sub>                                      | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                       | N <sub>0</sub>                                             | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                       |
| F <sub>7</sub>  | 31171.4                                             | 39041.83        | 39627.93        | 40061.48         | <b>37475.66</b>       | 31338.07                                                   | 39208.5         | 39927.93        | 40063.15         | <b>37634.41</b>       |
| F <sub>10</sub> | 31773.63                                            | 39613.73        | 39745.4         | 40843.97         | <b>37994.18</b>       | 31940.3                                                    | 39647.07        | 39812.07        | 41010.63         | <b>38102.52</b>       |
| F <sub>13</sub> | 34451.65                                            | 40439.8         | 40547.97        | 46389.82         | <b>40457.31</b>       | 34484.98                                                   | 40606.47        | 40714.63        | 46389.82         | <b>40548.98</b>       |
| Mean            | <b>32465.56</b>                                     | <b>39698.46</b> | <b>39973.77</b> | <b>42431.76</b>  | <b>38642.38</b>       | <b>32587.78</b>                                            | <b>39820.68</b> | <b>40151.54</b> | <b>42487.87</b>  | <b>38761.97</b>       |
|                 | S.Em.(±) = 169.41                                   |                 |                 |                  | CD (P= 0.05) = 496.86 | S.Em.(±) = 153.53                                          |                 |                 |                  | CD (P= 0.05) = 450.27 |

Table 4.2.3.1. Integrated effect of FYM and nitrogen on length of panicle (cm).

| Treatment       | Length of panicle (cm) in open field |                 |                 |                  |                     | Length of panicle (cm) in agri-horti system |                 |                 |                  |                     |
|-----------------|--------------------------------------|-----------------|-----------------|------------------|---------------------|---------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                      |                 |                 |                  | Mean                | Nitrogen levels                             |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                       | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                              | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 23.17                                | 25.17           | 23.46           | 24.19            | <b>24.00</b>        | 23.21                                       | 24.62           | 24.11           | 23.90            | <b>23.96</b>        |
| F <sub>10</sub> | 26.90                                | 22.84           | 24.75           | 23.93            | <b>24.61</b>        | 27.57                                       | 22.63           | 25.14           | 24.78            | <b>25.03</b>        |
| F <sub>13</sub> | 24.10                                | 26.96           | 26.05           | 26.33            | <b>25.86</b>        | 23.66                                       | 26.55           | 27.00           | 26.58            | <b>25.95</b>        |
| Mean            | <b>24.73</b>                         | <b>24.99</b>    | <b>24.75</b>    | <b>24.82</b>     | <b>24.82</b>        | <b>24.82</b>                                | <b>24.60</b>    | <b>25.42</b>    | <b>25.09</b>     | <b>24.98</b>        |
|                 | S.Em.(±) = 0.37                      |                 |                 |                  | CD (P= 0.05) = 1.07 | S.Em.(±) = 0.29                             |                 |                 |                  | CD (P= 0.05) = 0.85 |

Table 4.2.4.1. Integrated effect of FYM and nitrogen on girth of panicle (cm).

| Treatment       | Girth of panicle (cm) in open field |                 |                 |                  |                     | Girth of panicle (cm) in agri-horti system |                 |                 |                  |                     |
|-----------------|-------------------------------------|-----------------|-----------------|------------------|---------------------|--------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                     |                 |                 |                  | Mean                | Nitrogen levels                            |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                      | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                             | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 7.34                                | 8.47            | 9.15            | 7.63             | <b>8.15</b>         | 7.36                                       | 8.57            | 9.08            | 7.40             | <b>8.10</b>         |
| F <sub>10</sub> | 8.54                                | 10.66           | 8.69            | 9.36             | <b>9.31</b>         | 8.56                                       | 10.71           | 8.70            | 9.32             | <b>9.32</b>         |
| F <sub>13</sub> | 8.31                                | 8.62            | 9.18            | 9.36             | <b>8.87</b>         | 8.25                                       | 8.77            | 9.31            | 9.67             | <b>9.00</b>         |
| Mean            | <b>8.07</b>                         | <b>9.25</b>     | <b>9.01</b>     | <b>8.78</b>      | <b>8.78</b>         | <b>8.06</b>                                | <b>9.35</b>     | <b>9.03</b>     | <b>8.79</b>      | <b>8.81</b>         |
|                 | S.Em.(±) = 0.09                     |                 |                 |                  | CD (P= 0.05) = 0.28 | S.Em.(±) = 0.10                            |                 |                 |                  | CD (P= 0.05) = 0.29 |

Table 4.2.5.1. Integrated effect of FYM and nitrogen on number of grain panicle<sup>-1</sup>.

| Treatment       | Number of grain panicle <sup>-1</sup> in open field |                 |                 |                       |                | Number of grain panicle <sup>-1</sup> in agri-horti system |                 |                 |                       |                |
|-----------------|-----------------------------------------------------|-----------------|-----------------|-----------------------|----------------|------------------------------------------------------------|-----------------|-----------------|-----------------------|----------------|
|                 | Nitrogen levels                                     |                 |                 |                       | Mean           | Nitrogen levels                                            |                 |                 |                       | Mean           |
| FYM levels      | N <sub>0</sub>                                      | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>      |                | N <sub>0</sub>                                             | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>      |                |
| F <sub>7</sub>  | 1042.36                                             | 1408.63         | 1465.51         | 1765.05               | <b>1420.39</b> | 1035.69                                                    | 1441.96         | 1475.51         | 1771.72               | <b>1431.22</b> |
| F <sub>10</sub> | 1218.66                                             | 2276.66         | 2039.98         | 2089.36               | <b>1906.16</b> | 1225.32                                                    | 2283.32         | 2046.64         | 2122.70               | <b>1919.50</b> |
| F <sub>13</sub> | 1273.88                                             | 2129.02         | 2162.35         | 2220.53               | <b>1946.45</b> | 1232.88                                                    | 2135.69         | 2175.69         | 2250.53               | <b>1948.70</b> |
| Mean            | <b>1178.30</b>                                      | <b>1938.10</b>  | <b>1889.28</b>  | <b>2024.98</b>        | <b>1757.67</b> | <b>1164.63</b>                                             | <b>1953.66</b>  | <b>1899.28</b>  | <b>2048.32</b>        | <b>1766.47</b> |
|                 | S.Em.(±) = 93.16                                    |                 |                 | CD (P= 0.05) = 273.24 |                | S.Em.(±) = 94.98                                           |                 |                 | CD (P= 0.05) = 278.57 |                |

#### 4.2.5 Number of grain panicle<sup>-1</sup>

A critical analysis of the data clearly indicates that there was significant variation in number of grain panicle<sup>-1</sup> due to FYM and nitrogen levels. The data pertaining to the no. of grains panicle<sup>-1</sup> are presented in the table 4.2.1a. and 4.2.1b., figure 4.2.1a. and 4.2.1b.

##### **Agri-horti system**

**FYM:** There was significant effect on the number of grain panicle<sup>-1</sup> due to FYM fertilization. Maximum number of grain (1948.70 panicle<sup>-1</sup>) was recorded with 13 t FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with open system.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the number of grain panicle<sup>-1</sup> and found to be significantly superior with 120 kg N ha<sup>-1</sup>, and minimum number of grain was recorded with 0 kg N ha<sup>-1</sup>. The N<sub>120</sub> level produced the maximum number of grain (2048.32 panicle<sup>-1</sup>) from agri-horti system.

**Interaction:** Significant effect on number of grain panicle<sup>-1</sup> due to the FYM and nitrogen levels was observed F<sub>10</sub> (10 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg N ha<sup>-1</sup>) interacted with each other and produced the maximum number of grain panicle<sup>-1</sup>. F<sub>10</sub>N<sub>60</sub> treatment combination recorded maximum number of grain (2283.32 panicle<sup>-1</sup>) in agri-horti system.

##### **Open system**

**FYM:** The number of grain (1946.45 panicle<sup>-1</sup>) was also recorded with 13 kg FYM ha<sup>-1</sup> from open system.

**Nitrogen levels:** While the number of grain (2024.98 panicle<sup>-1</sup>) was observed in open system.

**Interaction:** Significant effect on number of grain panicle<sup>-1</sup> due to the FYM and nitrogen levels was observed. F<sub>10</sub> (10 tonnes ha<sup>-1</sup>) and N<sub>60</sub> (60 kg N ha<sup>-1</sup>) interacted with each other and produced the maximum number of grain panicle<sup>-1</sup>. F<sub>10</sub>N<sub>60</sub>

treatment combination recorded maximum number of grain (2276.66 panicle<sup>-1</sup>) in open system.

#### 4.2.6 Test weight (g)

A critical analysis of the data clearly indicates that there was significant variation in 1000 grain weight due to FYM and nitrogen levels. The data pertaining to the test weight are present in table 4.2.2a and 4.2.2b., figure 4.2.2a. and 4.2.2b.

##### **Agri-horti system**

**FYM:** There was a significant effect on the test weight (g) due to FYM fertilization. Maximum test weight (9.54 g) was recorded with 10 tonnes FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with open system.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the test weight (g) and the minimum test weight was recorded with 0 kg N ha<sup>-1</sup>. The test weight was found to be significantly maximum (9.59 g) with 120 kg N ha<sup>-1</sup> from agri-horti system and was also found statistically at par with open system.

**Interaction:** Significant effect of test weight due to FYM and nitrogen levels was observed. F<sub>10</sub> (10 t ha<sup>-1</sup>) and N<sub>60</sub> level (60 kg N ha<sup>-1</sup>) interacted with each other and produced the maximum test weight. F<sub>10</sub>N<sub>60</sub> treatment combination recorded maximum test weight (12.15 g) from agri-horti system.

##### **Open system**

**FYM:** The significant effect on the test weight (g) due to FYM fertilization was also observed in open. The test weight (9.51 g) was recorded with FYM.

**Nitrogen levels:** The test weight (9.57 g) was observed with 120 kg N ha<sup>-1</sup> from open system.

**Interaction:** Significant effect of test weight due to FYM and nitrogen levels was observed. F<sub>10</sub> (10 T ha<sup>-1</sup>) and N<sub>60</sub> level (60 kg N ha<sup>-1</sup>) interacted with each other. F<sub>10</sub>N<sub>60</sub> treatment combination recorded test weight (12.12 g) from open system.

#### 4.2.7 Grain yield (kg ha<sup>-1</sup>)

A critical analysis of the data clearly indicates that there was a significant variation in grain yield due to FYM and nitrogen levels. The data pertaining to the grain yield are presented in table 4.2.2a and 4.2.2b. figure 4.2.2a. and 4.2.2b.

##### **Agri-horti system**

**FYM:** There was a significant effect on the grain yield due to FYM fertilization. Maximum grain yield (2115.43 kg ha<sup>-1</sup>) was recorded with 13 t FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with open system.

**Nitrogen levels:** The grain yield was found to be significantly superior and recorded higher grain yield (2303.27 kg ha<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> from agri-horti system.

**Interaction:** Significant effect of grain yield due to FYM and nitrogen levels was observed. F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) interacted with each other. F<sub>13</sub>N<sub>120</sub> treatment combination recorded maximum grain yield (2495.86 kg ha<sup>-1</sup>) from agri-horti system.

##### **Open system**

**FYM:** The grain yield (2107.85 kg ha<sup>-1</sup>) was found with same level of FYM from open system.

**Nitrogen levels:** While the grain yield (2283.27 kg ha<sup>-1</sup>) was also found with same level from the open system.

**Interaction:** Significant effect of grain yield due to FYM and nitrogen levels was observed. F<sub>13</sub> (13 tonnes ha<sup>-1</sup>) and N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) interacted with each other. F<sub>13</sub>N<sub>120</sub> treatment combination exhibited grain yield (2489.20 kg ha<sup>-1</sup>) from open system.

#### 4.2.8 Stover yield ( $\text{kg ha}^{-1}$ )

Critical analyses of the data pertaining to the stover yield are present in table 4.2.2a and 4.2.2b, figure 4.2.2a. and 4.2.2b.

##### **Agri-horti system**

**FYM:** There was a significant effect on the stover yield ( $\text{kg ha}^{-1}$ ) due to FYM fertilization. The highest stover yield ( $5046.14 \text{ kg ha}^{-1}$ ) was recorded with  $13 \text{ t ha}^{-1}$  of FYM from agri-horti system.

**Nitrogen levels:** There was a significant effect of nitrogen on stover yield ( $\text{kg ha}^{-1}$ ). However, the stover yield ( $4992.57 \text{ kg ha}^{-1}$ ) was recorded with  $120 \text{ kg N ha}^{-1}$  from agri-horti system. The lowest was observed in  $\text{N}_0$  levels.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

##### **Open system**

**FYM:** In the open system stover yield ( $4955.56 \text{ kg ha}^{-1}$ ) was recorded from  $13 \text{ t FYM ha}^{-1}$  and lower was recorded with  $7 \text{ t FYM ha}^{-1}$ .

**Nitrogen levels:** The stover yield ( $4980.46 \text{ kg ha}^{-1}$ ) was observed from open system. The lowest was observed with  $\text{N}_0$  levels.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

#### 4.2.9 Biological yield ( $\text{kg ha}^{-1}$ )

The data pertaining to the biological yield are present in table 4.2.2a and 4.2.2b., figure 4.2.2a. and 4.2.2b.

**Agri-horti system**

**FYM:** There was a significant influence on the biological yield due to FYM fertilization. The biological yield ( $7161.57 \text{ kg ha}^{-1}$ ) was recorded with  $13 \text{ t FYM ha}^{-1}$ . The minimum biological yield ( $5868.43 \text{ kg ha}^{-1}$ ) was recorded with  $7 \text{ t FYM ha}^{-1}$  from agri-horti system.

**Nitrogen levels:** The favourable effect of nitrogen levels was recorded on the biological yield. The maximum biological yield ( $7295.84 \text{ kg ha}^{-1}$ ) was observed from agri-horti system with  $120 \text{ kg N ha}^{-1}$  while the minimum biological yield ( $5749.34 \text{ kg ha}^{-1}$ ) was observed from  $0 \text{ kg N ha}^{-1}$ .

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**Open system**

**FYM:** The biological yield ( $7063.41 \text{ kg ha}^{-1}$ ) was recorded with  $13 \text{ t FYM ha}^{-1}$  from open field while biological yield ( $5853.51 \text{ kg ha}^{-1}$ ) was obtained with  $7 \text{ t FYM ha}^{-1}$  in open field.

**Nitrogen levels:** The biological yield was found to be significantly superior by  $120 \text{ kg N ha}^{-1}$  produced the biological yield ( $5853.51 \text{ kg ha}^{-1}$ ) while the least biological yield ( $5608.57 \text{ kg ha}^{-1}$ ) observed with  $0 \text{ kg N ha}^{-1}$  from open field.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**4.2.10 Harvest index (%)****Agri-horti system**

**FYM:** There was no significant effect of FYM on harvest index. However, the maximum harvest index ( $29.81 \%$ ) was recorded with  $10 \text{ t FYM ha}^{-1}$  from agri-horti system.

**Nitrogen levels:** Favourable effect of nitrogen levels was recorded on the harvest index (%). The harvest index was found to be significantly maximum (31.56 %) with 120 kg N ha<sup>-1</sup> and minimum harvest index (28.38 %) was recorded with 0 kg N ha<sup>-1</sup>.

**Interaction:** Significant effect of harvest index due to FYM and nitrogen levels was observed. F<sub>10</sub> level (10 t FYM ha<sup>-1</sup>) and N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) interacted with each other and produced the highest harvest index. F<sub>10</sub>N<sub>120</sub> treatment combination recorded maximum harvest index (30.02 %) from sole cropping field.

### **Open system**

**FYM:** While the harvest index (30.13 %) was recorded with 13 t FYM ha<sup>-1</sup> from open field with same level of FYM.

**Nitrogen levels:** The harvest index was found to be significantly maximum (31.40 %) with 120 kg N ha<sup>-1</sup> was found from sole cropping.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**Table 4.2.2a. Effect of FYM and nitrogen levels on yield attributes in agri-horti system.**

| Treatments                                  | Test weight (g) | Grain yield (kg ha <sup>-1</sup> ) | Stover yield (kg ha <sup>-1</sup> ) | Biological yield (kg ha <sup>-1</sup> ) | Harvest index (%) |
|---------------------------------------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------------|-------------------|
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                 |                                    |                                     |                                         |                   |
| F <sub>7</sub>                              | 6.45            | 1728.33                            | 4140.10                             | 5868.43                                 | 29.43             |
| F <sub>10</sub>                             | 9.54            | 2024.19                            | 4731.92                             | 6756.11                                 | 29.81             |
| F <sub>13</sub>                             | 9.39            | 2115.43                            | 5046.14                             | 7161.57                                 | 29.49             |
| S.Em.(±)                                    | 0.18            | 38.09                              | 85.53                               | 100.67                                  | 0.51              |
| CD at 5%                                    | 0.53            | 105.85                             | 250.85                              | 295.24                                  | 1.51              |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                 |                                    |                                     |                                         |                   |
| N <sub>0</sub>                              | 6.14            | 1622.07                            | 4127.27                             | 5749.34                                 | 28.38             |
| N <sub>60</sub>                             | 9.00            | 1801.22                            | 4558.69                             | 6359.92                                 | 28.40             |
| N <sub>90</sub>                             | 9.10            | 2097.38                            | 4879.01                             | 6976.39                                 | 29.98             |
| N <sub>120</sub>                            | 9.59            | 2303.27                            | 4992.57                             | 7295.84                                 | 31.56             |
| S.Em.(±)                                    | 0.21            | 41.67                              | 98.76                               | 116.24                                  | 0.59              |
| CD at 5%                                    | 0.61            | 122.23                             | 289.66                              | 340.92                                  | 1.74              |
| F × N                                       | S               | S                                  | NS                                  | NS                                      | S                 |

**Table 4.2.2b. Effect of FYM and nitrogen levels on yield attributes in open system.**

| Treatments                                  | Test weight (g) | Grain yield (kg ha <sup>-1</sup> ) | Stover yield (kg ha <sup>-1</sup> ) | Biological yield (kg ha <sup>-1</sup> ) | Harvest index (%) |
|---------------------------------------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------------|-------------------|
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                 |                                    |                                     |                                         |                   |
| F <sub>7</sub>                              | 6.41            | 1719.66                            | 4133.85                             | 5853.51                                 | 29.37             |
| F <sub>10</sub>                             | 9.51            | 2003.36                            | 4830.26                             | 6833.61                                 | 29.12             |
| F <sub>13</sub>                             | 9.35            | 2107.85                            | 4955.56                             | 7063.41                                 | 30.13             |
| S.Em.(±)                                    | 0.17            | 36.92                              | 107.52                              | 96.45                                   | 1.01              |
| CD at 5%                                    | 0.52            | 108.29                             | 315.33                              | 282.88                                  | 2.95              |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                 |                                    |                                     |                                         |                   |
| N <sub>0</sub>                              | 6.11            | 1611.29                            | 3997.27                             | 5608.57                                 | 29.22             |
| N <sub>60</sub>                             | 8.96            | 1798.11                            | 4715.36                             | 6513.47                                 | 27.64             |
| N <sub>90</sub>                             | 9.06            | 2081.82                            | 4866.45                             | 6948.28                                 | 29.91             |
| N <sub>120</sub>                            | 9.57            | 2283.27                            | 4980.46                             | 7263.73                                 | 31.40             |
| S.Em.(±)                                    | 0.20            | 42.63                              | 124.15                              | 111.37                                  | 1.16              |
| CD at 5%                                    | 0.59            | 125.04                             | 364.11                              | 326.64                                  | 3.41              |
| F × N                                       | S               | S                                  | NS                                  | NS                                      | NS                |

Table 4.2.6.1. Integrated effect of FYM and nitrogen on test weight (g).

| Treatment       | Test weight (g) in open system |                 |                 |                    |             | Test weight (g) in agri-horti system |                 |                 |                    |             |
|-----------------|--------------------------------|-----------------|-----------------|--------------------|-------------|--------------------------------------|-----------------|-----------------|--------------------|-------------|
|                 | Nitrogen levels                |                 |                 |                    | Mean        | Nitrogen levels                      |                 |                 |                    | Mean        |
| FYM levels      | N <sub>0</sub>                 | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>   |             | N <sub>0</sub>                       | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>   |             |
| F <sub>7</sub>  | 4.54                           | 5.61            | 7.35            | 8.16               | <b>6.42</b> | 4.57                                 | 5.64            | 7.42            | 8.17               | <b>6.45</b> |
| F <sub>10</sub> | 6.30                           | 12.12           | 9.49            | 10.14              | <b>9.51</b> | 6.33                                 | 12.15           | 9.52            | 10.16              | <b>9.54</b> |
| F <sub>13</sub> | 7.48                           | 9.16            | 10.34           | 10.42              | <b>9.35</b> | 7.51                                 | 9.23            | 10.36           | 10.45              | <b>9.39</b> |
| Mean            | <b>6.11</b>                    | <b>8.96</b>     | <b>9.06</b>     | <b>9.57</b>        | <b>8.43</b> | <b>6.14</b>                          | <b>9.01</b>     | <b>9.10</b>     | <b>9.59</b>        | <b>8.46</b> |
|                 | S.Em.(±) = 0.35                |                 |                 | CD (P=0.05) = 1.04 |             | S.Em.(±) = 0.36                      |                 |                 | CD (P=0.05) = 1.06 |             |

Table 4.2.7.1. Integrated effect of FYM and nitrogen on grain yield (kg ha<sup>-1</sup>).

| Treatment       | Grain yield (kg ha <sup>-1</sup> ) in open system |                 |                 |                      |                | Grain yield (kg ha <sup>-1</sup> ) in agri-horti system |                 |                 |                      |                |
|-----------------|---------------------------------------------------|-----------------|-----------------|----------------------|----------------|---------------------------------------------------------|-----------------|-----------------|----------------------|----------------|
|                 | Nitrogen levels                                   |                 |                 |                      | Mean           | Nitrogen levels                                         |                 |                 |                      | Mean           |
| FYM levels      | N <sub>0</sub>                                    | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>     |                | N <sub>0</sub>                                          | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>     |                |
| F <sub>7</sub>  | 1498.68                                           | 1582.36         | 1797.97         | 1999.65              | <b>1719.66</b> | 1499.34                                                 | 1589.69         | 1804.64         | 2019.65              | <b>1728.33</b> |
| F <sub>10</sub> | 1508.82                                           | 1994.55         | 2149.09         | 2360.96              | <b>2003.36</b> | 1525.49                                                 | 1994.55         | 2182.42         | 2394.30              | <b>2024.19</b> |
| F <sub>13</sub> | 1826.38                                           | 1817.41         | 2298.41         | 2489.20              | <b>2107.85</b> | 1841.38                                                 | 1819.41         | 2305.07         | 2495.86              | <b>2115.43</b> |
| Mean            | <b>1611.29</b>                                    | <b>1798.11</b>  | <b>2081.82</b>  | <b>2283.27</b>       | <b>1943.62</b> | <b>1622.07</b>                                          | <b>1801.22</b>  | <b>2097.38</b>  | <b>2303.27</b>       | <b>1955.98</b> |
|                 | S.Em.(±) = 73.84                                  |                 |                 | CD (P=0.05) = 216.58 |                | S.Em.(±) = 72.18                                        |                 |                 | CD (P=0.05) = 211.70 |                |

Table 4.2.8.1. Integrated effect of FYM and nitrogen on harvest index (%).

| Treatment       | Harvest index (%) in agri-horti system |                 |                    |                  | Mean  |
|-----------------|----------------------------------------|-----------------|--------------------|------------------|-------|
|                 | Nitrogen levels                        |                 |                    |                  |       |
| FYM levels      | N <sub>0</sub>                         | N <sub>60</sub> | N <sub>90</sub>    | N <sub>120</sub> |       |
| F <sub>7</sub>  | 29.49                                  | 28.06           | 29.10              | 31.06            | 29.43 |
| F <sub>10</sub> | 25.42                                  | 31.30           | 30.51              | 32.02            | 29.81 |
| F <sub>13</sub> | 30.21                                  | 25.85           | 30.32              | 31.59            | 29.49 |
| Mean            | 28.38                                  | 28.40           | 29.98              | 31.56            | 29.58 |
| S.Em.(±) = 1.03 |                                        |                 | CD (P=0.05) = 3.02 |                  |       |

**Fig. 4.2.2a Effect of FYM and nitrogen level in yield attributes under agri-horti system.**

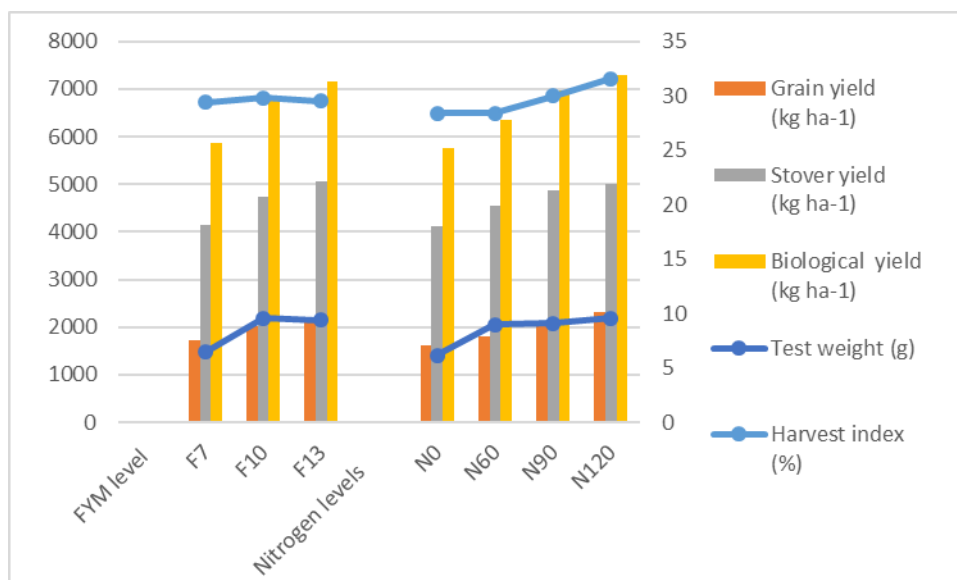
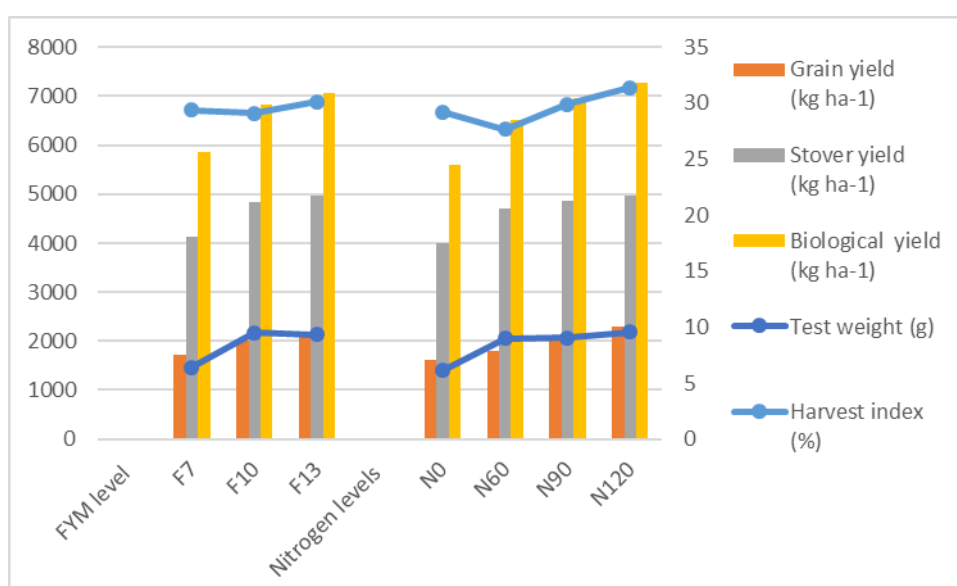


**Fig. 4.2.2b Effect of FYM and nitrogen level in yield attributes under open field.**



### 4.3 Nutrient analysis

#### 4.3.1a Nitrogen content (%)

The data pertaining to the nitrogen content (%) of plant stover and grains affected by FYM and nitrogen application are presented in table 4.3.1a. and 4.3.1b.

**FYM:** There was significant influence on the nitrogen content due to FYM fertilization.

**Agri-horti system:** Maximum nitrogen content (1.79%) was recorded with F<sub>13</sub>, 13 tonnes FYM ha<sup>-1</sup> in grain which was statistically higher to their lower FYM levels. It was found at par with F<sub>10</sub>, 10 tonnes FYM ha<sup>-1</sup> in grains.

**Open field:** The nitrogen content (1.31 %) was recorded with F<sub>13</sub>, 13 tonnes FYM ha<sup>-1</sup> in grain which was statistically higher to their lower FYM levels.

**Nitrogen:** Nitrogen level improved the nitrogen content in plant significantly. As the dose of nitrogen was increased from 0 kg N ha<sup>-1</sup> to 120 kg N ha<sup>-1</sup>, the nitrogen content (%) increased significantly up to 120 kg N ha<sup>-1</sup>.

**Table 4.3.1a. Effect of FYM and nitrogen on nitrogen and carbon content of *Pearl millet* under agri-horti system.**

| Treatments                                  | Nitrogen Content (%) |        | Carbon Content (%) |        |
|---------------------------------------------|----------------------|--------|--------------------|--------|
|                                             | Grain                | Stover | Grain              | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                      |        |                    |        |
| F <sub>7</sub>                              | 1.70                 | 1.06   | 56.87              | 54.33  |
| F <sub>10</sub>                             | 1.76                 | 1.13   | 57.95              | 59.33  |
| F <sub>13</sub>                             | 1.79                 | 1.13   | 58.85              | 59.15  |
| S.Em.(±)                                    | 0.04                 | 0.01   | 0.07               | 0.35   |
| CD at 5%                                    | 0.11                 | 0.03   | 0.20               | 1.03   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                      |        |                    |        |
| N <sub>0</sub>                              | 1.74                 | 1.12   | 56.74              | 57.20  |
| N <sub>60</sub>                             | 1.69                 | 1.10   | 57.28              | 57.10  |
| N <sub>90</sub>                             | 1.78                 | 1.13   | 58.44              | 58.16  |
| N <sub>120</sub>                            | 1.79                 | 1.09   | 59.10              | 57.96  |
| S.Em.(±)                                    | 0.05                 | 0.01   | 0.08               | 0.41   |
| CD at 5%                                    | 0.13                 | 0.03   | 0.24               | 1.19   |
| F × N                                       | NS                   | S      | S                  | S      |

**Table 4.3.1b. Effect of FYM and nitrogen on nitrogen and carbon content of *Pearl millet* under open field.**

| Treatments                                  | Nitrogen Content (%) |        | Carbon Content (%) |        |
|---------------------------------------------|----------------------|--------|--------------------|--------|
|                                             | Grain                | Stover | Grain              | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                      |        |                    |        |
| F <sub>7</sub>                              | 1.26                 | 0.54   | 55.12              | 53.32  |
| F <sub>10</sub>                             | 1.29                 | 0.56   | 57.02              | 58.31  |
| F <sub>13</sub>                             | 1.31                 | 0.59   | 57.83              | 58.22  |
| S.Em.(±)                                    | 0.00                 | 0.00   | 0.14               | 0.35   |
| CD at 5%                                    | 0.01                 | 0.01   | 0.40               | 1.04   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                      |        |                    |        |
| N <sub>0</sub>                              | 1.24                 | 0.50   | 55.39              | 56.17  |
| N <sub>60</sub>                             | 1.25                 | 0.53   | 55.96              | 56.19  |
| N <sub>90</sub>                             | 1.27                 | 0.56   | 57.07              | 57.23  |
| N <sub>120</sub>                            | 1.37                 | 0.64   | 58.20              | 56.87  |
| S.Em.(±)                                    | 0.00                 | 0.00   | 0.16               | 0.41   |
| CD at 5%                                    | 0.01                 | 0.01   | 0.46               | 1.20   |
| F × N                                       | NS                   | S      | S                  | S      |

Table 4.3.1a.1. Integrated effect of FYM and nitrogen on nitrogen content (%).

| Treatment       | Nitrogen content (%) in stover in open field |                 |                 |                  |                     | Nitrogen content (%) in stover in agri-horti system |                 |                 |                  |                    |
|-----------------|----------------------------------------------|-----------------|-----------------|------------------|---------------------|-----------------------------------------------------|-----------------|-----------------|------------------|--------------------|
|                 | Nitrogen levels                              |                 |                 |                  | Mean                | Nitrogen levels                                     |                 |                 |                  | Mean               |
| FYM levels      | N <sub>0</sub>                               | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                      | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                    |
| F <sub>7</sub>  | 0.48                                         | 0.50            | 0.54            | 0.61             | <b>0.54</b>         | 1.08                                                | 1.04            | 1.09            | 1.03             | <b>1.06</b>        |
| F <sub>10</sub> | 0.50                                         | 0.53            | 0.57            | 0.64             | <b>0.56</b>         | 1.14                                                | 1.10            | 1.11            | 1.18             | <b>1.13</b>        |
| F <sub>13</sub> | 0.52                                         | 0.57            | 0.58            | 0.67             | <b>0.59</b>         | 1.13                                                | 1.16            | 1.18            | 1.06             | <b>1.13</b>        |
| Mean            | <b>0.50</b>                                  | <b>0.53</b>     | <b>0.56</b>     | <b>0.64</b>      | <b>0.56</b>         | <b>1.12</b>                                         | <b>1.10</b>     | <b>1.13</b>     | <b>1.09</b>      | <b>1.11</b>        |
|                 | S.Em.(±) = 0.004                             |                 |                 |                  | CD (P= 0.05) = 0.01 | S.Em.(±) = 0.02                                     |                 |                 |                  | CD (P= 0.05)= 0.06 |

Table 4.3.2a.2. Integrated effect of FYM and nitrogen on carbon content (%).

| Treatment       | Carbon content (%) in grain in open field |                 |                 |                  |                     | Carbon content (%) in grain in agri-horti system |                 |                 |                  |                     |
|-----------------|-------------------------------------------|-----------------|-----------------|------------------|---------------------|--------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                           |                 |                 |                  | Mean                | Nitrogen levels                                  |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                            | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                   | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 48.41                                     | 57.29           | 59.21           | 55.56            | <b>55.12</b>        | 50.41                                            | 59.23           | 61.29           | 56.56            | <b>56.87</b>        |
| F <sub>10</sub> | 58.92                                     | 51.56           | 58.01           | 59.56            | <b>57.01</b>        | 59.95                                            | 52.56           | 59.02           | 60.26            | <b>57.95</b>        |
| F <sub>13</sub> | 58.84                                     | 59.02           | 53.99           | 59.47            | <b>57.83</b>        | 59.84                                            | 60.05           | 55.02           | 60.47            | <b>58.85</b>        |
| Mean            | <b>55.39</b>                              | <b>55.96</b>    | <b>57.07</b>    | <b>58.19</b>     | <b>56.65</b>        | <b>56.73</b>                                     | <b>57.28</b>    | <b>58.44</b>    | <b>59.1</b>      | <b>57.89</b>        |
|                 | S.Em.(±) = 0.27                           |                 |                 |                  | CD (P= 0.05) = 0.79 | S.Em.(±) = 0.14                                  |                 |                 |                  | CD (P= 0.05) = 0.41 |

Table 4.3.2a.1. Integrated effect of FYM and nitrogen on carbon content (%).

| Treatment       | Carbon content (%) in stover in open field |                 |                 |                     |              | Carbon content (%) in stover in agri-horti system |                 |                 |                     |              |
|-----------------|--------------------------------------------|-----------------|-----------------|---------------------|--------------|---------------------------------------------------|-----------------|-----------------|---------------------|--------------|
|                 | Nitrogen levels                            |                 |                 |                     | Mean         | Nitrogen levels                                   |                 |                 |                     | Mean         |
| FYM levels      | N <sub>0</sub>                             | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>    |              | N <sub>0</sub>                                    | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>    |              |
| F <sub>7</sub>  | 49.77                                      | 54.63           | 58.43           | 50.43               | <b>53.32</b> | 50.8                                              | 55.63           | 59.43           | 51.43               | <b>54.32</b> |
| F <sub>10</sub> | 60.67                                      | 52.13           | 55.87           | 64.57               | <b>58.31</b> | 61.7                                              | 53.13           | 56.9            | 65.63               | <b>59.33</b> |
| F <sub>13</sub> | 58.06                                      | 61.8            | 57.4            | 55.6                | <b>58.22</b> | 59.13                                             | 62.53           | 58.13           | 56.8                | <b>59.15</b> |
| Mean            | <b>56.17</b>                               | <b>56.19</b>    | <b>57.23</b>    | <b>56.87</b>        | <b>56.61</b> | <b>57.2</b>                                       | <b>57.1</b>     | <b>58.15</b>    | <b>57.95</b>        | <b>57.6</b>  |
|                 | S.Em.(±) = 0.71                            |                 |                 | CD (P= 0.05) = 2.08 |              | S.Em.(±) = 0.70                                   |                 |                 | CD (P= 0.05) = 2.05 |              |

**Agri-horti system:** The maximum nitrogen content (1.79 %) was recorded with 120 kg N ha<sup>-1</sup> in grain in agri-horti system.

**Open field:** While the nitrogen level (1.37%) was recorded from the sole cropping field.

**Interaction:** The 13 tonnes FYM ha<sup>-1</sup> and 90 kg N ha<sup>-1</sup> interacted with each other and produced the maximum nitrogen content (%) in grain. F<sub>13</sub>N<sub>90</sub> treatment combination recorded maximum nitrogen content (1.18 %) from agri-horti system.

#### 4.3.1b Nitrogen uptake (kg ha<sup>-1</sup>)

The data pertaining to the nitrogen uptake (kg ha<sup>-1</sup>) of plant of stover and grain as affected by FYM and nitrogen application are presented in table 4.3.3a. and 4.3.3b.

**FYM:** There was a significant influence on the nitrogen uptake (kg ha<sup>-1</sup>) due to FYM fertilization.

**Agri-horti system:** The maximum nitrogen uptake (58.05 kg ha<sup>-1</sup>) in stover was recorded with level F<sub>13</sub>, 13 tonnes FYM ha<sup>-1</sup> from agri-horti system.

**Open field:** While (30.10 kg ha<sup>-1</sup>) in stover was observed from sole cropping field which was significantly higher to their lower FYM levels.

**Nitrogen:** Nitrogen level improved the FYM and nitrogen and uptake (kg ha<sup>-1</sup>) in plant significantly. As the dose of nitrogen was increased from 0 kg N ha<sup>-1</sup> to 120 kg N ha<sup>-1</sup>, the nitrogen uptake (kg ha<sup>-1</sup>) increased significantly up to 120 kg N ha<sup>-1</sup>.

**Agri-horti system:** The maximum nitrogen uptake (55.12 kg ha<sup>-1</sup>) in stover was recorded at 90 kg N ha<sup>-1</sup> from agri-horti system.

**Open field:** While (32.02 kg ha<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> was observed from sole cropping field, which was statistically higher to their lower nitrogen levels.

**Interaction:** 13 tonnes FYM ha<sup>-1</sup> and 90 kg N ha<sup>-1</sup> interacted with each other and

produced the highest nitrogen uptake ( $\text{kg ha}^{-1}$ ) in stover.  $F_{13}N_{90}$  treatment combination recorded maximum nitrogen uptake ( $62.67 \text{ kg ha}^{-1}$ ) from agri-horti system.

#### **4.3.2a Carbon content (%)**

The data pertaining to the carbon content (%) of plant of stover and grain as affected by FYM and nitrogen application are presented in table 4.3.1a. and 4.3.1b.

**FYM:** There was significant influence on the carbon content due to FYM fertilization, which was statistically at par (80.71 %) with 10 tonnes FYM  $\text{ha}^{-1}$  sole cropping field. The levels  $F_{10}$  and  $F_{13}$  are also found statistically at par with each other at stover stage in both the fields.

**Agri-horti system:** The maximum carbon content (59.33%) was recorded with 10 tonnes FYM  $\text{ha}^{-1}$  in stover from agri-horti system which was statistically at par with the dose 13 tonnes FYM  $\text{ha}^{-1}$ .

**Open field:** The carbon content (58.31%) was recorded with 10 tonnes FYM  $\text{ha}^{-1}$  in stover from agri-horti system.

**Nitrogen:** Nitrogen level improved the carbon content in plant significantly.

**Agri-horti system:** The maximum carbon content (59.10 %) in grains was recorded with  $120 \text{ kg N ha}^{-1}$  from agri-horti system.

**Open field:** While the carbon content (58.20 %) as well as was observed in grains from sole cropping field.

**Interaction:** 13 tonnes FYM  $\text{ha}^{-1}$  and  $120 \text{ kg N ha}^{-1}$  interacted with each other and produced the highest carbon content (%) in grains.  $F_{13}N_{120}$  treatment combination recorded maximum nitrogen content (60.46 %) from agri-horti system.

#### 4.3.2b Carbon uptake ( $\text{kg ha}^{-1}$ )

The data pertaining to the carbon uptake ( $\text{kg ha}^{-1}$ ) of plant of stover and grain as affected by FYM and nitrogen application are presented in table 4.3.3a. and 4.3.3b.

**FYM:** There was a significant influence on the carbon uptake ( $\text{kg ha}^{-1}$ ) due to FYM fertilization.

**Agri-horti system:** The maximum carbon uptake ( $3032.92 \text{ kg ha}^{-1}$ ) in stover was recorded with  $13 \text{ tonnes FYM ha}^{-1}$  from agri-horti system.

**Open field:** While the carbon uptake ( $2981.03 \text{ kg ha}^{-1}$ ) in stover was observed from sole cropping field which was significantly higher to their lower FYM levels.

**Nitrogen:** Nitrogen level improved the carbon uptake ( $\text{kg ha}^{-1}$ ) in plant significantly. The carbon uptake increased significantly up to  $120 \text{ kg N ha}^{-1}$ .

**Agri-horti system:** The maximum carbon uptake ( $2905.40 \text{ kg ha}^{-1}$ ) in stover from agri- horti system was recorded at  $120 \text{ kg N ha}^{-1}$ .

**Open field:** While the carbon uptake ( $2842.96 \text{ kg ha}^{-1}$ ) was observed from sole cropping field.

**Interaction:** The  $13 \text{ tonnes FYM ha}^{-1}$  and  $120 \text{ kg N ha}^{-1}$  interacted with each other and produced the highest Carbon uptake ( $\text{kg ha}^{-1}$ ) in grains.  $F_{13}N_{120}$  treatment combination recorded maximum nitrogen uptake ( $1509.2 \text{ kg ha}^{-1}$ ) from agri-horti system.

#### 4.3.3a Phosphorus content (%)

The data pertaining to the phosphorus content (%) of plant of growth stages stover and grain as affected by FYM and nitrogen application are presented in table 4.3.2a. and 4.3.2b.

**FYM:** There was a significant influence on the phosphorus content due to FYM fertilization.

Table 4.3.2b.1. Integrated effect of FYM and nitrogen on carbon uptake (kg ha<sup>-1</sup>).

| Treatment       | Carbon uptake (kg ha <sup>-1</sup> ) in stover in open field |                 |                 |                  |                       | Carbon uptake (kg ha <sup>-1</sup> ) in stover in agri-horti system |                 |                 |                  |                       |
|-----------------|--------------------------------------------------------------|-----------------|-----------------|------------------|-----------------------|---------------------------------------------------------------------|-----------------|-----------------|------------------|-----------------------|
|                 | Nitrogen levels                                              |                 |                 |                  | Mean                  | Nitrogen levels                                                     |                 |                 |                  | Mean                  |
| FYM levels      | N <sub>0</sub>                                               | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                       | N <sub>0</sub>                                                      | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                       |
| F <sub>7</sub>  | 1948.99                                                      | 2232.47         | 2553.66         | 2267.77          | <b>2250.73</b>        | 1991.11                                                             | 2267.67         | 2598.55         | 2310.86          | <b>2292.05</b>        |
| F <sub>10</sub> | 2715.80                                                      | 2534.80         | 2756.57         | 3259.46          | <b>2816.66</b>        | 2764.78                                                             | 2601.36         | 2826.90         | 3335.28          | <b>2882.08</b>        |
| F <sub>13</sub> | 2670.73                                                      | 3212.41         | 3039.34         | 3001.64          | <b>2981.03</b>        | 2727.72                                                             | 3254.46         | 3079.46         | 3070.04          | <b>3032.92</b>        |
| Mean            | <b>2445.17</b>                                               | <b>2659.89</b>  | <b>2783.19</b>  | <b>2842.96</b>   | <b>2682.80</b>        | <b>2494.54</b>                                                      | <b>2707.83</b>  | <b>2834.97</b>  | <b>2905.39</b>   | <b>2735.68</b>        |
|                 | S.Em.(±) = 43.86                                             |                 |                 |                  | CD (P= 0.05) = 128.63 | S.Em.(±) = 43.38                                                    |                 |                 |                  | CD (P= 0.05) = 127.24 |

Table 4.3.2b.2. Integrated effect of FYM and nitrogen on carbon uptake (kg ha<sup>-1</sup>).

| Treatment       | Carbon uptake (kg ha <sup>-1</sup> ) in grain in open field |                 |                 |                  |                      | Carbon uptake (kg ha <sup>-1</sup> ) in grain in agri-horti system |                 |                 |                  |                      |
|-----------------|-------------------------------------------------------------|-----------------|-----------------|------------------|----------------------|--------------------------------------------------------------------|-----------------|-----------------|------------------|----------------------|
|                 | Nitrogen levels                                             |                 |                 |                  | Mean                 | Nitrogen levels                                                    |                 |                 |                  | Mean                 |
| FYM levels      | N <sub>0</sub>                                              | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                      | N <sub>0</sub>                                                     | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                      |
| F <sub>7</sub>  | 725.56                                                      | 906.47          | 1065.09         | 1111.17          | <b>952.07</b>        | 755.87                                                             | 941.33          | 1106.51         | 1142.69          | <b>986.60</b>        |
| F <sub>10</sub> | 888.98                                                      | 1028.50         | 1246.44         | 1426.82          | <b>1147.68</b>       | 914.56                                                             | 1048.44         | 1288.04         | 1443.48          | <b>1173.63</b>       |
| F <sub>13</sub> | 1083.81                                                     | 1073.57         | 1241.32         | 1480.18          | <b>1219.72</b>       | 1102.22                                                            | 1092.38         | 1268.79         | 1509.16          | <b>1243.14</b>       |
| Mean            | <b>899.45</b>                                               | <b>1002.85</b>  | <b>1184.28</b>  | <b>1339.39</b>   | <b>1106.49</b>       | <b>924.21</b>                                                      | <b>1027.38</b>  | <b>1221.11</b>  | <b>1365.11</b>   | <b>1134.46</b>       |
|                 | S.Em.(±) = 21.31                                            |                 |                 |                  | CD (P= 0.05) = 62.51 | S.Em.(±) = 20.09                                                   |                 |                 |                  | CD (P= 0.05) = 58.94 |

**Agri-horti system:** Maximum phosphorus content (0.32 %) in grains was recorded with level  $F_{13}$  13 tonnes FYM  $\text{ha}^{-1}$  from agri-horti system.

**Open field:** While the phosphorus content (0.32 %) in grains with same levels was recorded from the sole cropping field which was statistically at par with the reading observed from agri-horti system.

**Nitrogen:** Nitrogen level improved the phosphorus content in the plant significantly. As the dose of nitrogen was increased from 0 kg N  $\text{ha}^{-1}$  to 120 kg N  $\text{ha}^{-1}$ , the phosphorus content (%) increased significantly up to 120 kg N  $\text{ha}^{-1}$ . The maximum phosphorus content (0.38 %) at 40 DAS was recorded with both 0 kg N  $\text{ha}^{-1}$  and 120 kg N  $\text{ha}^{-1}$  which was statistically at par with each other.

**Agri-horti system:** The phosphorus content (0.34 %) in grains was recorded with both 120 kg N  $\text{ha}^{-1}$  which was statistically at par with 90 kg N  $\text{ha}^{-1}$ .

**Open field:** The maximum phosphorus content (0.35 %) in grain as well was recorded with 120 kg N  $\text{ha}^{-1}$  and which was statistically at par with 90 kg N  $\text{ha}^{-1}$ .

**Interaction:** The 13 tonnes FYM  $\text{ha}^{-1}$  and 120 kg N  $\text{ha}^{-1}$  interacted with each other and produced the highest phosphorus content (%) in grain.  $F_{13}N_{120}$  treatment combination recorded maximum phosphorus content (0.36%) in both agri-horti system and sole cropping field.

**Table 4.3.2a. Effect of FYM and nitrogen on phosphorus and potassium content of *Pearl millet* under agri-horti system.**

| Treatments                                  | Phosphorus Content (%) |        | Potassium Content (%) |        |
|---------------------------------------------|------------------------|--------|-----------------------|--------|
|                                             | Grain                  | Stover | Grain                 | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                        |        |                       |        |
| F <sub>7</sub>                              | 0.276                  | 0.076  | 0.451                 | 1.332  |
| F <sub>10</sub>                             | 0.294                  | 0.084  | 0.483                 | 1.456  |
| F <sub>13</sub>                             | 0.315                  | 0.091  | 0.507                 | 1.638  |
| S.E.m.(±)                                   | 0.002                  | 0.002  | 0.009                 | 0.034  |
| CD at 5%                                    | 0.007                  | 0.005  | 0.025                 | 0.101  |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                        |        |                       |        |
| N <sub>0</sub>                              | 0.239                  | 0.040  | 0.372                 | 1.259  |
| N <sub>60</sub>                             | 0.274                  | 0.080  | 0.442                 | 1.273  |
| N <sub>90</sub>                             | 0.322                  | 0.102  | 0.520                 | 1.521  |
| N <sub>120</sub>                            | 0.344                  | 0.112  | 0.587                 | 1.848  |
| S.E.m.(±)                                   | 0.003                  | 0.002  | 0.010                 | 0.039  |
| CD at 5%                                    | 0.008                  | 0.005  | 0.029                 | 0.116  |
| F × N                                       | S                      | NS     | NS                    | S      |

**Table 4.3.2b. Effect of FYM and nitrogen on phosphorus and potassium content of *Pearl millet* under open field.**

| Treatments                                  | Phosphorus Content (%) |        | Potassium Content (%) |        |
|---------------------------------------------|------------------------|--------|-----------------------|--------|
|                                             | Grain                  | Stover | Grain                 | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                        |        |                       |        |
| F <sub>7</sub>                              | 0.285                  | 0.083  | 0.463                 | 1.457  |
| F <sub>10</sub>                             | 0.302                  | 0.093  | 0.497                 | 1.581  |
| F <sub>13</sub>                             | 0.322                  | 0.101  | 0.522                 | 1.646  |
| S.E.m.(±)                                   | 0.002                  | 0.002  | 0.016                 | 0.034  |
| CD at 5%                                    | 0.006                  | 0.005  | 0.048                 | 0.100  |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                        |        |                       |        |
| N <sub>0</sub>                              | 0.245                  | 0.048  | 0.388                 | 1.266  |
| N <sub>60</sub>                             | 0.285                  | 0.089  | 0.454                 | 1.284  |
| N <sub>90</sub>                             | 0.330                  | 0.111  | 0.531                 | 1.684  |
| N <sub>120</sub>                            | 0.352                  | 0.122  | 0.604                 | 2.011  |
| S.E.m.(±)                                   | 0.002                  | 0.002  | 0.019                 | 0.039  |
| CD at 5%                                    | 0.007                  | 0.006  | 0.056                 | 0.116  |
| F × N                                       | S                      | NS     | NS                    | S      |

**Table 4.3.3a. Effect of FYM and nitrogen on nitrogen and carbon uptake (kg ha<sup>-1</sup>) of Pearl millet under agri-horti system.**

| Treatments                                  | Nitrogen Uptake (%) |        | Carbon Uptake (%) |         |
|---------------------------------------------|---------------------|--------|-------------------|---------|
|                                             | Grain               | Stover | Grain             | Stover  |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                     |        |                   |         |
| F <sub>7</sub>                              | 29.48               | 44.64  | 986.60            | 2292.05 |
| F <sub>10</sub>                             | 35.63               | 55.04  | 1173.63           | 2882.08 |
| F <sub>13</sub>                             | 37.87               | 58.05  | 1243.14           | 3032.92 |
| S.Em.(±)                                    | 0.75                | 0.40   | 10.05             | 21.69   |
| CD at 5%                                    | 2.20                | 1.18   | 29.47             | 63.62   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                     |        |                   |         |
| N <sub>0</sub>                              | 28.22               | 48.49  | 924.22            | 2494.54 |
| N <sub>60</sub>                             | 30.56               | 52.24  | 1027.39           | 2707.83 |
| N <sub>90</sub>                             | 37.14               | 55.12  | 1221.11           | 2834.97 |
| N <sub>120</sub>                            | 41.38               | 54.45  | 1365.11           | 2905.40 |
| S.Em.(±)                                    | 0.87                | 0.46   | 11.60             | 25.05   |
| CD at 5%                                    | 2.54                | 1.36   | 34.03             | 73.47   |
| F × N                                       | NS                  | S      | S                 | S       |

**Table 4.3.3b. Effect of FYM and nitrogen on nitrogen and carbon uptake (kg ha<sup>-1</sup>) of pearl millet under open field.**

| Treatments                                  | Nitrogen Uptake (%) |        | Carbon Uptake (%) |         |
|---------------------------------------------|---------------------|--------|-------------------|---------|
|                                             | Grain               | Stover | Grain             | Stover  |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                     |        |                   |         |
| F <sub>7</sub>                              | 21.81               | 22.70  | 952.07            | 2250.73 |
| F <sub>10</sub>                             | 25.92               | 27.14  | 1147.69           | 2816.66 |
| F <sub>13</sub>                             | 27.65               | 30.10  | 1219.72           | 2981.03 |
| S.Em.(±)                                    | 0.20                | 0.12   | 10.66             | 21.93   |
| CD at 5%                                    | 0.58                | 0.36   | 31.26             | 64.31   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                     |        |                   |         |
| N <sub>0</sub>                              | 19.97               | 21.79  | 899.45            | 2445.17 |
| N <sub>60</sub>                             | 22.58               | 25.32  | 1002.85           | 2659.90 |
| N <sub>90</sub>                             | 26.56               | 27.47  | 1184.28           | 2783.19 |
| N <sub>120</sub>                            | 31.41               | 32.02  | 1339.39           | 2842.96 |
| S.Em.(±)                                    | 0.23                | 0.14   | 12.31             | 25.32   |
| CD at 5%                                    | 0.67                | 0.42   | 36.09             | 74.26   |
| F × N                                       | S                   | S      | S                 | S       |

**Table 4.3.4a. Effect of FYM and nitrogen on phosphorus and potassium uptake ( $\text{kg ha}^{-1}$ ) of *Pearl millet* under agri-horti system.**

| Treatments                                              | Phosphorus Uptake (%) |        | Potassium Uptake (%) |        |
|---------------------------------------------------------|-----------------------|--------|----------------------|--------|
|                                                         | Grain                 | Stover | Grain                | Stover |
| <b>FYM level (tonnes <math>\text{ha}^{-1}</math>)</b>   |                       |        |                      |        |
| F <sub>7</sub>                                          | 4.85                  | 3.32   | 7.93                 | 56.33  |
| F <sub>10</sub>                                         | 6.09                  | 4.15   | 10.05                | 71.14  |
| F <sub>13</sub>                                         | 6.77                  | 4.74   | 10.96                | 84.86  |
| S.Em.( $\pm$ )                                          | 0.07                  | 0.07   | 0.09                 | 1.58   |
| CD at 5%                                                | 0.19                  | 0.20   | 0.25                 | 4.62   |
| <b>Nitrogen levels (<math>\text{kg ha}^{-1}</math>)</b> |                       |        |                      |        |
| N <sub>0</sub>                                          | 3.89                  | 1.85   | 6.05                 | 54.62  |
| N <sub>60</sub>                                         | 4.97                  | 3.80   | 7.98                 | 60.19  |
| N <sub>90</sub>                                         | 6.79                  | 5.01   | 11.00                | 75.23  |
| N <sub>120</sub>                                        | 7.96                  | 5.63   | 13.56                | 93.06  |
| S.Em.( $\pm$ )                                          | 0.08                  | 0.08   | 0.10                 | 1.82   |
| CD at 5%                                                | 0.22                  | 0.23   | 0.29                 | 5.34   |
| F $\times$ N                                            | S                     | S      | S                    | S      |

**Table 4.3.4b. Effect of FYM and nitrogen on phosphorus and potassium uptake ( $\text{kg ha}^{-1}$ ) of *Pearl millet* under open field.**

| Treatments                                              | Phosphorus Uptake (%) |        | Potassium Uptake (%) |        |
|---------------------------------------------------------|-----------------------|--------|----------------------|--------|
|                                                         | Grain                 | Stover | Grain                | Stover |
| <b>FYM level (tonnes <math>\text{ha}^{-1}</math>)</b>   |                       |        |                      |        |
| F <sub>7</sub>                                          | 4.98                  | 3.68   | 8.15                 | 61.95  |
| F <sub>10</sub>                                         | 6.19                  | 4.56   | 10.33                | 77.05  |
| F <sub>13</sub>                                         | 6.90                  | 5.25   | 11.30                | 85.13  |
| S.Em.( $\pm$ )                                          | 0.05                  | 0.07   | 0.09                 | 1.68   |
| CD at 5%                                                | 0.16                  | 0.20   | 0.26                 | 4.92   |
| <b>Nitrogen levels (<math>\text{kg ha}^{-1}</math>)</b> |                       |        |                      |        |
| N <sub>0</sub>                                          | 3.97                  | 2.23   | 6.30                 | 54.91  |
| N <sub>60</sub>                                         | 5.16                  | 4.22   | 8.20                 | 60.69  |
| N <sub>90</sub>                                         | 6.90                  | 5.43   | 11.24                | 83.10  |
| N <sub>120</sub>                                        | 8.07                  | 6.11   | 13.97                | 100.14 |
| S.Em.( $\pm$ )                                          | 0.06                  | 0.08   | 0.10                 | 1.94   |
| CD at 5%                                                | 0.18                  | 0.23   | 0.30                 | 5.68   |
| F $\times$ N                                            | S                     | S      | S                    | S      |

Table 4.3.3a.1. Integrated effect of FYM and nitrogen on phosphorus content (%).

| Treatment       | Phosphorus content (%) in grain in open field |                 |                 |                  |                     | Phosphorus content (%) in grain in agri-horti system field |                 |                 |                  |                      |
|-----------------|-----------------------------------------------|-----------------|-----------------|------------------|---------------------|------------------------------------------------------------|-----------------|-----------------|------------------|----------------------|
|                 | Nitrogen levels                               |                 |                 |                  | Mean                | Nitrogen levels                                            |                 |                 |                  | Mean                 |
| FYM levels      | N <sub>0</sub>                                | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                             | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                      |
| F <sub>7</sub>  | 0.23                                          | 0.26            | 0.31            | 0.34             | <b>0.28</b>         | 0.23                                                       | 0.24            | 0.3             | 0.33             | <b>0.27</b>          |
| F <sub>10</sub> | 0.24                                          | 0.28            | 0.33            | 0.35             | <b>0.30</b>         | 0.23                                                       | 0.27            | 0.32            | 0.34             | <b>0.29</b>          |
| F <sub>13</sub> | 0.26                                          | 0.32            | 0.35            | 0.36             | <b>0.32</b>         | 0.25                                                       | 0.31            | 0.34            | 0.36             | <b>0.31</b>          |
| Mean            | <b>0.24</b>                                   | <b>0.28</b>     | <b>0.33</b>     | <b>0.35</b>      | <b>0.30</b>         | <b>0.23</b>                                                | <b>0.27</b>     | <b>0.32</b>     | <b>0.34</b>      | <b>0.29</b>          |
|                 | S.Em.(±) = 0.004                              |                 |                 |                  | CD (P= 0.05) = 0.01 | S.Em.(±) = 0.005                                           |                 |                 |                  | CD (P= 0.05) = 0.014 |

Table 4.3.3b.1. Integrated effect of FYM and nitrogen on phosphorus uptake (kg ha<sup>-1</sup>).

| Treatment       | Phosphorus uptake (kg ha <sup>-1</sup> ) in stover in open field |                 |                 |                  |                     | Phosphorus uptake (kg ha <sup>-1</sup> ) in grain in agri-horti system field |                 |                 |                  |                     |
|-----------------|------------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|------------------------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                                                  |                 |                 |                  | Mean                | Nitrogen levels                                                              |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                                                   | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                                               | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 1.69                                                             | 3.41            | 4.52            | 5.09             | <b>3.68</b>         | 1.43                                                                         | 3.12            | 4.08            | 4.64             | <b>3.32</b>         |
| F <sub>10</sub> | 2.38                                                             | 4.22            | 5.43            | 6.22             | <b>4.56</b>         | 1.94                                                                         | 3.75            | 5.13            | 5.76             | <b>4.14</b>         |
| F <sub>13</sub> | 2.60                                                             | 5.03            | 6.35            | 7.01             | <b>5.25</b>         | 2.15                                                                         | 4.51            | 5.82            | 6.48             | <b>4.74</b>         |
| Mean            | <b>2.23</b>                                                      | <b>4.22</b>     | <b>5.43</b>     | <b>6.11</b>      | <b>4.49</b>         | <b>1.84</b>                                                                  | <b>3.79</b>     | <b>5.01</b>     | <b>5.63</b>      | <b>4.07</b>         |
|                 | S.Em.(±) = 0.13                                                  |                 |                 |                  | CD (P= 0.05) = 0.39 | S.Em.(±) = 0.14                                                              |                 |                 |                  | CD (P= 0.05) = 0.40 |

Table 4.3.3b.2. Integrated effect of FYM and nitrogen on phosphorus uptake ( $\text{kg ha}^{-1}$ ).

| Treatment       | Phosphorus uptake ( $\text{kg ha}^{-1}$ ) in grain in open field |                 |                 |                  |                     | Phosphorus uptake ( $\text{kg ha}^{-1}$ ) in grain in agri-horti system |                 |                 |                  |                     |
|-----------------|------------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|-------------------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                                                  |                 |                 |                  | Mean                | Nitrogen levels                                                         |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                                                   | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                                          | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 3.55                                                             | 4.06            | 5.57            | 6.73             | <b>4.98</b>         | 3.49                                                                    | 3.81            | 5.41            | 6.67             | <b>4.84</b>         |
| F <sub>10</sub> | 3.67                                                             | 5.58            | 7.16            | 8.34             | <b>6.19</b>         | 3.55                                                                    | 5.45            | 7.13            | 8.22             | <b>6.09</b>         |
| F <sub>13</sub> | 4.69                                                             | 5.82            | 7.97            | 9.12             | <b>6.89</b>         | 4.60                                                                    | 5.64            | 7.84            | 8.98             | <b>6.77</b>         |
| Mean            | <b>3.97</b>                                                      | <b>5.15</b>     | <b>6.89</b>     | <b>8.06</b>      | <b>6.02</b>         | <b>3.89</b>                                                             | <b>4.97</b>     | <b>6.79</b>     | <b>7.95</b>      | <b>5.90</b>         |
|                 | S.Em.(±) = 0.11                                                  |                 |                 |                  | CD (P= 0.05) = 0.31 | S.Em.(±) = 0.13                                                         |                 |                 |                  | CD (P= 0.05) = 0.38 |

Table 4.3.4a.1. Integrated effect of FYM and nitrogen on potassium content (%).

| Treatment       | Potassium content (%) in stover in open field |                 |                 |                  |                     | Potassium content (%) in stover in agri-horti system |                 |                 |                  |                     |
|-----------------|-----------------------------------------------|-----------------|-----------------|------------------|---------------------|------------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                               |                 |                 |                  | Mean                | Nitrogen levels                                      |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                                | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                       | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 1.26                                          | 1.27            | 1.29            | 2.00             | <b>1.46</b>         | 1.26                                                 | 1.27            | 1.28            | 1.53             | <b>1.33</b>         |
| F <sub>10</sub> | 1.26                                          | 1.28            | 1.76            | 2.01             | <b>1.58</b>         | 1.26                                                 | 1.28            | 1.29            | 2.00             | <b>1.45</b>         |
| F <sub>13</sub> | 1.27                                          | 1.29            | 2.00            | 2.02             | <b>1.64</b>         | 1.26                                                 | 1.28            | 2               | 2.01             | <b>1.64</b>         |
| Mean            | <b>1.26</b>                                   | <b>1.28</b>     | <b>1.68</b>     | <b>2.01</b>      | <b>1.56</b>         | <b>1.26</b>                                          | <b>1.27</b>     | <b>1.52</b>     | <b>1.85</b>      | <b>1.47</b>         |
|                 | S.Em.(±) = 0.07                               |                 |                 |                  | CD (P= 0.05) = 0.20 | S.Em.(±) = 0.06                                      |                 |                 |                  | CD (P= 0.05) = 0.20 |

Table 4.3.4a.2. Integrated effect of FYM and nitrogen on potassium content (%).

| Treatment       | Potassium content (%) in grain in open field |                 |                 |                  |                     | Potassium content (%) in grain in agri-horti system |                 |                 |                  |                     |
|-----------------|----------------------------------------------|-----------------|-----------------|------------------|---------------------|-----------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                              |                 |                 |                  | Mean                | Nitrogen levels                                     |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                               | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                      | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 0.38                                         | 0.43            | 0.47            | 0.57             | <b>0.46</b>         | 0.37                                                | 0.42            | 0.46            | 0.56             | <b>0.45</b>         |
| F <sub>10</sub> | 0.39                                         | 0.45            | 0.54            | 0.61             | <b>0.49</b>         | 0.37                                                | 0.44            | 0.53            | 0.59             | <b>0.48</b>         |
| F <sub>13</sub> | 0.39                                         | 0.48            | 0.58            | 0.63             | <b>0.52</b>         | 0.38                                                | 0.47            | 0.57            | 0.61             | <b>0.51</b>         |
| Mean            | <b>0.39</b>                                  | <b>0.45</b>     | <b>0.53</b>     | <b>0.60</b>      | <b>0.49</b>         | <b>0.37</b>                                         | <b>0.44</b>     | <b>0.52</b>     | <b>0.59</b>      | <b>0.48</b>         |
|                 | S.Em.(±) = 0.005                             |                 |                 |                  | CD (P= 0.05) = 0.02 | S.Em.(±) = 0.006                                    |                 |                 |                  | CD (P= 0.05) = 0.02 |

Table 4.3.4b.1. Integrated effect of FYM and nitrogen on potassium uptake (Kg ha<sup>-1</sup>).

| Treatment       | Potassium uptake (Kg ha <sup>-1</sup> ) in stover in open field |                 |                 |                  |                     | Potassium uptake (Kg ha <sup>-1</sup> ) in stover in agri-horti system |                 |                 |                  |                     |
|-----------------|-----------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|------------------------------------------------------------------------|-----------------|-----------------|------------------|---------------------|
|                 | Nitrogen levels                                                 |                 |                 |                  | Mean                | Nitrogen levels                                                        |                 |                 |                  | Mean                |
| FYM levels      | N <sub>0</sub>                                                  | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     | N <sub>0</sub>                                                         | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub> |                     |
| F <sub>7</sub>  | 49.52                                                           | 52.03           | 56.25           | 90.01            | <b>61.95</b>        | 49.26                                                                  | 51.63           | 55.82           | 68.61            | <b>56.33</b>        |
| F <sub>10</sub> | 56.63                                                           | 62.99           | 89.98           | 101.58           | <b>77.05</b>        | 56.33                                                                  | 62.50           | 63.92           | 101.79           | <b>71.14</b>        |
| F <sub>13</sub> | 58.56                                                           | 67.05           | 106.07          | 108.84           | <b>85.13</b>        | 58.27                                                                  | 66.44           | 105.94          | 108.79           | <b>84.86</b>        |
| Mean            | <b>54.91</b>                                                    | <b>60.69</b>    | <b>83.102</b>   | <b>100.14</b>    | <b>74.71</b>        | <b>54.62</b>                                                           | <b>60.19</b>    | <b>75.23</b>    | <b>93.06</b>     | <b>70.78</b>        |
|                 | S.Em.(±) = 3.35                                                 |                 |                 |                  | CD (P= 0.05) = 9.84 | S.Em.(±) = 3.15                                                        |                 |                 |                  | CD (P= 0.05) = 9.24 |

Table 4.3.4b.2. Integrated effect of FYM and nitrogen on potassium uptake ( $\text{kg ha}^{-1}$ ).

| Treatment       | Potassium uptake ( $\text{kg ha}^{-1}$ ) in grain in open field |                 |                 |                     |              | Potassium uptake ( $\text{kg ha}^{-1}$ ) in grain in agri-horti system |                 |                 |                     |              |
|-----------------|-----------------------------------------------------------------|-----------------|-----------------|---------------------|--------------|------------------------------------------------------------------------|-----------------|-----------------|---------------------|--------------|
|                 | Nitrogen levels                                                 |                 |                 |                     | Mean         | Nitrogen levels                                                        |                 |                 |                     | Mean         |
| FYM levels      | N <sub>0</sub>                                                  | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>    |              | N <sub>0</sub>                                                         | N <sub>60</sub> | N <sub>90</sub> | N <sub>120</sub>    |              |
| F <sub>7</sub>  | 5.69                                                            | 6.83            | 8.48            | 11.58               | <b>8.15</b>  | 5.49                                                                   | 6.67            | 8.30            | 11.25               | <b>7.93</b>  |
| F <sub>10</sub> | 5.89                                                            | 8.97            | 11.86           | 14.60               | <b>10.33</b> | 5.64                                                                   | 8.71            | 11.64           | 14.20               | <b>10.05</b> |
| F <sub>13</sub> | 7.31                                                            | 8.78            | 13.36           | 15.72               | <b>11.29</b> | 6.99                                                                   | 8.54            | 13.06           | 15.22               | <b>10.96</b> |
| Mean            | <b>6.30</b>                                                     | <b>8.19</b>     | <b>11.24</b>    | <b>13.97</b>        | <b>9.93</b>  | <b>6.05</b>                                                            | <b>7.98</b>     | <b>11.00</b>    | <b>13.56</b>        | <b>9.64</b>  |
|                 | S.Em.(±) = 0.18                                                 |                 |                 | CD (P= 0.05) = 0.52 |              | S.Em.(±) = 0.17                                                        |                 |                 | CD (P= 0.05) = 0.51 |              |

#### 4.3.3b. Phosphorus uptake ( $\text{kg ha}^{-1}$ )

The data pertaining to the phosphorus uptake ( $\text{kg ha}^{-1}$ ) of plant stover and grain as affected by FYM and nitrogen application are presented in table 4.3.4a. and 4.3.4b.

**FYM:** There was significant influence on the phosphorus uptake ( $\text{kg ha}^{-1}$ ) due to FYM fertilization.

**Agri-horti system:** While the maximum phosphorus uptake ( $6.77 \text{ kg ha}^{-1}$ ) in grains with  $F_{13}$  level was observed from agri-horti system.

**Open field:** The maximum phosphorus uptake ( $6.90 \text{ kg ha}^{-1}$ ) in grains was recorded with 13 tonnes FYM  $\text{ha}^{-1}$  from sole cropping field.

**Nitrogen:** Nitrogen level improved phosphorus uptake ( $\text{kg ha}^{-1}$ ) in plant significantly. As the dose of nitrogen was increased from  $0 \text{ kg N ha}^{-1}$  to  $120 \text{ kg N ha}^{-1}$ , the nitrogen uptake ( $\text{kg ha}^{-1}$ ) increased significantly up to  $120 \text{ kg N ha}^{-1}$ .

**Agri-horti system:** While the phosphorus uptake ( $7.96 \text{ kg ha}^{-1}$ ) with  $120 \text{ kg N ha}^{-1}$  in grain was recorded from agri-horti system.

**Open field:** The maximum phosphorus uptake ( $8.07 \text{ kg ha}^{-1}$ ) was recorded with  $120 \text{ kg N ha}^{-1}$  in grain from sole cropping field

**Interaction:** 13 tonnes FYM  $\text{ha}^{-1}$  and  $120 \text{ kg N ha}^{-1}$  interacted with each other and produced the highest phosphorus uptake ( $\text{kg ha}^{-1}$ ) in grain.  $F_{13}N_{120}$  treatment combination recorded maximum phosphorus uptake ( $9.12 \text{ kg ha}^{-1}$ ) from sole cropping field.

#### 4.3.4a. Potassium content (%)

The data pertaining to the potassium content (%) of plant of stover and grain as affected by FYM and nitrogen application are presented in table 4.3.2a. and 4.3.2b.

**FYM:** There was a significant influence on the potassium content due to FYM fertilization.

**Agri-horti system:** Maximum potassium content (1.65 %) with 13 kg FYM ha<sup>-1</sup> in stover was recorded from sole cropping field.

**Open field:** While the potassium content (1.64 %) at with same level of FYM in stover was recorded from agri-horti system it was also found at par with the reading of sole cropping field.

**Nitrogen:** Nitrogen level improved the potassium content in plant significantly. As the dose of nitrogen was increased from 0 kg N ha<sup>-1</sup> to 120 kg N ha<sup>-1</sup>. The level N<sub>0</sub> and N<sub>60</sub> was statistically at par with each other.

**Agri-horti system:** The maximum potassium content (%) increased significantly up to 120 kg N ha<sup>-1</sup> while (1.85 %) with 120 kg N ha<sup>-1</sup> was recorded in stover and which was observed from agri-horti system.

**Open field:** The potassium content (%) increased significantly up to 120 kg N ha<sup>-1</sup> (2.01 %) with 120 kg N ha<sup>-1</sup> was recorded in stover and which was observed from sole cropping field.

**Interaction:** 13 tonnes FYM ha<sup>-1</sup> and 120 kg N ha<sup>-1</sup> interacted with each other and produced the highest potassium content (%) in stover. F<sub>13</sub>N<sub>120</sub> treatment combination recorded maximum potassium content (2.02 %) from sole cropping field.

#### 4.3.4b. Potassium uptake (kg ha<sup>-1</sup>)

The data pertaining to the potassium uptake (kg ha<sup>-1</sup>) of plant of stover and grain as affected by FYM and nitrogen application are presented in table 4.3.4a. and 4.3.4b.

**FYM:** There was significant influence on the potassium uptake (kg ha<sup>-1</sup>) due to FYM fertilization.

**Agri-horti system:** While the potassium uptake (84.86 kg ha<sup>-1</sup>) in stover with 13 tonnes FYM ha<sup>-1</sup> was observed from agri-horti system which were found significantly higher to their lower FYM levels.

**Open field:** The maximum potassium uptake ( $85.13 \text{ kg ha}^{-1}$ ) in stover with 13 tonnes FYM  $\text{ha}^{-1}$  from sole cropping field.

**Nitrogen:** Nitrogen level improved the potassium uptake ( $\text{kg ha}^{-1}$ ) in stover significantly. As the dose of nitrogen was increased from  $0 \text{ kg N ha}^{-1}$  to  $120 \text{ kg N ha}^{-1}$ , the nitrogen uptake ( $\text{kg ha}^{-1}$ ) increased significantly up to  $120 \text{ kg N ha}^{-1}$ .

**Agri-horti system:** While the potassium uptake ( $93.06 \text{ kg ha}^{-1}$ ) in stover with  $120 \text{ kg N ha}^{-1}$  was recorded from agri-horti system.

**Open field:** The maximum potassium uptake ( $100.14 \text{ kg ha}^{-1}$ ) in stover was recorded at  $120 \text{ kg N ha}^{-1}$  which was statistically higher to their lower nitrogen levels.

**Interaction:** The 13 tonnes FYM  $\text{ha}^{-1}$  and  $120 \text{ kg N ha}^{-1}$  interacted with each other and produced the highest potassium uptake ( $\text{kg ha}^{-1}$ ) in stover.  $F_{13}N_{120}$  treatment combination recorded maximum potassium uptake ( $108.84 \text{ kg ha}^{-1}$ ) in stover from sole cropping field.

#### 4.3.5. Protein content (%) and Protein yield ( $\text{kg ha}^{-1}$ )

The data pertaining to the protein content (%) and protein yield of grain as affected by FYM and nitrogen application are presented in table 4.3.5.

##### Protein content (%)

**FYM:** There was significant influence on the protein content due to FYM fertilization. The maximum protein content as observed are:

**Agri-horti system:** The maximum protein content (10.28 %) in grains from agri-horti system was recorded with 13 tonnes FYM  $\text{ha}^{-1}$ .

**Open field:** While the protein content (7.51 %) in grain with 13 tonnes FYM  $\text{ha}^{-1}$  from sole cropping was observed.

**Table. 4.3.5. Effect of FYM and nitrogen on protein content and protein yield in grains of *Pearl millet* under open field and agri-horti system.**

| Treatments                                  | Protein content (%) in grain |        | Protein yield (kg ha <sup>-1</sup> ) in grain |          |
|---------------------------------------------|------------------------------|--------|-----------------------------------------------|----------|
|                                             | Open                         | System | Open                                          | System   |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                              |        |                                               |          |
| F <sub>7</sub>                              | 7.26                         | 9.75   | 12539.35                                      | 16935.47 |
| F <sub>10</sub>                             | 7.39                         | 10.12  | 14904.66                                      | 20482.56 |
| F <sub>13</sub>                             | 7.51                         | 10.28  | 15901.22                                      | 21777.62 |
| S.Em.(±)                                    | 0.002                        | 0.039  | 36.92                                         | 36.09    |
| CD at 5%                                    | 0.006                        | 0.114  | 108.29                                        | 105.85   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                              |        |                                               |          |
| N <sub>0</sub>                              | 7.11                         | 9.99   | 11481.81                                      | 16228.14 |
| N <sub>60</sub>                             | 7.21                         | 9.72   | 12981.61                                      | 17561.54 |
| N <sub>90</sub>                             | 7.32                         | 10.21  | 15269.28                                      | 21351.76 |
| N <sub>120</sub>                            | 7.90                         | 10.30  | 18060.93                                      | 23786.08 |
| S.Em.(±)                                    | 0.002                        | 0.045  | 42.63                                         | 41.67    |
| CD at 5%                                    | 0.007                        | 0.132  | 125.04                                        | 122.67   |
| F × N                                       | NS                           | NS     | NS                                            | NS       |

**Nitrogen:** Nitrogen level improved the protein content in grain significantly. As the dose of nitrogen was increased from 0 kg N ha<sup>-1</sup> to 120 kg N ha<sup>-1</sup>, the protein content increased significantly up to 120 kg N ha<sup>-1</sup>.

**Agri-horti system:** The maximum protein content (10.30 %) with 120 kg N ha<sup>-1</sup> was recorded from agri-horti system which was significantly higher to their lower nitrogen levels.

**Open field:** While, the protein content (7.90 %) with 120 kg N ha<sup>-1</sup> was observed from sole cropping field.

#### **Protein yield (kg ha<sup>-1</sup>)**

**FYM:** There was significant influence on the protein yield due to FYM fertilization. The maximum protein yield as observed are:

**Agri-horti system:** The maximum protein yield (21777.62 kg ha<sup>-1</sup>) in grains from agri-horti system was recorded with 13 tonnes FYM ha<sup>-1</sup>.

**Open field:** While the high protein yield (15901.22 kg ha<sup>-1</sup>) in grain with 13 tonnes FYM ha<sup>-1</sup> from sole cropping was observed.

#### **Nitrogen:**

**Agri-horti system:** The maximum protein yield (23786.08 kg ha<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> was observed in agri-horti system.

**Open field:** The high protein yield was observed (18060.93 kg ha<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> from sole cropping field.

### **4.4. Economics**

#### **4.4.1. Cost of cultivation**

The data table 4.4. and figure 4.4. clearly indicates that there was variation in cost of cultivation due to FYM and nitrogen application.

**FYM:** In case of FYM levels maximum cost of cultivation

**Agri-horti system:** It was notice that with 13 tonnes FYM ha<sup>-1</sup> (Rs. 7988.12 ha<sup>-1</sup>) cost of cultivation varied which was followed by 10 tonnes FYM ha<sup>-1</sup> (Rs. 7983.80 ha<sup>-1</sup>) and it was minimum in 7 tonnes FYM ha<sup>-1</sup> (Rs. 7973.85 ha<sup>-1</sup>) as observed.

**Open field:** The cost of cultivation with 13 tonnes FYM ha<sup>-1</sup> (Rs. 7988.12 ha<sup>-1</sup>) in open field also.

**Nitrogen:** The cost of cultivation with doses of nitrogen was reflected as follows.

**Agri-horti system:** The higher cost of cultivation ( Rs. 7988.12 ha<sup>-1</sup>) was found under 120 kg N ha<sup>-1</sup>, followed by 90 kg N ha<sup>-1</sup> (Rs. 7982.49 ha<sup>-1</sup>) and 60 kg N ha<sup>-1</sup> (Rs. 7976.85 ha<sup>-1</sup>) and it was minimum in 0 kg N ha<sup>-1</sup> (Rs. 7965.59 ha<sup>-1</sup>).

**Open field:** The same higher cost of cultivation (Rs. 7988.12 ha<sup>-1</sup>) was found under 120 kg N ha<sup>-1</sup>, followed by 90 kg N ha<sup>-1</sup> (Rs. 7982.49 ha<sup>-1</sup>) and 60 kg N ha<sup>-1</sup> (Rs. 7976.85 ha<sup>-1</sup>) and it was minimum in 0 kg N ha<sup>-1</sup> (Rs. 7965.59 ha<sup>-1</sup>).

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**Table 4.4. Effect of FYM and nitrogen levels on economics of agri-horti system.**

| Treatments                                  | Cost of cultivation<br>(Rs ha <sup>-1</sup> ) | Gross return<br>(Rs ha <sup>-1</sup> ) | Net return<br>(Rs ha <sup>-1</sup> ) | B : C ratio<br>(%) |
|---------------------------------------------|-----------------------------------------------|----------------------------------------|--------------------------------------|--------------------|
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                                               |                                        |                                      |                    |
| F <sub>7</sub>                              | 7973.85                                       | 42728.43                               | 34754.58                             | 5.35               |
| F <sub>10</sub>                             | 7983.80                                       | 43666.11                               | 35682.31                             | 5.46               |
| F <sub>13</sub>                             | 7988.12                                       | 44029.91                               | 36041.79                             | 5.51               |
| S.Em.(±)                                    | ----                                          | 2.98                                   | 29.80                                | 2.05               |
| CD at 5%                                    | ----                                          | 84.67                                  | 81.77                                | 0.09               |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                               |                                        |                                      |                    |
| N <sub>0</sub>                              | 7965.59                                       | 42745.46                               | 34779.87                             | 5.36               |
| N <sub>60</sub>                             | 7976.85                                       | 43311.58                               | 35334.73                             | 5.43               |
| N <sub>90</sub>                             | 7982.49                                       | 43761.39                               | 35778.9                              | 5.48               |
| N <sub>120</sub>                            | 7988.12                                       | 44080.84                               | 36092.72                             | 5.52               |
| S.Em.(±)                                    | ----                                          | 36.20                                  | 42.10                                | 2.04               |
| CD at 5%                                    | ----                                          | 84.42                                  | 94.42                                | 0.07               |
| F × N                                       | ----                                          | NS                                     | NS                                   | NS                 |

**Table 4.4. Effect of FYM and nitrogen levels on economics of open field.**

| Treatments                                  | Cost of cultivation<br>(Rs ha <sup>-1</sup> ) | Gross return<br>(Rs ha <sup>-1</sup> ) | Net return<br>(Rs ha <sup>-1</sup> ) | B : C ratio<br>(%) |
|---------------------------------------------|-----------------------------------------------|----------------------------------------|--------------------------------------|--------------------|
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |                                               |                                        |                                      |                    |
| F <sub>7</sub>                              | 7973.85                                       | 35936.85                               | 27963                                | 4.50               |
| F <sub>10</sub>                             | 7983.80                                       | 36833.61                               | 28849.81                             | 4.61               |
| F <sub>13</sub>                             | 7988.12                                       | 37230.07                               | 29241.95                             | 4.66               |
| S.Em.(±)                                    | ----                                          | 29.93                                  | 30.13                                | 1.12               |
| CD at 5%                                    | ----                                          | 83.73                                  | 83.93                                | 0.18               |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |                                               |                                        |                                      |                    |
| N <sub>0</sub>                              | 7965.59                                       | 35941.90                               | 27976.31                             | 4.51               |
| N <sub>60</sub>                             | 7976.85                                       | 36513.47                               | 28536.62                             | 4.57               |
| N <sub>90</sub>                             | 7982.49                                       | 36948.28                               | 28965.79                             | 4.63               |
| N <sub>120</sub>                            | 7988.12                                       | 37263.73                               | 29275.61                             | 4.66               |
| S.Em.(±)                                    | ----                                          | 33.26                                  | 33.74                                | 1.14               |
| CD at 5%                                    | ----                                          | 95.10                                  | 95.60                                | 0.17               |
| F × N                                       | ----                                          | NS                                     | NS                                   | NS                 |

**Fig. 4.4.** Effect of FYM and nitrogen levels on economics (Rs. ha<sup>-1</sup>) and B:C ratio (%) in agri-horti system field.

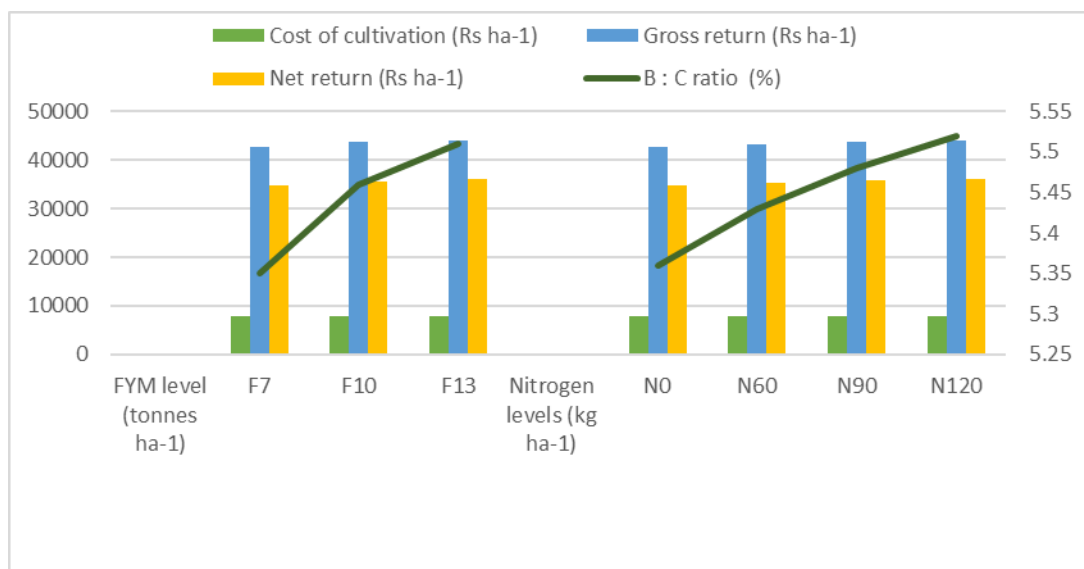
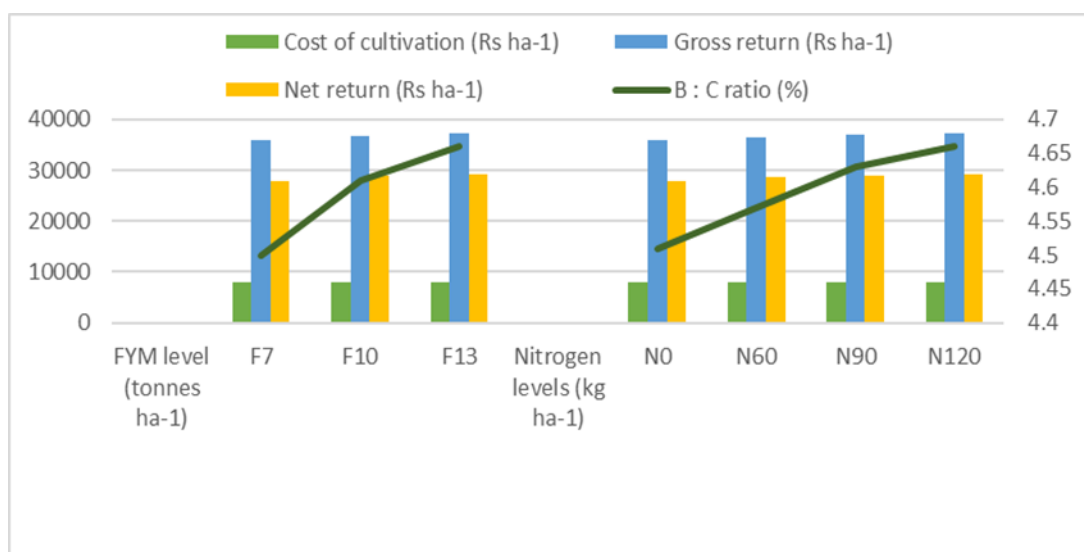


**Fig. 4.4.** Effect of FYM and nitrogen levels on economics (Rs. ha<sup>-1</sup>) and B:C ratio (%) in open field.



#### 4.4.2. Gross return (Rs ha<sup>-1</sup>)

Summary of the data on economics returns of various treatments are presented in table 4.4. and depicted in figure 4.4.

**FYM:** There was significant effect on the gross return (Rs. ha<sup>-1</sup>) due to FYM fertilization.

**Agri-horti system:** The maximum gross return (Rs. 44029.91 ha<sup>-1</sup>) in agri-horti system was recorded with 13 tonnes FYM ha<sup>-1</sup> which was statistically higher to their lower FYM levels.

**Open field:** The gross return (Rs. 37230.07 ha<sup>-1</sup>) in open field was recorded with 13 tonnes FYM ha<sup>-1</sup> which was statistically at par with the observation of agri-horti system.

**Nitrogen:** Analysis of data revealed that gross return (Rs. ha<sup>-1</sup>) due to nitrogen level was found significant. The gross return was found to be significantly superior with 120 kg N ha<sup>-1</sup>.

**Agri-horti system:** The 120 kg N ha<sup>-1</sup> produced the maximum gross return (Rs. 44080.84 ha<sup>-1</sup>) in agri-horti system.

**Open field :** The gross return observed was (37263.73 ha<sup>-1</sup>) which was statistically at par with the observation from agri-horti system.

#### 4.4.3. Net return (Rs ha<sup>-1</sup>)

Summary of the data on economics returns of various treatments are presented in table 4.4 and depicted in figure 4.4.

**FYM:** There was significant effect on the net return (Rs. ha<sup>-1</sup>) due to FYM fertilization.

**Agri-horti system:** The maximum net return (Rs. 36041.79 ha<sup>-1</sup>) in agri-horti system was recorded with 13 tonnes FYM ha<sup>-1</sup>.

**Open field:** While (Rs. 29241.95 ha<sup>-1</sup>) was observed in sole cropping field which statistically at with the observation with the agri-horti system.

**Nitrogen:** Analysis of data revealed that net return (Rs. ha<sup>-1</sup>) due to nitrogen level was found significant. The net return was found to be significantly superior with 120 kg N ha<sup>-1</sup>.

**Agri-horti system:** The 120 kg N ha<sup>-1</sup> produced the maximum net return (Rs. 36092.72 ha<sup>-1</sup>) for agri-horti system.

**Open field:** Thereafter, net return of (Rs. 29275.61 ha<sup>-1</sup>) was observed for sole cropping field.

#### **4.4.4. B: C ratio**

Summary of the data on economics returns of various treatments are presented in table 4.4. and depicted in figure 4.4.

**FYM:** There was a significant effect on the B:C ratio due to FYM fertilization.

**Agri-horti system:** The maximum B:C ratio (5.51) was recorded with 13 tonnes FYM ha<sup>-1</sup> of agri-horti system which was statistically at par with 13 tonnes FYM ha<sup>-1</sup> of sole cropping field.

**Open field :** The B:C ratio (4.66) was recorded with 13 tonnes FYM ha<sup>-1</sup> of sole cropping field.

**Nitrogen:** The B:C ratio was found to be significantly superior with 120 kg N ha<sup>-1</sup>. The minimum B:C ratio was recorded with 0 kg N ha<sup>-1</sup> for both the fields.

**Agri-horti system:** The maximum B:C ratio (5.52) was recorded with 120 kg N ha<sup>-1</sup> of agri-horti system which was statistically at par with 120 kg N ha<sup>-1</sup> of sole cropping field.

**Open field :** The B:C ratio (4.66) was recorded with 120 kg N ha<sup>-1</sup> of sole cropping field. The 90 kg N ha<sup>-1</sup> was statistically at par with each other.

**Interaction:** FYM and Nitrogen levels failed to interact with each other so result is non-significant.

#### 4.5. Nutrient stoichiometry estimation

##### 4.5.1. C:N ratio

**Table 4.5.1. Effect of FYM levels on C:N ratio of each growth stages of *Pearl millet* in open field and agri-horti system.**

| Treatments                                  | System |        | Open  |        |
|---------------------------------------------|--------|--------|-------|--------|
|                                             | Grain  | Stover | Grain | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |        |        |       |        |
| F <sub>7</sub>                              | 33.47  | 51.35  | 43.66 | 99.13  |
| F <sub>10</sub>                             | 32.94  | 52.37  | 44.28 | 103.77 |
| F <sub>13</sub>                             | 32.83  | 52.25  | 44.11 | 99.04  |
| S.Em.(±)                                    | 0.23   | 0.68   | 0.61  | 0.68   |
| CD at 5%                                    | 0.67   | 1.54   | 1.78  | 4.56   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |        |        |       |        |
| N <sub>0</sub>                              | 32.75  | 51.44  | 45.04 | 112.20 |
| N <sub>60</sub>                             | 33.62  | 51.83  | 44.42 | 105.05 |
| N <sub>90</sub>                             | 32.88  | 51.44  | 44.60 | 101.33 |
| N <sub>120</sub>                            | 32.99  | 53.36  | 42.64 | 88.80  |
| S.Em.(±)                                    | 0.22   | 0.68   | 0.62  | 0.69   |
| CD at 5%                                    | 0.65   | 1.55   | 1.77  | 4.54   |
| F × N                                       | NS     | NS     | NS    | NS     |

##### 4.5.2. C:P ratio

**Table 4.5.2. Effect of FYM levels on C:P ratio of each growth stages of *Pearl millet* in open field and agri-horti system.**

| Treatments                                  | System |         | Open   |         |
|---------------------------------------------|--------|---------|--------|---------|
|                                             | Grain  | Stover  | Grain  | Stover  |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |        |         |        |         |
| F <sub>7</sub>                              | 203.53 | 690.10  | 191.29 | 611.81  |
| F <sub>10</sub>                             | 192.69 | 695.02  | 185.42 | 617.09  |
| F <sub>13</sub>                             | 183.72 | 639.38  | 176.77 | 567.81  |
| S.Em.(±)                                    | 0.86   | 1.25    | 0.96   | 1.23    |
| CD at 5%                                    | 2.71   | 4.18    | 2.60   | 4.12    |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |        |         |        |         |
| N <sub>0</sub>                              | 237.76 | 1352.00 | 226.63 | 1096.08 |
| N <sub>60</sub>                             | 206.71 | 713.12  | 194.54 | 630.79  |
| N <sub>90</sub>                             | 179.79 | 565.53  | 171.66 | 512.37  |
| N <sub>120</sub>                            | 171.56 | 516.34  | 166.05 | 465.20  |
| S.Em.(±)                                    | 0.86   | 1.76    | 0.87   | 1.07    |
| CD at 5%                                    | 3.01   | 4.23    | 2.76   | 4.45    |
| F × N                                       | NS     | NS      | NS     | NS      |

## 4.5.3. C:K ratio

Table 4.5.3. Effect of FYM levels on C:K ratio of each growth stages of *Pearl millet* in open field and agri-horti system.

| Treatments                                  | System |        | Open   |        |
|---------------------------------------------|--------|--------|--------|--------|
|                                             | Grain  | Stover | Grain  | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |        |        |        |        |
| F <sub>7</sub>                              | 124.40 | 40.69  | 116.82 | 36.33  |
| F <sub>10</sub>                             | 116.79 | 40.51  | 111.07 | 36.56  |
| F <sub>13</sub>                             | 113.45 | 35.74  | 107.97 | 35.02  |
| S.Em.(±)                                    | 1.66   | 1.65   | 1.65   | 1.63   |
| CD at 5%                                    | 4.87   | 4.85   | 4.85   | 4.83   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |        |        |        |        |
| N <sub>0</sub>                              | 152.85 | 45.67  | 142.75 | 44.53  |
| N <sub>60</sub>                             | 128.80 | 44.99  | 122.30 | 43.83  |
| N <sub>90</sub>                             | 110.99 | 37.69  | 105.40 | 33.49  |
| N <sub>120</sub>                            | 100.69 | 31.22  | 95.88  | 28.39  |
| S.Em.(±)                                    | 1.68   | 1.65   | 1.68   | 1.66   |
| CD at 5%                                    | 4.89   | 4.82   | 4.87   | 4.81   |
| F × N                                       | NS     | NS     | NS     | NS     |

## 4.5.4. N:P ratio

Table 4.5.4. Effect of FYM levels on N:P ratio of each growth stages of *Pearl millet* in open field and agri-horti system.

| Treatments                                  | System |        | Open  |        |
|---------------------------------------------|--------|--------|-------|--------|
|                                             | Grain  | Stover | Grain | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |        |        |       |        |
| F <sub>7</sub>                              | 6.08   | 13.44  | 4.38  | 6.17   |
| F <sub>10</sub>                             | 5.85   | 13.27  | 4.19  | 5.95   |
| F <sub>13</sub>                             | 5.60   | 12.24  | 4.01  | 5.73   |
| S.Em.(±)                                    | 0.05   | 0.09   | 0.03  | 0.04   |
| CD at 5%                                    | 0.13   | 0.21   | 0.11  | 0.12   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |        |        |       |        |
| N <sub>0</sub>                              | 7.26   | 26.28  | 5.03  | 9.77   |
| N <sub>60</sub>                             | 6.15   | 13.76  | 4.38  | 6.00   |
| N <sub>90</sub>                             | 5.47   | 10.99  | 3.85  | 5.06   |
| N <sub>120</sub>                            | 5.20   | 9.68   | 3.89  | 5.24   |
| S.Em.(±)                                    | 0.06   | 0.16   | 0.04  | 0.08   |
| CD at 5%                                    | 0.13   | 0.49   | 0.12  | 0.19   |
| F × N                                       | NS     | NS     | NS    | NS     |

## 4.5.5. N:K ratio

Table 4.5.5. Effect of FYM levels on N:K ratio of each growth stages of *Pearl millet* in open field and agri-horti system.

| Treatments                                  | System |        | Open  |        |
|---------------------------------------------|--------|--------|-------|--------|
|                                             | Grain  | Stover | Grain | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |        |        |       |        |
| F <sub>7</sub>                              | 3.72   | 0.79   | 2.68  | 0.37   |
| F <sub>10</sub>                             | 3.55   | 0.77   | 2.51  | 0.35   |
| F <sub>13</sub>                             | 3.46   | 0.68   | 2.45  | 0.35   |
| S.Em.(±)                                    | 0.05   | 0.12   | 0.05  | 0.10   |
| CD at 5%                                    | 0.15   | 0.36   | 0.15  | 0.31   |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |        |        |       |        |
| N <sub>0</sub>                              | 4.67   | 0.89   | 3.17  | 0.40   |
| N <sub>60</sub>                             | 3.83   | 0.87   | 2.75  | 0.42   |
| N <sub>90</sub>                             | 3.38   | 0.73   | 2.36  | 0.33   |
| N <sub>120</sub>                            | 3.05   | 0.59   | 2.25  | 0.32   |
| S.Em.(±)                                    | 0.04   | 0.14   | 0.06  | 0.03   |
| CD at 5%                                    | 0.12   | 0.37   | 0.16  | 0.12   |
| F × N                                       | NS     | NS     | NS    | NS     |

## 4.5.6. P:K ratio

Table 4.5.6. Effect of FYM levels on P:K ratio of each growth stages of *Pearl millet* in open field and agri-horti system.

| Treatments                                  | System |        | Open  |        |
|---------------------------------------------|--------|--------|-------|--------|
|                                             | Grain  | Stover | Grain | Stover |
| <b>FYM level (tonnes ha<sup>-1</sup>)</b>   |        |        |       |        |
| F <sub>7</sub>                              | 0.612  | 0.056  | 0.615 | 0.057  |
| F <sub>10</sub>                             | 0.609  | 0.057  | 0.608 | 0.059  |
| F <sub>13</sub>                             | 0.622  | 0.055  | 0.617 | 0.061  |
| S.Em.(±)                                    | 0.100  | 0.027  | 0.100 | 0.010  |
| CD at 5%                                    | 0.312  | 0.062  | 0.300 | 0.067  |
| <b>Nitrogen levels (kg ha<sup>-1</sup>)</b> |        |        |       |        |
| N <sub>0</sub>                              | 0.642  | 0.032  | 0.633 | 0.037  |
| N <sub>60</sub>                             | 0.621  | 0.063  | 0.628 | 0.069  |
| N <sub>90</sub>                             | 0.619  | 0.067  | 0.621 | 0.065  |
| N <sub>120</sub>                            | 0.587  | 0.061  | 0.583 | 0.061  |
| S.Em.(±)                                    | 0.124  | 0.001  | 0.116 | 0.020  |
| CD at 5%                                    | 0.329  | 0.021  | 0.320 | 0.062  |
| F × N                                       | NS     | NS     | NS    | NS     |

#### 4.5.1. C:N ratio

Summary of the data on nutrient stoichiometry estimation of various treatments are presented in table 4.5.1.

##### **Agri-horti system**

**FYM:** There was a significant effect on the C:N ratio due to FYM fertilization. The C:N ratio (52.37) was recorded with 10 tonnes FYM ha<sup>-1</sup> in stover of agri-horti system which was found statistically at par with 13 tonnes FYM ha<sup>-1</sup>. The C:N ratios in grains was found low. The observation of 10 tonnes FYM ha<sup>-1</sup> and 13 tonnes FYM ha<sup>-1</sup> was significantly at par with each other in stover.

**Nitrogen levels:** The C:N ratio was found to be significantly superior with 0 kg N ha<sup>-1</sup>. The C:N ratio (53.36) was recorded with 120 kg N ha<sup>-1</sup> in stover of agri-horti system. The observation of 0 kg N ha<sup>-1</sup> and 90kg N ha<sup>-1</sup> was found significantly at par with each other in stover.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

##### **Open system**

**FYM:** The maximum C:N ratio (103.77) was recorded with 10 tonnes FYM ha<sup>-1</sup> of open field. The observation of 10 tonnes FYM ha<sup>-1</sup> and 13 tonnes FYM ha<sup>-1</sup> was significantly at par with each other in stover while low in grains.

**Nitrogen levels:** The maximum C: N ratio (112.20) was recorded with 0 kg N ha<sup>-1</sup> in stover of sole –cropping field. The observation of 60 kg N ha<sup>-1</sup> and 90kg N ha<sup>-1</sup> was found significantly at par with each other in stover.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

#### 4.5.2. C:P ratio

Summary of the data on nutrient stoichiometry estimation of various treatments are presented in table 4.5.2.

##### **Agri-horti system**

**FYM:** There was a significant effect on the C:P ratio due to FYM fertilization. The maximum C: P ratio (695.02) was recorded with 10 tonnes FYM ha<sup>-1</sup> in stover of agri-horti system which was found significantly at par with 7 tonnes FYM ha<sup>-1</sup>. The C: P ratio (203.53) with 7 tonnes FYM ha<sup>-1</sup> was found in grain was low.

**Nitrogen levels:** The maximum C: P ratio (1352.00) was recorded with 0 kg N ha<sup>-1</sup> in stover of agri-horti system. The minimum C: P ratio ( 171.56 ) was recorded with 120 kg N ha<sup>-1</sup> in grains.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

##### **Open system**

**FYM:** The C: P ratio (617.09) was recorded with 13 tonnes FYM ha<sup>-1</sup> in stover of open field which was found significantly at par with 7 tonnes FYM ha<sup>-1</sup>.

**Nitrogen levels:** The C: P ratio (1096.08) was recorded with 0 kg N ha<sup>-1</sup> in stover of open field.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

#### 4.5.3. C: K ratio

Summary of the data on nutrient stoichiometry estimation of various treatments are presented in table 4.5.3.

**Agri-horti system**

**FYM:** There was a significant effect on the C: K ratio due to FYM fertilization. The C: K ratio (124.40) was recorded with 7 tonnes FYM ha<sup>-1</sup> in grains. The observation of 10 t FYM ha<sup>-1</sup> and 13 t FYM ha<sup>-1</sup> was found significantly at par with each other in grains. The C: K ratio in grains was found low.

**Nitrogen levels:** The C: K ratio was found to be significantly superior (152.85) with 0 kg N ha<sup>-1</sup>.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**Open system**

**FYM:** The C: K ratio (116.82) was recorded with 7 tonnes FYM ha<sup>-1</sup> of open field in grains. The C: K ratio in grains were low.

**Nitrogen levels:** The C: K ratio (142.75) was recorded with 0 kg N ha<sup>-1</sup> in grains of open field.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

**4.5.4. N: P ratio**

Summary of the data on nutrient stoichiometry estimation of various treatments are presented in table 4.5.4.

**Agri-horti system**

**FYM:** The N: P ratio (13.44) was recorded with 7 tonnes FYM ha<sup>-1</sup> in stover of agri-horti system which was found statistically at par with 13 tonnes FYM ha<sup>-1</sup>.

**Nitrogen levels:** The maximum N: P ratio (26.28) was recorded with 0 kg N ha<sup>-1</sup> in stover of agri-horti system.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

#### **Open system**

**FYM:** The N: P ratio (6.17) was recorded with 7 tonnes FYM ha<sup>-1</sup> of open field in stover. The observation of 10 tonnes FYM ha<sup>-1</sup> and 13 tonnes FYM ha<sup>-1</sup> was significantly at par with each other in stover. The lowest was observed in grains.

**Nitrogen levels:** The N: P ratio (9.77) was recorded with 0 kg N ha<sup>-1</sup> in stover of open field. The observation of 90 kg N ha<sup>-1</sup> and 120 kg N ha<sup>-1</sup> was found significantly at par with each other in stover.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

#### **4.5.5. N: K ratio**

Summary of the data on nutrient stoichiometry estimation of various treatments are presented in table 4.5.5.

#### **Agri-horti system**

**FYM:** There was a significant effect on the N: K ratio due to FYM fertilization. The maximum N: K ratio (3.72) was recorded with 7 tonnes FYM ha<sup>-1</sup> in grains of agri-horti system. The N: K ratio in stover was low.

**Nitrogen levels:** The maximum N: K ratio (4.67) was recorded with 0 kg N ha<sup>-1</sup> in grains of agri-horti system.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

### Open system

**FYM:** The N: K ratio (2.68) was recorded with 7 tonnes FYM ha<sup>-1</sup> of open field. The observation of 10 tonnes FYM ha<sup>-1</sup> and 13 tonnes FYM ha<sup>-1</sup> was significantly at par with each other in grains.

**Nitrogen levels:** The N: K ratio (3.17) was recorded with 0 kg N ha<sup>-1</sup> in grains of open field.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

### 4.5.6. P: K ratio

Summary of the data on nutrient stoichiometry estimation of various treatments are presented in table 4.5.6.

### Agri-horti system

**FYM:** There was a significant effect on the P: K ratio due to FYM fertilization. The P: K ratio (0.622) was recorded with 13 tonnes FYM ha<sup>-1</sup> in grains of agri-horti system. The P: K ratio was low in stover.

**Nitrogen levels:** The maximum P: K ratio (0.642) was recorded with 0 kg N ha<sup>-1</sup> in grain of agri-horti system. The observation of 60 kg N ha<sup>-1</sup> and 90 kg N ha<sup>-1</sup> was found significantly at par with each other in grain.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.

### Open system

**FYM:** The P: K ratio (0.617) was recorded with 13 tonnes FYM ha<sup>-1</sup> of open field in grain which was significantly at par with 7 tonnes FYM ha<sup>-1</sup> in grain. The P: K ratio was low in stover.

**Nitrogen levels:** The P: K ratio (0.633) was recorded with 0 kg N ha<sup>-1</sup> in grains of open field which was found significantly with 60 kg N ha<sup>-1</sup> at par with each other in grain.

**Interaction:** FYM and nitrogen levels failed to interact with each other so result is non-significant.



## DISCUSSION

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The growth and development of crop is directly related to environmental factors and agronomic practices as well as efficient management of nutrients and also this factor play a vital role in deciding crop productivity. The present experiment was undertaken to evaluate the effect of FYM and nitrogen levels on yield and nutrient stoichiometry of pearl millet under bael based agri-horti system. The results of the present investigation described in previous chapter are discussed and explained in the light of available information related to present investigation and findings of other scientist works in this field.

### 5.1 FYM

Farmyard manure is a good organic source of nutrient. They are also rich in micronutrients besides having plant growth promoting substances viz., hormones, enzymes and humus forming beneficial microbes. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity which promote growth and development of plants.

#### 5.1.1 Growth attributes

The effect of FYM application on plant height was influenced but it could not reach to significant level at all growth stage except 40 DAS. The data on plant growth recorded at 20, 40, 60 DAS and at harvest as given in (Table 4.1.1). In case of FYM levels the maximum plant height of plant (191.31cm) was recorded at the time of harvest with 13 tonne FYM ha<sup>-1</sup> in open field. FYM promotes the proper growth of plants providing suitable conditions. Similar result was reported by Gupta *et al.* (1996) and Kokobe and Derbew (2013).

FYM also has a potential to increase tillering in pearl millet which may perhaps cause a significant increase in dry matter accumulation. The maximum number of tillers were recorded (3.28 plant<sup>-1</sup>) was recorded at 40 DAS with F<sub>13</sub> level (13 tonnes) in

agri- horti system field and was also at par with open field at all the stages (Table 4.1.2). Reddy *et al.* (2016) also reported similar finding. Kumar *et al.* (2001) reported that the use of high doses of FYM significantly increase pearl millet growth.

FYM application also affect the leaf count (Table 4.1.3) which increased with age of the crop and reach to maximum level at 40 DAS (22.43 plant<sup>-1</sup>) with 13 t FYM ha<sup>-1</sup> in agri-horti system because of continuous supply of nutrients, moisture light thereafter it decreased. This may be due to senescence, mortality and leaf drying.

The effect of FYM application on internode length (Table 4.1.5) was influenced non significantly but internodal count (Table 4.1.4) was found with significant differences by the application of FYM during at 40 and at harvest growth stages. Maximum internode count (8.74 plant<sup>-1</sup>) with F<sub>10</sub> level (10 t N ha<sup>-1</sup>) and internodal length plant<sup>-1</sup> (21.53 cm) was observed by F<sub>7</sub> level (7 t FYM ha<sup>-1</sup>) at harvest both in agri-horti field.

Maximum crop dry matter accumulation was recorded by F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>) at all the stages there was no significant differences found at in all growth stages (Table 4.1.6). This finding corroborate with the finding of Khandelwal *et al.* (2017).

The crop growth rate (g day<sup>-1</sup>) also significantly increased continuously with the advancement of the crop growth stages (Table 4.1.7). The effect of FYM application on crop growth rate (g day<sup>-1</sup>) was influenced at all growth stages. The highest value (1.78 g day<sup>-1</sup>) was recorded with F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>) during 40 DAS in agri-horti system. It was observed that at 40 DAS it was higher and got decreased at 60 DAS and again increased at harvest it because the plant faced the extensive growth stages. Plant adequately supplied of the organic matter consequently contributed to better growth enzymes, aeration leads to development of individual plant and show the significant result to the crop growth rate.

### 5.1.2 Yield attributes and yield

Number of panicle plant<sup>-1</sup> and effective tillers was found to significantly increased with increasing level of FYM (Table 4.2.1a,b). The maximum number of panicle plant<sup>-1</sup> (1.34 ) was recorded at F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>) in agri-horti system, it was

found significantly at par with sole cropping field. It remained higher than that of lower levels of FYM and this consequently led to more number of panicle bearing tillers and panicle. Significant increase in number of panicle plant<sup>-1</sup> with increasing levels of FYM was also recorded by several workers Khandelwal *et al.* (2017).

The length of panicle increased significantly due to increase in the levels of FYM (Table 4.2.1a,b). The increase in length of panicle at higher level of FYM might be attributed to better nutrition of panicle primordia. Maximum length of panicle (25.95 cm) was recorded with F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>). However, the maximum girth of panicle (9.32 cm) was recorded with F<sub>10</sub> level (10 t FYM ha<sup>-1</sup>). Both were observed in agri-horti system. These findings corroborate the finding of Gupta *et al.* (1996).

The number of grain panicle<sup>-1</sup> increased significantly with increase in levels of FYM (Table 4.2.1a,b). The number of grain panicle<sup>-1</sup> is generally associated with panicle length which was affected favourably due to FYM application. The maximum number of grain panicle<sup>-1</sup> was observed at F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>) in both the fields. However, grain weight is increased significantly with increasing level of FYM. This might be due to initiation of nutrition in spikelets. Similar results were recorded by Jakhar *et al.* (2006).

Pearl millet yield being the result of various yield attributes and was significantly affected by FYM application (Table 4.2.2a,b). The maximum grain yield (2115.43 kg ha<sup>-1</sup>) was recorded with F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>) in agri-horti system. This is in agreement with the finding Patel *et al.* (2008).

### 5.1.3 Nutrients content and uptake

The data (Table 4.3.1a to 4.3.5) pertaining to the N,P,K,C and protein content (%) of grain and stover and its uptake as affected by FYM application had significant effect. The highest value was recorded at F<sub>13</sub> level (13 t FYM ha<sup>-1</sup>) for N and P contents in agri-horti system and K content in open system. While C content showed higher in stover with F<sub>10</sub> in agri-horti system. The uptake also significantly affected by FYM levels and observed higher values at F<sub>13</sub> level in all C, P and K in grain in agri-horti

system and N in stover in open field. The protein content and uptake was also higher with F<sub>13</sub>. FYM levels enhanced the plant nutrient content and uptakes and increase the metabolism. The Bairwa *et al.* (2017) showed that similar studies in plant nutrients content and uptakes.

## 5.2 Nitrogen

### 5.2.1 Growth attributes

Nitrogen is the primary nutrient and plays a vital role in growth as well as development of the plant. Plant height is controlled by the genetic makeup of the species and the environment to which the plant are subjected during the growth and development. The effect of nitrogen levels on plant height was significant at all growth stage (Table 4.1.1). In general plant growth increase with the advancement of crop growth stages and reached to maximum at harvest. The tallest plant (198.97cm) was recorded at harvest with N<sub>90</sub> level (90 kg N ha<sup>-1</sup>) in open field. This result is confirmed by Yadava (1998), Verma *et al.* (2006) and Chaudhari *et al.* (2002).

The number of tillers plant<sup>-1</sup> were significantly increased with an increase in fertilizer level (Table 4.1.2). The maximum tillers number plant<sup>-1</sup> was found with (3.51 plant<sup>-1</sup>) with N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) as at 40 DAS and 60 DAS in agri-horti system and thereafter, decreased. This may be due to mutual competition among the plants for light, nutrients and other growth input resulting in mortality of tillers after 40 DAS. Increase in nitrogen levels in general, increased the number of tillers significantly probably due to increasing the production of new meristematic tissues. Increase in number of tillers due to application of nitrogen has also been reported by Yadava (1998) and Chaudhari *et al.* (2002).

The leaf count (no. plant<sup>-1</sup>) increased with age of the crop and reach to maximum level at 40 DAS (Table 4.1.3), because of continuous supply of nutrients, moisture light thereafter it decreased. This may be due to senescence, mortality and leaf drying. The maximum leaf count (24.33 plant<sup>-1</sup>) was recorded with N<sub>120</sub> level (120 kg N ha<sup>-1</sup>)

in agri-horti system. Ayub *et al.* (2009) also reported the numbers of leaves plant<sup>-1</sup> were increased significantly at each increased nitrogen level.

The Internode count (no. plant<sup>-1</sup>) significantly increased continuously with the advancement of the crop growth stages (Table 4.1.4). The effect of nitrogen application on internode count was influenced significantly only at 60 DAS. It could be due to adequate supply of nutrition and favourable condition for growth in this stage. Similarly, internodal length (Table 4.1.5) was found with significant differences by the application of nitrogen during all the growth stages. Maximum internode count (9.10 plant<sup>-1</sup>) and internodal length plant<sup>-1</sup> (23.30 cm) was observed by N<sub>60</sub> level (60 kg N ha<sup>-1</sup>) at harvest in agri-horti system.

The crop dry matter accumulation (g plant<sup>-1</sup>) significantly increased continuously with the advancement of the crop growth stages (Table 4.1.6). The effect of nitrogen application on crop dry matter accumulation was influenced at all growth stages. The highest value (61.76 g) was recorded with N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) in agri-horti system. Dry matter accumulation of plants is the final outcome of photosynthetic activities. A significant increase in plant dry matter at different stages of growth due to increase in nitrogen levels might be attributed to the effect of nitrogen in increasing the amount and efficiency of chlorophyll which influence the photosynthetic efficiency and formation of other nitrogen compounds. Similar result also reported by Mesquita and Pinto (2000) and Singh *et al.* (2000).

The crop growth rate (g day<sup>-1</sup>) also significantly increased continuously with the advancement of the crop growth stages (Table 4.1.7). The effect of nitrogen application on crop growth rate (g day<sup>-1</sup>) was influenced at all growth stages. The highest value (1.97 g day<sup>-1</sup>) was recorded with N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) during 40 DAS in agri-horti system. Plant adequately supplied with N had more number of functional leaves and photosynthesizing area and this consequently contributed to better growth and development of individual plant and show the significant result to the crop growth rate.

### 5.2.2 Yield attributes and yield

The storage capacity of pearl millet depends on the number of panicle plant<sup>-1</sup> and unit area, number of grain panicle<sup>-1</sup>, length of panicle as well as grain weight panicle. (table 4.2.1a,b and 4.2.2a,b).

Number of panicle plant<sup>-1</sup> and effective tillers was found to significantly increase with increasing level of nitrogen. This may be due to the fact that the number of tillers at higher levels of nitrogen was so high that even after increased mortality, it remained significantly higher (1.40 plant<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> from both fields than that of lower levels of nitrogen and this consequently led to more number of panicle bearing tillers and panicle at higher level of nitrogen. This finding corroborates the finding of Singh and Sharma (1995), Munda *et al.* (1983).

The length of panicle increased significantly due to increase in the levels of nitrogen. It was observed that the highest (25.42 cm) with 90 kg N ha<sup>-1</sup> from agri-horti system. The increase in length of panicle at higher level of nitrogen might be attributed to better nutrition of panicle primordia. This is in agreement with the finding of Sharma *et al.* (1999), Alkaff and Saeed (2007).

The number of grain panicle<sup>-1</sup> increased significantly with increase in levels of nitrogen. The number of grain panicle<sup>-1</sup> is generally associated with Panicle length which was affected favourably due to nitrogen application. Thus significant difference in number of grain panicle<sup>-1</sup> was observed. Significant increase in number of grain panicle<sup>-1</sup> with increasing levels of nitrogen was also recorded by several workers Alkaff and Saeed (2007), Choudhari *et al.* (2002).

Test weight is mainly controlled by genetic makeup of the variety, though it increased significantly with increasing level of nitrogen. This might be due to better nutrition of spikelets. Similar results were recorded by Alkaff and Saeed (2007) and Verma *et al.* (2006).

Grain yield was significantly influenced by levels of nitrogen and significantly maximum grain yield (2303.27 kg ha<sup>-1</sup>) was recorded at N<sub>120</sub> level (120 kg N ha<sup>-1</sup>)

from agri-horti system field. It is well known fact that grain yield is the outcome of yield attributing characters, which also showed increasing used with increasing levels of nitrogen. Positive grain yield may be due to nitrogen being a major nutrient, affected all physico-chemical process. The finding of present investigation corroborates with the findings of Yakadri and Reddy (2009).

### 5.2.3 Nutrients content and uptake

The data (Table 4.3.1a to 4.3.5) pertaining to the N,P,K,C and protein content (%) of grain and stover and its uptake as affected by nitrogen application had significant effect. The highest value was recorded at N<sub>120</sub> level (120 kg N ha<sup>-1</sup>) for N and C contents in agri-horti system. While P and K content showed higher in sole open field with same level of N doses. The uptake also significantly affected by nitrogen levels and observed higher values at N<sub>120</sub> level in C, P and K while N showed with N<sub>90</sub> (90 kg N ha<sup>-1</sup>). The protein content and uptake was also higher with N<sub>120</sub>. The Silva *et al.* (2012) evaluated that the addition of N doses promoted a rise of crude protein (CP) content at all the cuts of pearl millet. Swami *et al.* (1993) also reported that plant uptake of N was higher and increased with increasing N rate.

### 5.3 FYM and Nitrogen interaction

In the present study, the interaction effect of FYM and nitrogen levels was observed on various growth, yield parameter and nutrient content, uptake parameters and they were found having the significant results. This may be because it had fulfilled the requirement of FYM and nitrogen nutrition. The maximum values were observed with F<sub>13</sub> N<sub>120</sub> (13 t FYM ha<sup>-1</sup> x 120 kg N ha<sup>-1</sup>) combination followed by in some interaction with F<sub>13</sub> N<sub>90</sub> (13 t FYM ha<sup>-1</sup> x 90 kg N ha<sup>-1</sup>) combination and minimum value with control treatment.

### 5.4 Nutrient Stoichiometry

The Nutrient Stoichiometry studies were performed on following C:N, C:P, C:K, N:P, N:K, P:K ratios (Table 4.5.1 – 4.5.6). The C: N ratio (112.20 %) in stover of open field. The C: P ratio (1352 %) in stover of agri-horti system. The C: K ratio (152.85

%) in grains of agri-horti system. The N: P ratio (26.28 %) in stover of agri-horti system. The N: K ratio (4.67 %) in grains of agri-horti system. The P: K ratio (1.20 %) in grains of agri-horti system. The N: P: K ratio (1.20 %) in grains of agri-horti system. The C: N : P ratio (0.011 %) in stover of agri-horti system. These were observed with 0 kg N ha<sup>-1</sup>.



## **SUMMARY AND CONCLUSION**

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In this chapter an attempt has been made to summarize, and also to draw valid conclusions based on the significant findings of the present investigation entitled “Effect of FYM and nitrogen levels on yield and nutrient stoichiometry of pearl millet under bael based agri-horti system”. The investigation was conducted in Kharif season of 2016 at the research farm of Rajiv Gandhi South Campus, Barkachha, Banaras Hindu University, Mirzapur.

The soil of experiment field was sandy clay loam with moderate fertility. The experiment was laid out in RBD (factorial) with three levels of FYM (7, 10 and 13 t FYM ha<sup>-1</sup>) and four levels of nitrogen (0, 60, 90 and 120 kg ha<sup>-1</sup>). Urea was used as a source of nitrogen and local FYM. In three split doses the full amount of nitrogen as per treatment specification with the recommended dose of phosphorus and potassium (P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O) were applied as a basal application.

Data on growth parameters viz. plant height, number of tillers, plant leaf count, crop dry matter accumulation, internodal count, internodal length, number of running meters of tillers, dry matter accumulation and crop growth rate were recorded at the different stages of plant growth of pearl millet crop under agri-horti system and sole cropping field. Yield characters viz. number of panicle, length of panicle, girth of panicle, number of grains panicle<sup>-1</sup>, test weight, grain and straw yield hectare<sup>-1</sup> and harvest index were recorded. The nutrient analysis was observed viz. N content and uptake, K content and uptake, P content and uptake & C content and uptake. There nutrient stoichiometry ratios were also evaluated viz. C:N, C:P, C:K, N:P, N:K and P:K.

The effect of treatments on growth, yield, nutrient analysis and nutrient stoichiometry of pearl millet under agri-horti system were recorded in term of different indices of observation. Standard field techniques, method of observation, analyses of data were used. The silent features of experimental findings are summarized here under:

1. FYM levels significantly affect the plant height at all the growth stages and maximum plant height (191.31cm) was recorded at the time of harvest with 13 tonne FYM ha<sup>-1</sup> in open field. Nitrogen level had significant effect on plant height except at 60 DAS and at harvest with 90 kg N ha<sup>-1</sup>. The maximum plant height (198.97cm) was observed in open field.
2. FYM levels significantly affect the number of tillers plant<sup>-1</sup> at all the growth stages. The maximum number of tillers (3.28 plant<sup>-1</sup>) was recorded at 40 DAS and 60 DAS with F<sub>13</sub> level (13 tonnes) in agri- horti system and thereafter, decreased. Nitrogen level also had a significant effect on number of tillers plant<sup>-1</sup> at all the growth stages. The maximum number of tillers observed (3.51 plant<sup>-1</sup>) with 120 kg N ha<sup>-1</sup> at 40 DAS in agri- horti system.
3. FYM levels significantly affect the leaf count (no. plant<sup>-1</sup>) at all the growth stages and maximum leaf count (22.43 plant<sup>-1</sup>) was recorded at 40 DAS with 13 t ha<sup>-1</sup> in agri-horti system. Nitrogen level also had a significant effect on leaf count (no. plant<sup>-1</sup>) at all the growth stages. The maximum number of leaf count (24.33 plant<sup>-1</sup>) was recorded at 40 DAS with 120 kg N ha<sup>-1</sup> in agri-horti system.
4. FYM levels had significant effect on the internodal count (no. plant<sup>-1</sup>) at all the growth stages except 60 DAS and at harvest, maximum internodal count (8.74 plant<sup>-1</sup>) was recorded at the time of harvest with 10 t FYM ha<sup>-1</sup> from agri-horti system. Nitrogen level also had a significant effect on internodal count (no. plant<sup>-1</sup>) at all the growth stages and maximum internodal count (9.09 plant<sup>-1</sup>) was recorded at the time of harvest with 60 kg N ha<sup>-1</sup> from agri-horti system.
5. FYM levels significantly affect the internodal length (cm) at all the growth stages and maximum internodal length (21.53 cm) was recorded at harvest with 7 t FYM ha<sup>-1</sup> from agri-horti system. Nitrogen level also had a significant effect on internodal length (cm) at all growth stages and maximum internodal length (23.30 cm) was recorded at harvest with 60 kg N ha<sup>-1</sup> from agri-horti system.

6. FYM levels significantly affect the crop dry matter accumulation ( $\text{g plant}^{-1}$ ) at all the growth stages and maximum crop dry matter accumulation (59.65 g) was recorded at the time of harvest with  $13 \text{ t ha}^{-1}$  from agri-horti system. Nitrogen level also had a significant effect on crop dry matter accumulation ( $\text{g plant}^{-1}$ ) at all growth stages and maximum crop dry matter accumulation (61.76 g) recorded with  $120 \text{ kg N ha}^{-1}$  at the harvest from agri-horti system.
7. FYM levels significantly affect the crop growth rate ( $\text{g day}^{-1}$ ) at all the growth stages and maximum crop growth rate (1.78 g) was recorded at the time of harvest with  $13 \text{ t FYM ha}^{-1}$  from agri-horti system. Nitrogen level also had a significant effect on crop growth rate ( $\text{g day}^{-1}$ ) at all growth stages and maximum crop growth rate ( $1.97 \text{ g day}^{-1}$ ) was recorded with  $120 \text{ kg N ha}^{-1}$  at 40 DAS from agri-horti system.
8. FYM levels significantly affect the number of panicle  $\text{plant}^{-1}$  and maximum number of panicle ( $1.34 \text{ plant}^{-1}$ ) was recorded with  $13 \text{ tonnes FYM ha}^{-1}$  from agri-horti system which was statistically at par with open field. Nitrogen level also had a significant effect on number of panicle  $\text{plant}^{-1}$  and maximum number of panicle ( $1.40 \text{ plant}^{-1}$ ) with  $120 \text{ kg N ha}^{-1}$  from agri-horti system which was at par with open field.
9. FYM levels significantly affect the number of panicle  $\text{ha}^{-1}$  and maximum number of panicle ( $40548.98 \text{ ha}^{-1}$ ) was recorded with  $13 \text{ tonnes FYM ha}^{-1}$  from agri-horti system which was statistically at par with open field. Nitrogen level also had a significant effect on number of panicle  $\text{ha}^{-1}$  and maximum number of panicle ( $42487.87 \text{ ha}^{-1}$ ) with  $120 \text{ kg N ha}^{-1}$  was obtained from agri-horti system.
10. FYM levels significantly affect the length of panicle (cm) and maximum length of panicle (25.95 cm) was recorded with  $13 \text{ tonnes FYM ha}^{-1}$  from agri-horti system which was statistically at par with the produce from open field at same level of FYM. Nitrogen level also had a significant effect on length of panicle (cm) and maximum length of panicle (25.42 cm) was obtained with  $90 \text{ kg N ha}^{-1}$  from agri-horti system.

11. FYM levels significantly affect the girth of panicle (cm) and maximum girth of panicle (9.32 cm) was recorded with 10 t FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with the open field. Nitrogen level also had a significant effect on girth of panicle (cm) and maximum girth of panicle (9.32 cm) was obtained with 60 kg N ha<sup>-1</sup> from agri- horti system.
12. FYM levels significantly affect the number of grain panicle<sup>-1</sup> and maximum number of grain panicle<sup>-1</sup> was recorded with 13 t FYM ha<sup>-1</sup>. Nitrogen level also had a significant effect on number of grain panicle<sup>-1</sup> and maximum number of grain panicle<sup>-1</sup> was recorded with 120 kg N ha<sup>-1</sup>. Combination of F x N also showed interaction effect on number of grain panicle<sup>-1</sup> and maximum number of grain (2283.32 panicle<sup>-1</sup>) recorded by combination of 10 t FYM ha<sup>-1</sup> x 60 kg N ha<sup>-1</sup>.
13. FYM levels significantly affect the test weight (g) and maximum test weight (9.54 g) was recorded with 10 t FYM ha<sup>-1</sup>. Nitrogen level also had a significant effect on test weight (g) and maximum test weight (9.59 g) with 120 kg N ha<sup>-1</sup> from agri-horti system and was found statistically at par with open field. Combination of F x N also showed interaction effect on test weight and maximum test weight (12.15 g) recorded by combination of 10 t FYM ha<sup>-1</sup> x 60 kg N ha<sup>-1</sup>.
14. FYM levels significantly affect the grain yield (kg ha<sup>-1</sup>) and maximum grain yield (2115.43 kg ha<sup>-1</sup>) was recorded with 13 t FYM ha<sup>-1</sup> from agri-horti system which was statistically at par with open field. Nitrogen level also had a significant effect on grain yield (kg ha<sup>-1</sup>) and maximum grain yield (2303.27 kg ha<sup>-1</sup>) was obtained with 120 kg N ha<sup>-1</sup> from agri-horti system. Combination of F x N also showed interaction effect on grain yield (kg ha<sup>-1</sup>) and maximum grain yield (2495.86 kg ha<sup>-1</sup>) recorded by combination of 13 t FYM ha<sup>-1</sup> x 120 kg N ha<sup>-1</sup>.
15. FYM levels significantly affect the stover yield (kg ha<sup>-1</sup>) however, maximum stover yield (5046.14 kg ha<sup>-1</sup>) was recorded with 13 tonnes ha<sup>-1</sup> of FYM from agri-horti system which was statistically at par with open field with same dose of FYM. Nitrogen level had a significant effect on stover yield (kg ha<sup>-1</sup>) and

maximum stover yield ( $4992.57 \text{ kg ha}^{-1}$ ) was recorded with  $120 \text{ kg N ha}^{-1}$  from agri-horti system.

16. FYM levels significantly affect the biological yield ( $\text{kg ha}^{-1}$ ) and maximum biological yield ( $7161.57 \text{ kg ha}^{-1}$ ) was recorded with  $13 \text{ t FYM ha}^{-1}$  in agri-horti system. Nitrogen level also had a significant effect on biological yield ( $\text{kg ha}^{-1}$ ) and maximum biological yield ( $7295.84 \text{ kg ha}^{-1}$ ) was recorded with  $120 \text{ kg N ha}^{-1}$ .
17. FYM levels non-significantly affect the harvest index and maximum harvest index ( $30.13 \%$ ) was recorded with  $10 \text{ t FYM ha}^{-1}$ . Nitrogen level also had a significant effect on harvest index and maximum harvest index ( $31.56 \%$ ) was recorded with  $120 \text{ kg N ha}^{-1}$ .
18. FYM levels significantly affect the nitrogen content and maximum nitrogen content ( $1.79 \%$ ) was recorded with  $13 \text{ t FYM ha}^{-1}$  in grains in agri-horti system. Nitrogen level also had a significant effect on nitrogen content and maximum nitrogen content ( $1.79 \%$ ) was recorded with  $120 \text{ kg N ha}^{-1}$  in grains in agri-horti system.
19. FYM levels significantly affect the nitrogen uptake and maximum nitrogen uptake ( $58.05 \text{ kg ha}^{-1}$ ) in stover was recorded with  $13 \text{ t FYM ha}^{-1}$  from agri-horti system. Nitrogen level also had a significant effect on nitrogen uptake and maximum nitrogen uptake ( $55.12 \text{ kg ha}^{-1}$ ) was recorded with  $90 \text{ kg N ha}^{-1}$ .
20. FYM levels significantly affect the carbon content and maximum carbon content ( $59.33\%$ ) was recorded with  $10 \text{ t FYM ha}^{-1}$  in stover from agri-horti system. Nitrogen level had significant effect on carbon content and maximum carbon content ( $59.10 \%$ ) in grains was recorded with  $120 \text{ kg N ha}^{-1}$  from agri-horti system.
21. FYM levels significantly affect the carbon uptake and maximum carbon uptake ( $3032.92 \text{ kg ha}^{-1}$ ) in stover was recorded with  $13 \text{ t FYM ha}^{-1}$  from agri-horti system. Nitrogen level also had a significant effect on carbon uptake and

maximum carbon uptake ( $2905.40 \text{ kg ha}^{-1}$ ) in stover from agri- horti system was recorded at  $120 \text{ kg N ha}^{-1}$ .

22. FYM levels significantly affect the phosphorus content and maximum phosphorus content ( $0.32 \%$ ) in grains was recorded with  $13 \text{ t FYM ha}^{-1}$  from agri-horti system. Nitrogen level had also significant effect on phosphorus content and maximum phosphorus content ( $0.35 \%$ ) in grain with  $120 \text{ kg N ha}^{-1}$  in open field.
23. FYM levels significantly affect the phosphorus uptake and maximum phosphorus uptake ( $6.90 \text{ kg ha}^{-1}$ ) with  $13 \text{ t FYM ha}^{-1}$  in grains was observed from open field. Nitrogen level also had a significant effect on phosphorus uptake and maximum phosphorus uptake ( $8.07 \text{ kg ha}^{-1}$ ) with  $120 \text{ kg N ha}^{-1}$  in grain was recorded from open field.
24. FYM levels significantly affect the potassium content and maximum potassium content ( $1.64 \%$ ) with  $13 \text{ kg FYM ha}^{-1}$  in stover was recorded from open field. Nitrogen level also had a significant effect on potassium content and maximum potassium content ( $2.01 \%$ ) with  $120 \text{ kg N ha}^{-1}$  was recorded in stover from open field.
25. FYM levels significantly affect the potassium uptake and maximum potassium uptake ( $85.13 \text{ kg ha}^{-1}$ ) in stover with  $13 \text{ t FYM ha}^{-1}$  observed from open field. Nitrogen level also had a significant effect on potassium uptake and maximum potassium uptake ( $100.14 \text{ kg ha}^{-1}$ ) in stover was recorded with  $120 \text{ kg N ha}^{-1}$  from open field.
26. FYM levels significantly affect the protein content and maximum protein content ( $10.28 \%$ ) in grains from agri-horti system was recorded with  $13 \text{ t FYM ha}^{-1}$ . Nitrogen level also had a significant effect on protein content and maximum protein content ( $10.30 \%$ ) with  $120 \text{ kg N ha}^{-1}$  was recorded from agri-horti system.
27. FYM levels significantly affect the protein yield ( $21777.62 \text{ kg ha}^{-1}$ ) in grains with  $13 \text{ t FYM ha}^{-1}$  observed from agri-horti system. Nitrogen level also had a

significant effect on protein yield and maximum protein yield (23786.08 kg ha<sup>-1</sup>) in grains was recorded with 120 kg N ha<sup>-1</sup> from agri-horti system.

28. FYM levels significantly affect gross return and maximum gross return (Rs. 44029.91 ha<sup>-1</sup>) was recorded with 13 t FYM ha<sup>-1</sup> of agri-horti system. Nitrogen level also had a significant effect on gross return and maximum gross return (Rs. 44080.84 ha<sup>-1</sup>) was recorded with 120 kg N ha<sup>-1</sup> from agri-horti system.
29. FYM levels significantly affect the net return and maximum net return (Rs. 36041.79 ha<sup>-1</sup>) was recorded with 13 t FYM ha<sup>-1</sup> of agri-horti system. Nitrogen level also had a significant effect on net return and maximum net return (Rs. 36092.72 ha<sup>-1</sup>) was recorded with 120 kg N ha<sup>-1</sup> from agri-horti system.
30. FYM levels significantly affect the B: C ratio and maximum B: C ratio (5.51 %) was recorded with 13 t FYM ha<sup>-1</sup> of agri-horti system. Nitrogen level also had a significant effect on B: C ratio and maximum B : C ratio (5.52 %) was recorded with 120 kg N ha<sup>-1</sup> from agri-horti system.
31. FYM levels significantly affect the C: N ratio and maximum C: N ratio (103.77 %) was recorded with 10 t FYM ha<sup>-1</sup> of open field in stover. Nitrogen level also had a significant effect on C: N ratio and maximum C: N ratio (112.20 %) was recorded with 0 kg N ha<sup>-1</sup> in stover of open field.
32. FYM levels significantly affect the C: P ratio and maximum C: P ratio (695.02 %) was recorded with 10 t FYM ha<sup>-1</sup> in stover of agri-horti system. Nitrogen level also had a significant effect on C: P ratio and maximum C: P ratio (1352 %) was recorded with 0 kg N ha<sup>-1</sup> in stover of agri-horti system.
33. FYM levels significantly affect the C: K ratio and maximum C: K ratio (124.40 %) was recorded with 7 tonnes FYM ha<sup>-1</sup> in grains from agri-horti system. Nitrogen level also had a significant effect on C: K ratio and maximum C: K ratio (152.85 %) was recorded with 0 kg N ha<sup>-1</sup> in grains of agri-horti system.
34. FYM levels significantly affect the N: P ratio and maximum N: P ratio (13.44 %) was recorded with 7 t FYM ha<sup>-1</sup> in stover of agri-horti system. Nitrogen

level also had a significant effect on N: P ratio and maximum N: P ratio (26.28 %) was recorded with 0 kg N ha<sup>-1</sup> in stover of agri-horti system.

35. FYM levels significantly affect the N: K ratio and maximum N: K ratio (3.72 %) was recorded with 7 t FYM ha<sup>-1</sup> in grains of agri-horti system. Nitrogen level also had a significant effect on N: K ratio and maximum N: K ratio (4.67 %) was recorded with 0 kg N ha<sup>-1</sup> in grains of agri-horti system.
36. FYM levels significantly affect the P: K ratio and maximum P: K ratio (0.62 %) was recorded with 13 t FYM ha<sup>-1</sup> in grains of agri-horti system. Nitrogen level also had a significant effect on P: K ratio and maximum P: K ratio (0.64 %) was recorded with 0 kg N ha<sup>-1</sup> in grains of agri-horti system.

### **Conclusion:**

On the basis of one year field and laboratory study it may be concluded that:

- Highest yield of pearl millet crop was obtained with the application of nitrogen 120 N kg ha<sup>-1</sup> and FYM level 13 t FYM ha<sup>-1</sup> (2303.27 kg ha<sup>-1</sup>) from agri-horti system which was found a suitable dose of fertilizer.
- The highest net returns (Rs. 36092.72 ha<sup>-1</sup>) and B: C (5.52 %) was obtained with the application of nitrogen 120 kg N ha<sup>-1</sup> from agri-horti system.
- The growth of pearl millet was co-limited by C: N, C: P and P: K ratio with the application of F<sub>10</sub> N<sub>0</sub> and F<sub>13</sub> N<sub>0</sub> from open field and agri-horti system. These has broaden the essentiality of nutrient stoichiometry in plant growth.



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## APPENDICES

### Appendix I: Characteristics of Fruit Tree (Bael)

**Table 1: Growth parameters of fruit tree at sowing.**

| Fruit tree | Height (m) | Canopy Diameter (feet) | Stem Girth (cm) | No. of branch tree <sup>-1</sup> | Shading Area |           |
|------------|------------|------------------------|-----------------|----------------------------------|--------------|-----------|
|            |            |                        |                 |                                  | Length (m)   | Width (m) |
| Bael       | 9.49       | 14.84                  | 50.34           | 15                               | 20.13        | 3.02      |

**Table 2: Growth parameters of fruit tree at harvest.**

| Fruit tree | Height (m) | Canopy Diameter (feet) | Stem Girth (cm) | No. of branch tree <sup>-1</sup> | Shading Area |           |
|------------|------------|------------------------|-----------------|----------------------------------|--------------|-----------|
|            |            |                        |                 |                                  | Length (m)   | Width (m) |
| Bael       | 9.65       | 14.98                  | 52.75           | 18                               | 22.5         | 3.10      |

**Table 3: Yield attributes, yield and economic of fruit tree.**

| Fruit Tree | Number of average fruit tree <sup>-1</sup> | Average weight of fruit (g) | Number of fruit tree ha <sup>-1</sup> | Fruit yield (kg ha <sup>-1</sup> ) | Rate of fruit (Rs. kg <sup>-1</sup> ) | Gross income from fruit tree (Rs.) |
|------------|--------------------------------------------|-----------------------------|---------------------------------------|------------------------------------|---------------------------------------|------------------------------------|
| Bael       | 27.82                                      | 345                         | 198                                   | 1900                               | 25                                    | 47500.00                           |

**Appendix II. Common cost of cultivation (₹ ha<sup>-1</sup>).**

| S. No. | Operations                                   | Input                           | Rate (Rs.)                                          | Cost (Rs.) |
|--------|----------------------------------------------|---------------------------------|-----------------------------------------------------|------------|
| 1.     | Land preparation                             |                                 |                                                     |            |
|        | 1. One deep ploughing by soil turning plough | One tractor (35 HP) for 2.5 hrs | 250 Rs. hrs <sup>-1</sup>                           | 625        |
|        | 2. Harrowing and planking                    | One tractor (35 HP) for 4 hrs   | 250 Rs. hrs <sup>-1</sup>                           | 1000       |
| 2.     | Layout                                       | 4 labour day <sup>-1</sup>      | 200 Rs. (Men)<br>200 Rs. (Women)                    | 800        |
| 3      | Seed                                         | 10 kg ha <sup>-1</sup>          | 150 Rs. Kg <sup>-1</sup>                            | 1500       |
| 4..    | Seed sowing and fertilizer application       | 4 labour day <sup>-1</sup>      | 100 Rs. labour <sup>-1</sup><br>( 1 hour duration ) | 400        |
| 5.     | Thinning                                     | 4 labour day <sup>-1</sup>      | 150 Rs. labour <sup>-1</sup><br>( 1 hour duration ) | 600        |
| 6.     | Plant protection                             | Nil                             | Nil                                                 | Nil        |
| 7.     | Harvesting and Threshing                     | 4 labour                        | 200 Rs. labour <sup>-1</sup>                        | 800        |
| 8.     | Harvesting of Bael                           | 2 labour                        | 200 Rs. labour <sup>-1</sup>                        | 400        |
| 9.     | Land revenue                                 | For 6 month                     | 150 Rs. annum <sup>-1</sup>                         | 75         |
| 10.    | Interest on working capital                  | For 6 month                     | 14 % annum <sup>-1</sup>                            | 1717       |
|        |                                              |                                 | Total (Rs.)                                         | 7917       |

## Appendix III: Variable Cost

| Treatment | Labour | Labour cost @200 Rs./Lab | FYM kg ha <sup>-1</sup><br>(1 t =1000 kg, converted to kg) | Fertilizer doses (kg/ha <sup>-1</sup> ) |     |       | Cost of Fertilizer (Rs. ha <sup>-1</sup> ) | Treatment Cost (Rs. ha <sup>-1</sup> ) | Common Cost (Rs. ha <sup>-1</sup> ) | Total Cost (Rs. ha <sup>-1</sup> ) |
|-----------|--------|--------------------------|------------------------------------------------------------|-----------------------------------------|-----|-------|--------------------------------------------|----------------------------------------|-------------------------------------|------------------------------------|
|           |        |                          |                                                            | (as per fertilizers recommended doses)  |     |       |                                            |                                        |                                     |                                    |
|           |        |                          |                                                            | UREA                                    | SSP | MOP   |                                            |                                        |                                     |                                    |
| F7N0 (C)  | 2      | 400                      | 8.4                                                        | -                                       | -   | -     | 1.68                                       | 10.08                                  | 7917                                | 7927.08                            |
| F7 N60    | 2      | 400                      | 8.4                                                        | 0.156                                   | 0.3 | 0.06  | 8.536                                      | 51.2136                                | 7917                                | 7968.21                            |
| F7N90     | 2      | 400                      | 8.4                                                        | 0.235                                   | 0.3 | 0.06  | 9.474                                      | 56.8469                                | 7917                                | 7973.85                            |
| F7N120    | 2      | 400                      | 8.4                                                        | 0.313                                   | 0.3 | 0.06  | 10.413                                     | 62.4802                                | 7917                                | 7979.48                            |
| F10N0     | 2      | 400                      | 12                                                         |                                         | 0.3 | 0.06  | 7.378                                      | 44.267                                 | 7917                                | 7961.27                            |
| F10N60    | 2      | 400                      | 12                                                         | 0.156                                   | 0.3 | 0.06  | 9.256                                      | 55.5336                                | 7917                                | 7972.53                            |
| F10N90    | 2      | 400                      | 12                                                         | 0.235                                   | 0.3 | 0.06  | 10.194                                     | 61.1669                                | 7917                                | 7978.17                            |
| F10N120   | 2      | 400                      | 12                                                         | 0.313                                   | 0.3 | 0.06  | 11.133                                     | 66.8002                                | 7917                                | 7983.8                             |
| F13N0     | 2      | 400                      | 15.6                                                       |                                         | 0.3 | 0.06  | 8.098                                      | 48.587                                 | 7917                                | 7965.59                            |
| F13N60    | 2      | 400                      | 15.6                                                       | 0.156                                   | 0.3 | 0.06  | 9.976                                      | 59.8536                                | 7917                                | 7976.85                            |
| F13N90    | 2      | 400                      | 15.6                                                       | 0.235                                   | 0.3 | 0.06  | 10.914                                     | 65.4869                                | 7917                                | 7982.49                            |
| F13N120   | 2      | 400                      | 15.6                                                       | 0.313                                   | 0.3 | 0.06  | 11.853                                     | 71.1202                                | 7917                                | 7988.12                            |
|           |        |                          |                                                            | 2.11248                                 | 3.3 | 0.659 | 108.906                                    | 653.436                                |                                     | 95657.4                            |

FYM: Rs. 200/t (in kg 0.2), Urea: Rs. 12/kg, SSP: Rs. 13/kg, MOP: 18/kg

