Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
JPP 2020; SP6: 135-140

**Manisha Sahu**
Department of Farm Machinery and Power Engineering, Pt. SKS, CARS, Rajnandgaon, IGKV, Raipur, India

**Sunil Agrawal**
Department of Agronomy, College of Agriculture, IGKV, Raipur, India

**VM Victor**
Department of Farm Machinery and Power Engineering, SVCAET&RS, IGKV, Raipur, India

**Ajay Verma**
Department of Farm Machinery and Power Engineering, SVCAET&RS, IGKV, Raipur, India

**Correspondence**
**Manisha Sahu**
Department of Farm Machinery and Power Engineering, Pt. SKS, CARS, Rajnandgaon, IGKV, Raipur, India

**International Web-Conference**
**On**
**New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development**
**(21-22 June, 2020)**

# Comparative study of different methods of FYM application on growth and yield of rice (*Oryza sativa*)

**Manisha Sahu, Sunil Agrawal, VM Victor and Ajay Verma**

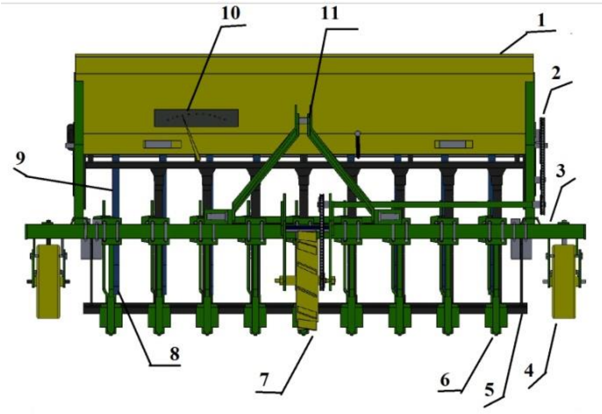
## Abstract
A unit for the application of farmyard manure (FYM) in the field with planting of seeds was designed and developed. The developed applicator cum planter had a FYM hopper capacity of 302 kg and was pulled by 50 H.P. tractor. Tractor drawn FYM applicator cum planter had nine tyne shovel type furrow opener to place the FYM in band form. Inverted 'T' type furrow opener was used to place the seeds with individual seed box for each furrow opener. Inclined metering plate was used to meter the seeds. Grain yield was maximum at 100 per cent RDN through the applicator with 40.51 q/ha followed by 75 per cent RDN through applicator and 100 per cent RDN through manual broadcasting with 38.49 q/ha and 33.51 q/ha, respectively. Whereas lowest grain yield 18.41 q/ha was noted under control treatment. From the study it was concluded that the plant growth parameters and yield attributes were affected by different method of FYM application followed by different dose of nitrogen.

**Keywords:** Farmyard manure, FYM applicator cum planter, Grain yield, Harvest Index

## Introduction
Greenhouse gas emissions ($N_2O$ and $CH_4$) were much higher from the anaerobically stacked farmyard manure than from the composted pit (Amon *et al*., 2001) [1]. Manure serves as an excellent source of both primary and secondary nutrients required for crop growth. In addition, land application improves overall soil quality that supplies indirect benefits to the farmer through improved crop response, reductions in inorganic inputs of fertilizers, limiting materials and pesticides and reduced soil water losses (Risse *et al*. (2006) [10]. Animal manure is an excellent nutrient source because it contains most of the plant essential elements. Land application of manure will produce crop yields equivalent or superior to those obtained with chemical fertilizers. The potential of three agricultural waste composts, farmyard manure (FYM), banana waste (BW) and pressmud (PM) were tested for maize. Experiment results showed highly significant increase in plant height, dry matter yields and NPK contents with the application of fertilizers, particularly nitrogen (N) (Memon *et al.* (2012) [4]. Increasing levels of farmyard manure upto 15 t/ha significantly increased growth characters like plant height, dry matter accumulation, number of branches, crop growth rate (CGR), leaf area index (LAI), yield attributes, seed, stover and biological yield, N, P, K content in both seed and stover, their uptake, protein percent and protein yield, net return and B:C ratio moongbean and cowpeas seed (Vikrant (2002) [14]. The overall objective was to know the effect of FYM band application on rice production.

## Materials and Methods
### System description
The tractor drawn FYM applicator cum planter consisted of a FYM hopper, an agitator metering unit, seed box, inclined plate seed metering unit, a shovel assemble for FYM, a Inverted 'T' type assembly for seed, a double angle iron, a main frame and orifices. The FYM hopper, with capacity of 302 kg, was fabricated to store the FYM and with the help of agitating unit FYM was crushed and deliver through orifice to the shovel type furrow opener to a tilled field.

A tractor of 50 H.P. (John Deer) was used to drive the FYM applicator cum planter. Hitching system was given to the implement which was hitch to the tractor with three point hitch link. Tines of shovels were mounted on the main frame which spacing was adjustable according to the row distance of crop. Depth of FYM application can be varied with the help of gauge wheel. FYM was applied in band form and surface incorporation was done with double angle iron behind of shovel assembly. Double angle iron performed the work of planker. Inverted 'T' tines assemble were mounted on mainframe behind the planker. Seed was sown on the band of FYM within row. Seed spacing was adjusted with the help of appropriate number of teeth of sprocket used in seed metering shaft.




1. FYM hopper and seed box in back side, 2. Power transmission system, 3. Main frame, 4. Gauge wheel, 5. Planker, 6. Furrow opener for FYM, 7. Drive wheel, 8. Furrow opener for seed (just behind the FYM furrow opener), 9. Seed tube, 10. Indicator of orifice opening position.

**Fig. 1:** Schematic view of FYM applicator cum planter

**Fig. 2:** FYM applicator cum planter in actual use

**Chemical Analysis**

Chemical analysis was done at dried form of FYM is presented in Table 1. Availability of nitrogen in experimental FYM was measured using the alkaline $KMnO_4$ method (Subbaiah and Asija, 1956). Phosphorus was also measured, using the Olsen's method, described in (Olsen *et al.*, 1954) [8]. Availability of potassium in the FYM was determined by using flame photometric method (Hanway and Heidle, 1952) [2]

**Table 1:** Physico-chemical properties of the experimental FYM

| Contents, % | FYM |
|---|---|
| Nitrogen | 0.65 |
| Phosphorus | 0.20 |
| Potassium | 0.50 |

**Experimental Details**

FYM agitator crushes and delivers the FYM to the shovel type furrow opener to apply FYM in band form on a tilled field. Then the furrows were covered by soil with the help of double angle iron rod (Fig.1). Inverted 'T' type furrow opener was attached on frame behind the shovel type furrow opener for sowing the rice seeds. For experimental purpose field size of (130 m × 58 m) was used to investigate the performance of the developed FYM applicator cum planter for crop production. Total five treatments and four replications were used in RBD design. Performance was studied on the basis of statistical analysis of different treatments. In treatment ($T_1$) 100 per cent RDN was applied FYM through manual broadcasting, treatment ($T_2$) was applied 100 per cent RDN through FYM by tractor drawn FYM applicator cum planter. Similarly treatment ($T_3$) and ($T_4$) was applied FYM through tractor drawn FYM applicator cum planter with 75 per cent and 50 per cent RDN, respectively. Treatment ($T_5$) was control. Rice crop was used in this study, so the distance between tines was adjusted to 22.5 cm. Spacing between two hills was 10 cm. Data pertaining to the effect of different treatments on growth characters, yield attributes and yields were analysed. Details of treatment and other experimental details are presented in Table 2. The physicochemical properties of soil of experimental field are presented in Table 3.

**Table 2:** Details of treatments and other experimental details

| | Crop | Rice |
|---|---|---|
| | Variety | IR 36 |
| A. | Treatments | Symbol |
| | 1. 100 % RDN through FYM by manual broadcasting | $T_1$ |
| | 2. 100 % RDN through FYM by tractor drawn FYM applicator cum planter | $T_2$ |
| | 3. 75 % RDN through FYM by tractor drawn FYM applicator cum planter | $T_3$ |
| | 4. 50 % RDN through FYM by tractor drawn FYM applicator cum planter | $T_4$ |
| | 5. Control | $T_5$ |
| B. | Experimental details | |
| | 1. Experimental design | RBD |
| | 2. Field size | 130 × 58 $m^2$ |
| | 3. Plot size | 28 × 12 $m^2$ |
| | 4. Plant geometry | |
| | a) Row to row spacing (cm)<br>b) Plant to plant spacing (cm) | 22.5<br>10 |

**Table 3:** Physico-chemical properties of soil of the experimental site

| | Properties | Values |
|---|---|---|
| **A.** | **Physical properties** | |
| | **1. Mechanical composition** | |
| | Sand (%) | 22.10 |
| | Silt (%) | 30.36 |
| | Clay (%) | 47.54 |
| | Texture class | Vertisols |
| | 2. Bulk density (g/cc) | 1.42 |
| **B.** | **Chemical properties** | |
| | 5. Organic carbon (g/kg) | 0.62 |
| | 6. Available N (kg/ha) | 231 |
| | 7. Available P (kg/ha) | 21.60 |
| | 8. Available K (kg/ha) | 411 |
| | 9. pH (1:2.5) Soil: water suspension | 6.90 |
| | 10. E.C. (ds/m) | 0.14 |

**Water management**
In experiment field during *kharif* season, after FYM application cum planting operation the flood irrigation was given and after germination the plots were maintained at 5±2 cm during vegetative growth and development phases.

**Weeding**
To maintain the experimental area weed free, weeder was employed twice in entire experimental field at 30 and 60 DAS in rice.

**Harvesting, Threshing and Winnowing**
In Experiment plot during *kharif* season, in order to avoid border effect the lengthwise two rows from both sides and widthwise two hills of gross plot were removed. Remaining plant of net plot was harvested manually by using sickle and the crop was left in the field for sun drying for two days and then bundled. Stubbles of rice were incorporated in soil. After bundling, the produce was weighed plot-wise. Threshing was done by manually with the help of wooden sticks. The material threshed from each plot was kept separately and grain was separated from the chaff and straw by winnowing with the help of *supa* after this the cleaned grains were weighed treatment wise on an electronic balance.

**Pre-harvest observation**
**Plant population (No./m$^2$)**
The plant population in each plot was counted in five randomly selected of each plot and then plants were counted in 1 m$^2$ area after sowing and was worked out for average population.

**Plant height (cm)**
Height of five tagged plants in each plot was recorded in cm before harvesting and then average was worked out and used for statistical analysis. Plant height was measured in cm from ground surface to uppermost leaf top. Afterward the average height was worked out by dividing the summation by five.

**Number of the tillers/plant**
Tillers were counted from 5 tagged hills before harvesting from each plot to compute average number of tillers/plant.

**Leaf area index (LAI)**
Leaf area was recorded from three hills. Leaves were collected and grouped in 3-7 groups according to length and width of the leaves. The length and width of a representative leaf of each group was measured with the help of scale. The leaf area index was calculated at 30, 60 and 90 DAS. The leaf area was worked out by the formula Leaf area/hill was worked out as per the procedure given by IRRI (1972).
Leaf area/cm$^2$ of each leaf in middle tiller = K × L × W
K = leaf area coefficient (0.75 was used for all the growth stages.),
L = maximum length of the leaf, cm and
W = maximum width of the leaf, cm
Leaf area per hill = Leaf area of middle tiller × number of leaves/hill

Leaf area index (LAI) was described by Watson (1947) which expresses the total leaf area in relation with the total ground area in which the crop is grown. LAI was determined with the help of the following formula:

$$\text{Leaf area index} = \frac{\text{Total leaf area of plant}}{\text{Total ground area of plant}} \quad (1)$$

**Post- harvest observations**
**Filled, unfilled and total grains/panicle**
The filled, unfilled and total grains were counted from five panicles, which were already collected for the measurement of length and then average was calculated separately.

**Sterility percentage**
The number of filled and unfilled grains/panicle was counted separately from the five panicles in each plot and sterility percentage was computed with the following formula:

$$\text{Sterlity percentage} = \frac{\text{Number of unfilled spikelets/panicle}}{\text{Total number of spikelets/panicle}} \quad (2)$$

**Grain and straw yield (q/ha)**
The crop from each net plot was harvested separately. The grains were separated from straw by threshing. The weight of grains was recorded and expressed in q/ha and the straw weight was worked out by subtracting the weight of grains from the bundle weight of the produce and expressed in q/ha.

**Harvest index (%)**
The harvest index was calculated by dividing the grain yield with biological yield (grain + straw yield) in q/ha and multiplied by 100.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield (grain + straw)}} \times 100 \quad (3)$$

**Results and Discussion**
**Pre harvest observation**

## Plant population

Plant population (no./$m^2$) of rice at 30 DAS and at harvest are presented in Table 4. The results revealed that the different recommended dose of nitrogen by FYM did not influence plant population significantly either at 30 DAS or at harvest. Similar results were found by Kurchania and Panwar, 2011 [3] for liquid slurry and FYM application.

**Table 4:** Plant population at all treatments as influenced by different method and rate of application of FYM

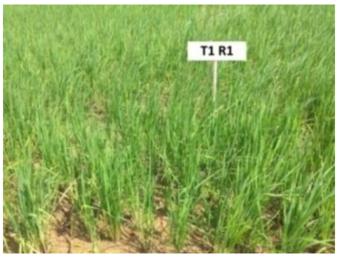
| Treatments | Plant population, no./$m^2$ | |
|---|---|---|
| | 30 DAS | At harvest |
| $T_1$ (100 per cent N through manual broadcasting) | 107.4 | 104.63 |
| $T_2$ (100 per cent N through FYM applicator cum planter) | 107.6 | 105.13 |
| $T_3$ (75 per cent N through FYM applicator cum planter) | 106.4 | 104.38 |
| $T_4$ (50 per cent N through FYM applicator cum planter) | 106.4 | 105.50 |
| $T_5$ (Control) | 107.0 | 104.25 |
| SEm± | 1.20 | 1.38 |
| CD (P=0.05) | NS | NS |

## Plant height (cm)

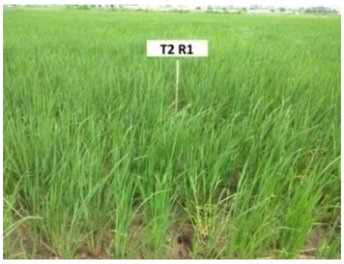
Plant height increased with the crop age which revealed by Table 5. At all the observational stages, tallest plants were recorded under 100 per cent N through tractor drawn FYM applicator cum planter ($T_2$), followed by 75 per cent N through FYM applicator cum planter ($T_3$) followed by 100 per cent N through manual broadcasting at basal ($T_4$) and at 50 per cent N through tractor drawn FYM applicator cum planter. On the other hand, control plot ($T_5$) produced the shortest plants.

**Table 5:** Different treatments are noted at the time of harvest as influenced by different method and rate of application of FYM

| Treatments | Plant height, cm | Number of tillers/plant (No.) |
|---|---|---|
| $T_1$ (100 per cent N through manual broadcasting) | 104.02 | 10.2 |
| $T_2$ (100 per cent N through FYM applicator cum planter) | 113.58 | 11.6 |
| $T_3$ (75 per cent N through FYM applicator cum planter) | 108.25 | 11.1 |
| $T_4$ (50 per cent N through FYM applicator cum planter) | 99.47 | 9.3 |
| $T_5$ (Control) | 87.14 | 6.1 |
| SEm± | 2.23 | 0.3 |
| CD (P=0.05) | 6.70 | 0.8 |




**(a):** 100per cent RDN through FYM by manual broadcasting




**(b):** 100per cent RDN through FYM applicator cum planter


**(c):** 75per cent RDN through FYM applicator cum planter


**(d):** 50per cent RDN through FYM applicator cum planter


**(e):** Control treatment

**Fig. 3:** View of experimental plot

The variation in plant height due to different method and rate of application of FYM was due to variation in availability of nutrients to the rice crop. The treatment 100 per cent N through tractor drawn FYM applicator cum planter ($T_2$), produced significantly highest plant height of rice as compared to other treatments at all growth stages. This might be due to highest percentage of nitrogen, more amounts of nutrients and facilitated more photosynthesis process and ultimately increased the growth parameter plant height rice.

## Number of tillers/plant (No.)

Obtained number of tillers/plant was significantly affected at different method and rate of application of FYM presented in Table 5. Out of four recommended dose of nitrogen treatment 100 per cent N through FYM applicator ($T_2$) produced significantly higher number of tillers/plant at 30, 60, 90 DAS and at harvest as compared to remaining treatments. However 75 per cent N through FYM applicator ($T_3$) was at par to the treatment 100 per cent N through FYM applicator ($T_2$). Further, control plot ($T_5$) produced the lowest tillers from the beginning till harvest.

**Table 6:** Leaf area index at various durations of rice as influenced by different method and rate of application of FYM

| Treatment | Leaf area index (LAI) | | |
|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS |
| $T_1$ (100 per cent N through manual broadcasting) | 1.34 | 3.19 | 3.89 |
| $T_2$ (100 per cent N through FYM applicator cum planter) | 1.56 | 4.19 | 4.99 |
| $T_3$ (75 per cent N through FYM applicator cum planter) | 1.48 | 3.88 | 4.73 |
| $T_4$ (50 per cent N through FYM applicator cum planter) | 1.28 | 3.57 | 4.35 |
| $T_5$ (Control) | 0.90 | 1.95 | 2.38 |
| SEm$\pm$ | 0.06 | 0.27 | 0.32 |
| CD (P=0.05) | 0.17 | 0.81 | 0.96 |

**Leaf area index**

The leaf area index (LAI) computed at 30, 60 and 90 DAS are presented in Table 6. In general, leaf area index increased from 30 DAS to 90 DAS, but the pace of increase was more from 30 DAS to 60 DAS and it decreased from 60 DAS to 90 DAS.

Significantly higher leaf area index at 30, 60 and 90 DAS was recorded under treatment 100 per cent FYM through FYM applicator cum planter ($T_2$) as compared to others. However, treatment 75 per cent N through FYM applicator cum planter ($T_3$) and 50 per cent N through FYM applicator cum planter ($T_4$) also recorded comparable values as well as treatment control ($T_5$) was recorded lowest leaf area index at 30, 60 and 90 DAS.

**Post-harvest observations**

**Total grains/panicle (No.)**

The data on total number of grains/panicle as influenced by different method and rate of FYM application are presented in Table 4.17. As regards to different dose of nitrogen, significantly highest number of total grains/panicle was noted under treatment 100per cent N through FYM applicator ($T_2$). However it was at par to treatment 75 per cent N through FYM applicator ($T_3$) gave second highest total grains/panicle.

**Table 7:** Grains per panicle and sterility (per cent) of rice as influenced by different method and rate of application of FYM

| Treatment | Total number of grains/panicle, (No.) | Filled grains/panicle, (No.) | Unfilled grains/panicle, (No.) | Sterility (per cent) |
|---|---|---|---|---|
| $T_1$ (100 per cent N through manual broadcasting) | 162 | 127 | 35 | 21.60 |
| $T_2$ (100 per cent N through FYM applicator cum planter) | 188 | 146 | 41 | 21.80 |
| $T_3$ (75 per cent N through FYM applicator cum planter) | 176 | 138 | 37 | 21.02 |
| $T_4$ (50 per cent N through FYM applicator cum planter) | 147 | 111 | 36 | 24.48 |
| $T_5$ (Control) | 122 | 97 | 25 | 20.49 |
| SEm$\pm$ | 4 | 4 | 6 | 3.29 |
| CD (P=0.05) | 13 | 12 | NS | NS |

**Filled grains per panicle (No.)**

The data on filled grains/panicle of rice as influenced by different treatments of different dose of nitrogen are presented in Table 7.

The number of filled grains/panicle of rice was significantly higher under 100 per cent N through FYM applicator ($T_2$). However, it was at par to treatment 75 per cent N through FYM applicator ($T_3$). Whereas significantly lowest number of filled grains/panicle was noted under control treatment ($N_5$).

**Unfilled grains/panicle (No.)**

The unfilled grains/panicle of rice remained unaffected due to different method and rate of FYM application as shown in Table 7.

**Sterility percentage**

The data on sterility percentage of rice remained unaffected due to different method and rate of FYM application as shown in Table 7.

The findings of different dose of nitrogen revealed that significantly highest growth parameters (plant height, number of tillers/plant, leaf area index) and yield attributes (total grains/panicle, filled grains/panicle, unfilled grains/panicle, sterility percentage) were registered at 100 per cent N through FYM applicator ($T_2$), but it was at par to 75 per cent N through FYM applicator ($T_3$).

The variation in plant growth due to different dose of nitrogen was due to variation in availability of nutrients (Rao *et al.*, 2013) [9]. The treatment 100 per cent N through FYM applicator ($T_2$) produced highest growth parameters like plant height and number of tillers/plant. This might be due to highest amount of FYM was available to the plant due to direct contact of FYM to the seed in band application through FYM applicator. Mhaske *et al.* (1997) [5] reported higher plant height and number of tillers/plant with the application of FYM @ 12 t/ha compared to no FYM application. The number of tillers/plant declined slightly from panicle initiation stage onwards and this might be due to self-thinning mechanism, resource constraint or intra plant competition. Mirza *et al.* (2005) [6] reported that the effective tillers were increased by the application of FYM.

**Grain yield (q/ha)**

The data on grain yield of rice as influenced by different dose of nitrogen after threshing are presented in Table 8. Among different dose of nitrogen, significantly highest grain yield 40.51 q/ha of rice was recorded under treatment 100 per cent N through FYM applicator ($T_2$) which was at par to treatment 75 per cent N through FYM applicator ($T_3$). Whereas lowest grain yield 18.41 q/ha was noted under control treatment ($T_5$)

**Table 8:** Grain and straw yield and harvest index of rice as influenced by different method and rate of application of FYM

| Treatment | Grain yield (q/ha) | Straw yield (q/ha) | Harvest index (per cent) |
|---|---|---|---|
| $T_1$ (100 per cent N through manual broadcasting) | 33.51 | 56.81 | 37.10 |
| $T_2$ (100 per cent N through FYM applicator cum planter) | 40.51 | 70.90 | 36.36 |
| $T_3$ (75 per cent N through FYM applicator cum planter) | 38.49 | 66.99 | 36.49 |
| $T_4$(50 per cent N through FYM applicator cum planter) | 28.55 | 47.52 | 37.53 |
| $T_5$ (Control) | 18.41 | 35.35 | 34.24 |
| SEm$\pm$ | 1.30 | 1.64 | 1.38 |
| CD (P=0.05) | 3.0 | 4.93 | NS |

**Straw yield (q/ha)**

The data on straw yield of rice as influenced by different dose of nitrogen after threshing are presented in Table 8. As regards to different dose of nitrogen, significantly highest straw yield 70.90 q/ha of rice was noted under treatment 100 per cent N through FYM applicator ($T_2$), which was comparable to treatment 75 per cent N through FYM applicator ($T_3$) was 66.99 q/ha. Further, control plot ($T_5$) recorded 35.35 q/ha which was the lowest straw yield.

**Harvest index (per cent)**

The data on harvest index of rice remained unaffected due to different treatments of different dose of nitrogen are presented in Table 8.

The growth parameters (plant height, number of tillers/plant and leaf area index) and yield attributes (effective tillers/plant, panicle length, panicle weight, test weight, total grains/panicle, filled grains/panicle) were also registered significantly higher under 75 per cent N through FYM applicator ($T_3$) which was at par to treatment 100 per cent N through FYM applicator ($T_2$). The yield increase in above treatments may be the cumulative effect of all these increases. Band application of FYM has advantage that the FYM was applicable only for those areas where seeds are applied. Hence, the band application should be done with in the row of seed sowing in the field. Therefore band application of FYM also reduces the excess amount of FYM applied in the field. Another study was also conducted that have any side effect to the crop when FYM is directly applied to the seed. Band application of different rates of FYM, the 15 t/ha of FYM produced the statistically similar cane yield as the recommended rate of 20 t/ha (Singh *et al*. 2013) [11]. Organic nutrient management has significant effect on grain yield of rice was also reported by Surekha (2007) [13]. Organic nutrition has increased the plant vigour with higher absorption of nutrients resulted in higher productive tiller production and ultimately higher grain yield (Nagarju and Krishnappa, 1995) [7].

**Conclusion**

FYM can be used as commercial fertilizer applied in band with sowing operation. Environment can be saved from harmful chemical by using farmyard manure. The findings of different dose of nitrogen revealed that significantly highest grain and straw yields were registered under 100 per cent N through FYM applicator ($T_2$). Further slow release of all organic nutrients at all successive growth stages of crop and highest availability of all organic nutrients up to longer period in $T_2$ (100 per cent N through FYM applicator) in band form led to greater availability of essential nutrients to plants and improving the soil environment which facilitate in better root proliferation leading to higher absorption of water and nutrients and ultimately resulting in higher yield. These might have helped to release greater amount of N and P from soil along with micronutrients mobilization and significantly influenced the plant growth characters (plant height and productive tillers).

**Reference**


1. Amon B, Amon T, Boxberger J, Alt C. Emissions of NH3, N2O and CH4 from dairy cows housed in a farmyard manure tying stall (housing, manure storage, manure spreading). Nutrient Cycling in Agro ecosystems. 2001; 60:103-113.
2. Hanway JJ, Heidel H. Soil analysis methods as used in lowa state college\soil testing laboratory. Iowa Agriculture. 1952; 57:1-31.
3. Kurchania AK, Panwar NL. Experimental investigation of an applicator of liquid slurry, from biogas production, for crop production. Environmental Technology. 2011; 32(8):873-878.
4. Memon M, Memon KS, Mirani S, Jamro GM. Comparative evaluation of organic wastes for improving maize growth and NPK content. African Journal of Biotechnology. 2012; 11(39):9343-9349.
5. Mhaske NS, Borkar SL, Rajgire HJ. Effects of nitrogen levels on growth, yield and grain quality of rice. Journal of Soils and Crops. 1997; 7(l):83-86.
6. Mirza BB, Zia MS, Szombathova N, Zaujec A. Rehabilitation of soils through environmental friendly techonologies: Role of *Sesbania* and farm yard manure. Agricultura Tropica Et Subtropica. 2005; 38(1):11-17.
7. Nagaraju SM, Krishnappa AM. Performance of Mussorie phos with adjutants in red soils. Indian J. Microbio. 1995; 10:16-17.
8. Olsen SR, Cole CV, Wantanable FS, Dean LA. Estimation of available phosphorus in soil by extraction with Sodium bicarbonate. United State Dept. of Agric. CIRC., Washinton, D.C., 1954, 939p.
9. Rao KT, Rao AU, Ramu PS, Shekher D, Rao NV. Effect of organic manures on performance of scented varieties of rice in high altitude areas of Andhra Pradesh. International Journal of Current Microbiology and Appiled Sciences. 2013; 2(11):339-346.
10. Risse LM, Cabrera ML, Franzluebbers AJ, Gaskin JW, Gilley JE, Killorn R *et al*. Land application of manure for beneficial reuse. Biological Systems Engineering: Papers and Publications. 2006; 65:283-316.
11. Singh K, Singh A, Singh D. Productivity, profitability and soil properties influenced by planting methods and band application of fym in autumn sugarcane. Sugar Tech. 2013; 15(2):145-151.
12. Subbaiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soil. Current Science. 1956; 25:259.
13. Surekha K. Nitrogen release pattern from organic sources of - different C: N ratios and lignin content and their contribution to irrigated rice (*Oryza sativa)*. Indian Journal of Agronomy. 2007; 52(3):220-224.
14. Vikrant M. Effect of farmyard manure and phosphorus levels on production potential of Moongbean (*Vigna Radiata* (L) Wilezek) And Cowpeas (*Vigna Unguiculata* (L) Walp). M. Tech., Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hisar, 2002, 36p.