JOURNAL OF AGRICULTURE AND BASIC SCIENCES
ISSN Online: 2518-4210
http://www.jabsjournal.com/

*Full Length Research Article*

# Exploiting green manuring as a tool for sustainable maize (*Zea mays* L.) production

**Haroon Zaman Khan, Muhammad Atif Shabir*, Hafiz Ausaf Ahmad Haqqani, Nadeem Akbar, Asif Iqbal**
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan
*Corresponding author: aatif.shabir@yahoo.com

## Abstract

High price, continuous degradation of soil fertility and low organic matter are considerable reasons of low soil fertility and less productivity of maize in Pakistan. Nitrogen use efficiency and nutrient availability can be enhanced by adding organic matter in soil through organic (green manuring) amendments. A field research experiment was conducted to evaluate the effect of green manuring on the yield of autumn maize (*Zea mays* L.) by reducing recommended doses (250, 125, 125 kg $ha^{-1}$) of NPK up to 50%. Experiment was conducted at Agronomic Research Area, Department of Agronomy, University of Agriculture, Faisalabad during the autumn season 2014. Triplicated randomized complete block design was followed to conduct experiment. Plot size was 6 m × 4.5 m with row to row distance of 75 cm. Comparative efficiency of seven different crops (Cowpea, Mungbean, Green gram, Mashbean, Clusterbean, Soyabean, Jantar) as a source of green manure was evaluated by reducing recommended dose of fertilizers (RDF) upto 50%. Standard procedures for recording parameters related to yield and quality of maize were followed. Incorporation of green manures with reduced quantity of inorganic fertilizers significantly increased the maize yield. Maximum plant height at maturity (227 cm), cob length (21.66 cm), number of grain rows per cob (16.26), number of grains per cob (438), 1000-grain weight (300.3 g), grain yield (7.56 t $ha^{-1}$), biological yield (19.63 t $ha^{-1}$) and grain protein contents (9.95 %) were recorded. It's concluded form study that (Jantar + 50% NPK of RDF) should be used for autumn maize in order to get maximum yield on sustainable basis.

**Key words:** Organic matter, nutrient availability, green manuring, maize, Pkaistan
**Received: 19-02-2016; Accepted: 25-04-2016**

## Introduction

Maize (*Zea mays* L.) is one of the important cereals grown in Pakistan. Maize has high genetic potential and being the highest yielding cereal crop in the world is of significant importance for Pakistan, where rapidly growing population has already facing shortage of food supplies. Maize and wheat are the major important cereals which are satisfying the need of grains in developed as well as developing countries (FAO, 2013). In Pakistan, it is being cultivated on 1117 thousand hectares with annual grain production is 4527 thousand tons (GOP, 2014). It can be grown successfully twice a year as spring and autumn and is capable to utilize limited available resources more efficiently than other long duration crops.

Before the introduction of inorganic (synthetic) fertilizers, farmers mostly depend on organic amendments as the sole source to enhance fertility and productivity of the soil. After that use of inorganic fertilizers started and farmers left the use of organic fertilizers because inorganic fertilizers were an efficient replacement as ready source of nutrients. However, chemical fertilizers enhance the crop productivity but on the other side their permanent use decrease soil fertility and cause contamination in ground water (Sagardoy, 1993). Higher yield of crops require a large amount of synthetic chemical fertilizers however it will be costly and dangerous for environment (Kozdro *et al*., 2004). Artificial fertilizer has also been used for crop production but it is often in short supply and costly (Okwu and Ukanwa, 2007). Pakistani soils have less than 1% organic matter (Azad and Yousaf, 1982). Continuous use of chemical fertilizers produces ecological problems by adding greenhouse gases (GHGs) to the environment and by disturbing the soil microorganisms (Oad *et al*., 2004). Losses of inorganic fertilizers can be compensated by the use of organic fertilizers such as green manure and their significance cannot be disregarded (Elfstrand *et al*., 2007). About 70% of the nutrients from chemical fertilizers are lost through leaching, immobilization and mineralization (Glass, 2003). Organic matter is considered as most important part effecting physical, chemical and microbiological properties of soil which positively affect crop growth by supplying nutrients (Maobe *et al*., 2011).

Organic matter through green manuring has better results for fertilizer use efficiency and nutrients availability (Abrol *et al*., 1988). Green manuring which has a great potential for enhancing the soil nitrogen availability to next crop plants and for conserving nitrogen and improving the long term soil fertility and soil health (Ashraf *et al*., 2004). With green manuring nutrients are released at a slower rate and also N from N-fixing bacteria becomes accessible for a long time span (Freyer, 2003).

Green manuring has an important role in farming because soil fertility, nutrient status and crop production depend largely on the use of organic fertilizers in both organic and conventional farming (Talgre *et al*., 2009). Green manures provide some or all the N required for non- leguminous crops (Guldan *et al*., 1997) and green manure increases availability of N, P, K and soil organic carbon (Yaduvanshi, 2001). The integration of inorganic and organic nutrient sources to plants not only supply essential nutrients but also improves nutrient use efficiency and subsequently reduce the environmental hazards (Ahmad *et al*., 1996). Both organic and inorganic sources of nutrients have been made significant improvements on the soil fertility status and combine use of both nutrient sources have the potential for greater economic efficiency (Jama *et al*., 2000).

Combined application of organic and chemical fertilizers is greatly essential for sustaining yield of crops and enhancing soil productivity (Pan *et al*., 2009). Integrated management of nutrients involving the balanced use of both inorganic and organic sources is most appropriate approach to overcome soil fertility constraints (Abedi *et al*., 2010) and also attain N stability through integration (Kaizzi *et al*., 2002). Therefore, the current research experiment was planned to evaluate the effect of different green manures for reducing the recommended dose of fertilizers to autumn maize under the agro-climatic conditions of Faisalabad-Pakistan.

## Material and methods

The experiment was carried out at Agronomic Research Area, University of Agriculture, Faisalabad (31.26°N, Longitude 73.06°E and Altitude 184 m), Pakistan during the autumn season, 2014. The experiment was laid out in randomized complete block design with three replications having plot size of 4.5 x 6 m. It comprised of 11 treatments viz $T_0$ (control), $T_1$ (100% NPK of RDF), $T_2$ (75% NPK of RDF), $T_3$ (50% NPK of RDF), and rest of treatments include different green manures with 50% NPK of RDF which are $T_4$ (Cowpea + 50% NPK of RDF), $T_5$ (Mungbean + 50% NPK of RDF), $T_6$ (Green gram + 50% NPK of RDF), $T_7$ (Mashbean+ 50% NPK of RDF), $T_8$ (Clusterbean + 50% NPK of RDF), $T_9$ (Soyabean + 50% NPK of RDF) and $T_{10}$ (Jantar + 50% NPK of RDF). NPK was applied at the rate of 250, 125, 125 kg $ha^{-1}$ respectively.

Green manure crops were sown for 45 days in respective treatment's plot and then incorporated for 2-3 weeks before sowing of maize. Maize single cross hybrid (DK-919) was sown on 27th of July, 2014, by manual dibbling (choppa method) with 15 cm plant to plant distance on 75cm apart ridges. Chemical analysis of soil was done before sowing of green manures (Table 1), before sowing of maize (Table 2) and after harvesting of maize (Table 3). Recommended dose of NPK (250, 125, 125 kg $ha^{-1}$ respectively) was applied through Urea, DAP and SSP according to the treatments, total amount of P & K were applied as basel dose while N was applied in 3 equal splits (at sowing, knee height, at flowering). Standard procedures were followed to collect the data for growth and yield parameters. Total 10 plants from each plot were selected at random and their height was measured with the help of measuring tape and average was calculated. From each plot, ten cobs were selected and cob length, number of rows per cob and number of grains per cob were counted and averaged. From each plot five samples of 1000-grains were randomly collected to record their weight and then average was recorded. At maturity, crop was harvested and sun dried; overall biomass of each plot was obtained and converted to tones per hectare. Harvest index (HI) of each plot was calculated by using the formula:

HI = (Economic yield/ Biological yield) x 100

The data collected were analyzed statistically by using Fisher's analysis of variance technique and LSD at 5% probability was used to compare the differences among treatments' means (Steel *et al*., 1997).

## Results

### Plant height (cm)

Data presented in (Table 4) showed significant effects of green manuring and NPK rates on plant height. The comparison of individual treatments' means exhibited that maximum maize plant height (227 cm) was recorded in $T_{10}$ (Jantar + 50% NPK of RDF) but was statistically similar to $T_1$ (100% NPK of RDF) with 226.4 cm plant height. Minimum plant height (157.2 cm) was measured from plot where no fertilizer was applied ($T_0$).

### Cob length (cm)

Results regarding the cob length (cm) of maize are given in table 4. It was clear from the table that cob length was significantly affected by different sources of green manuring and NPK rates. Comparison of individual treatment means showed that maximum cob length (21.66 cm) was observed in $T_{10}$ (Jantar + 50% NPK of RDF). However $T_1$ and $T_5$ were statistically at par with $T_{10}$ where 19.76 cm and 18.86 cm cob length were recorded respectively. Minimum cob length (13.89 cm) was observed in $T_0$ treatment.

### Number of grain rows per cob

The results (Table 4) showed that different green manures with inorganic NPK fertilizer significantly affected the number of grain rows per cob. Significantly maximum number of grain rows per cob (16.26) was recorded in $T_{10}$ where Jantar was used as a green manure crop with reduced NPK rates (50%). While minimum number of grain rows per cob (10.80) were in $T_0$ treatment (control).

**Number of grains per cob**

The results regarding the number of grains per cob of maize showed significant differences among treatments. The data (Table 4) showed that maximum number of grains per cob (438.0) were obtained with $T_{10}$ (Jantar + 50% NPK of RDF) although it was statistically at par with $T_1$ and $T_5$ treatments. The lowest number of grains per cob (307.67) were recorded in case of $T_0$ (control) treatment.

**1000-grain weight (g)**

Data given in Table 4 showed that 1000-grain weight was affected by green manuring and different NPK rates. Significantly more 1000-grain weight (300.3 g) was recorded with the treatment where plots with Jantar as a green manure and 50% NPK of RDF ($T_{10}$). While minimum 1000-grain weight (182.6 g) was observed where control ($T_0$) was applied.

**Grain yield (t ha$^{-1}$)**

Results presented in Table-4 declared that grain yield was significantly affected by the applied treatments. All data presented in table-2 clearly showed that significantly maximum grain yield (7.56 t ha$^{-1}$) was obtained from $T_{10}$ (Jantar + 50% NPK of RDF) followed by $T_1$ (100% NPK of RDF). While minimum grain yield (2.99 t ha$^{-1}$) was recorded from plot where there was no use of organic and inorganic fertilizers ($T_0$).

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

In the current experiment, biological yield was significantly affected by green manuring and different NPK rates. The results (Table 4) showed that maximum biological yield (19.63 t ha$^{-1}$) was recorded with $T_{10}$ (Jantar + 50% NPK of RDF) however it was statistically at par with treatments $T_1$, and $T_5$, where 18.85 t ha$^{-1}$ and 18.74 t ha$^{-1}$ biological yield was recorded respectively. While minimum biological yield (10.34 t ha$^{-1}$) was observed in control.

**Harvest index (%)**

Application of organic (green manuring) and inorganic fertilizers had significantly affected the harvest index of maize hybrids. The treatments means (Table 4) showed that maximum harvest index (39.04%) was observed for $T_{10}$ (Jantar + 50% NPK of RDF) however it was statistically at par with $T_1$, $T_4$ and $T_8$, (37.47%), (38.49%) and (38.90%) respectively. Minimum harvest index (28.97%) was observed in those plots where no inorganic fertilizer and green manure was applied.

## Discussion

In general, the low soil organic matter, N and K contents indicated poor soil fertility. The incorporation of green manure (GM) was therefore expected to be beneficial to the crop and soils. After decomposition of the incorporated manure, basic cat-ions are released in the soil which are responsible for raising the initial pH of the soil to a more favorable level for good crop production (Pucknee and Summer, 1997).

Results presented in Table 4 indicated that all of the parameters showed highest results under the application of $T_{10}$ (Jantar + 50% NPK of RDF). These results might be due to the reason that incorporation of green manures improves soil fertility and supply adequate amount of nutrients for enhancing crop growth specially nitrogen and organic matter. In addition, more availability of nutrients through green manuring and inorganic fertilizer that leads to enhanced translocation of assimilates from source to sink. Similar results have been obtained by (Jehan *et al*., 2006).

Organic manure supply N for improved vegetative and reproductive growth for maize. Because organic manures provide nutrient slowly, decrease leaching losses and increase the productivity of the soil (Corrcial *et al*., 2005). Organic sources have some positive relation with mineral fertilizers to supply essential nutrients and also increase their use efficiency to increase the productivity of soil (Elfstrand *et al*., 2007).

All the parameters were significantly and positively responsive to integrated use of both nutrient sources. Adequate amount of N on one hand and on the other hand incorporation of green manure crops minimize nitrogen leaching which plays its role to increase the availability of nutrients in early as well as on later stages of growth. Green manuring increases organic matter in soil and maintain the productivity of the soil for long period. Similar results were obtained by Mugwe *et al*. (2009) who reported that maize yield increased with synergistic use of organic matter and inorganic N. With organic manuring phosphorus, potassium, calcium, magnesium, copper, iron, zinc and manganese concentrations become higher in plants as well as in soil. Moreover, higher level of N significantly improved the plant height, 100-grain weight, grain yield, and uptake of N, P and K in maize plants (Siam *et al*., 2008).

**Conclusion**

It is concluded that under agro-climatic conditions of Faisalabad, application of jantar as a green manure + 50% NPK of RDF enhance yield of maize on sustainable basis.

## References


Abedi, T., Alemzadeh, T. and Kazemeini, S.A. (2010). Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat. *Aus. J. Crop Sci.,* 4, 384-389.

Abrol, I.P. and Palaniappan, S.P. (1988). Green manure crops in irrigated and rain fed lowland rice-based cropping systems in south Asia. p. 72-82. *In*: Proc. Symposium on Sustainable Agriculture, IRRI, Philippines. *Adv. Agron.,* 88: 97–185.

Ahmad, N., Rashid, M. and Vaes, A.G. (1996). Fertilizers and their uses in Pakistan. NFDC p. 142-149 and p. 172-175.

Ashraf, M., Mahmood, T., Azam, F., and Qureshi, R.M. (2004). Comparative effects of applying leguminous and non-leguminous green manures and inorganic N on biomass yield and nitrogen uptake in flooded rice (*Oryza sativa* L.). *Bio. Fert. Soils.,* 40: 147 152.

Azad, M.I. and Yousaf, (1982). Recycling of organic matter to improve the soil productivity. *Pak. J. Agri. Res.,* 22: 15-18.

Corrcial, C.M., Coutinho, J.F., Bjorn, L.O. and Torres Pereira, J.M.G. 2005. Ultraviolent radiation and nitrogen effects on the growth and yield of maize under Mediterranean field condition. *Euro. J. Agron.,* 12: 117- 125.

Elfstrand, S., Bath, B. and Martensson, A. (2007). Influence of various forms of green manure amendment on soil microbial community composition, enzyme activity and nutrient levels in leek. *App. Soil Eco.,* 36: 70–82.

FAO, (Food and Agriculture Organization) (2013). Maize, rice and wheat area harvested, production quantity, yield. Food and Agriculture Organization of the United Nations, Statistics Division.

Freyer, B. (2003). Crop Rotation. Eugen Ulmer GmbH & Co, Stuttgart. (In German).

Glass, A. (2003) Nitrogen Use Efficiency of crop plants: Physiological Constraints upon Nitrogen Absorption. *Crit. Rev. Plant Sci.,* 22: 453-470.

Government of Pakistan, (2014). Pakistan economic survey 2013-14. Ministry of finance, Islamabad, Pakistan.

Guldan S.J., Martin, C.A., Lindemann, W.C., Cueto-Wong, J. and R.L. Steiner, R.L. (1997). Yield and green manure benefits of interseeded legumes in a high desert environment. *Agron. J.,* 89: 757–762.

Jama, B., Palm, C.A., Buresh, R.J., Niang, A., Gachengo, C. and Nziguheba, A.B. (2000). *Tithonia diversifolia* as a green manure for soil fertility improvement in western Kenya. *Agrofor. Sys.,* 49: 201-221.

Jehan, B., Shakeel, A., Mohammad, T., Habib, A. and S. Mohammad, S. (2006). Response of maize to planting methods and fertilizer N. 3: 8-14.

Kaizzi, C.K., Ssali, H., Nansamba, A. and Vlek, L.G. (2002). The potential cost and benefit of velvet bean (*Mucuna pruriens*) an inorganic N fertilizers in improving maize production under soils of different fertility. IFPRI/ ZEF/ NARO working paper.

Kozdro, J., Trevors J.T. and Van Elas, J.D. (2004). Influence of introduced potential biocontrol agents on maize seedling growth and bacterial community structure in the rhizosphere. *Soil Bio. Biochem.,* 36 : 1775-1784.

Maobe, S.N., Mburu, M.W.K., Akundabweni, L.S., Ndufa, L.S., Mureithi, J.K., Gachene, J.G., Okello, C.G.K. and Makini, J.J. (2011). Economic analysis of Mucuna green manure nitrogen application in maize production with green manure incorporation cost. *J. Sust. Dev. Agric. Environ.,* 6(1): 21-29.

Mugwe, J., D. Mugendi, J. Kungu and M.M. Muna. 2009. Maize yields response to application of organic and inorganic input under on-station and on-farm experiments in central Kenya. *Exp. Agric.,* 45: 47-59.

Oad, F.C., Buriro, U.A. and Agha, S.K. (2004). Effect of organic and inorganic fertilizer application on maize fodder production. *Asian J. Plant Sci.,* 3: 375-377.

Okwu, D.E. and Ukanwa, N.S. (2007). Nutritive value and phytochemical contents of fluted pumpkin vegetable grown with different levels of turkey droppings. African Crop Science Conference Proceedings. 8: 1759-1964.

Pucknee, S. and Summer, E. (1997). Cation and nitrogen contents of organic matter determine its liming potential. *Soil Sci. Soc. Amer. J.,* 61: 86-96.

Pan, G., Zhou, P., Li, Z., Pete, S., Li, L., Qiu, D., Zhang X., Xu, X., Shen S. and Chen, X. (2009). Combined inorganic/organic fertilization enhances N efficiency and increases rice productivity through organic carbon accumulation in a rice paddy from the Tai Lake region, China. *Agric. Ecosys. Environ.,* 131: 274-280.

Sagardoy, J. A. (1993). An overview of pollution of water by agriculture. *In*: Prevention of Water Pollution by Agriculture and Related Activities, Proceedings of the FAO Expert Consultation, Santiago, Chile, 20-23 Oct. 1992. Water Report 1. FAO, Rome. pp. 19-26.

Siam, H.S., G. Abd El-Kader Mona and H.I. El-Alia. 2008. Yield and yield components of maize as affected by different sources and application rates of nitrogen fertilizer. *Res. Agric. Biol. Sci.,* 4: 399-412.

Steel, R.G.D, Torrie, J.H. and Dicke, D.A. (1997.) Principles and Procedures of Statistics. A Biometrical Approach. 3rd Ed. McGraw Hill Book Co. Inc., New York. pp: 172-177.

Talgre, L., Lauringson, E., Roostalu, H., Astover, A., Eremeev, V. and Selge, A. (2009). The effects of pure and under sowing green manures on yields of succeeding spring cereals. *Acta Agriculture Scandinavica,,* 59: 70–76.

Yaduvanshi, R.L. (2001). On-farm experiments on integrated nutrient management in rice-wheat cropping system. *Exp. Agric.,* 37: 99-113.

JOURNAL OF AGRICULTURE AND BASIC SCIENCES
ISSN Print: ISSN Online:
http://

*Full Length Research Article*

**Table 1.** Soil analysis before sowing of green manure crops

**Chemical Analysis**

| | |
|---|---|
| pH | 8 |
| EC ( $dSm^{-1}$) | 1.3 |
| Total N (%) | 0.037 |
| Available Phosphorus (ppm) | 5.1 |
| Potassium (ppm) | 106 |
| Organic Matter (%) | 0.49 |
| Textural Class | Loam |

**Table 2.** Soil analysis after 45 days incorporation of green manure crops.

**Chemical Analysis**

| Treatments | pH | EC ( $dSm^{-1}$) | Available Phosphorus (ppm) | Available N (%) | Potassium (ppm) | Organic Matter (%) | Textural Class |
|---|---|---|---|---|---|---|---|
| Area where cowpea was used as a green manure crop | 8 | 1.86 | 11.7 | 0.28 | 140 | 1.12 | Loam |
| Area where mungbean was used as a green manure crop | 8 | 1.28 | 11.5 | 0.30 | 160 | 1.19 | Loam |
| Area where green gram was used as a green manure crop | 8.1 | 1.4 | 11.1 | 0.21 | 160 | 0.84 | Loam |
| Area where mashbean was used as a green manure crop | 8.1 | 1.18 | 2.2 | 0.13 | 160 | 0.84 | Loam |
| Area where clusterbean was used as a green manure crop | 8.4 | 1.49 | 4.5 | 0.13 | 140 | 0.28 | Loam |
| Area where soyabean was used as a green manure crop | 8.3 | 1.19 | 11.2 | 0.27 | 160 | 0.49 | Loam |
| Area where jantar was used as a green manure crop | 8.3 | 1.71 | 16.7 | 0.35 | 140 | 0.35 | Loam |

**Table 3.** Soil analysis after harvesting of maize

| Treatments | Chemical Analysis | | | | | | |
|---|---|---|---|---|---|---|---|
| | pH | EC ($dSm^{-1}$) | Available Phosphorus (ppm) | Available N (%) | Potassium (ppm) | Organic Matter (%) | Textural Class |
| Area where cowpea was used as a green manure crop | 8.1 | 1.61 | 9.3 | 0.047 | 280 | 1.40 | Loam |
| Area where mungbean was used as a green manure crop | 8.1 | 1.68 | 8 | 0.072 | 220 | 1.40 | Loam |
| Area where green gram was used as a green manure crop | 8.1 | 1.35 | 8.4 | 0.029 | 240 | 1.75 | Loam |
| Area where mashbean was used as a green manure crop | 8.1 | 1.90 | 11.7 | 0.0176 | 220 | 1.61 | Loam |
| Area where clusterbean was used as a green manure crop | 8.1 | 1.44 | 11 | 0.012 | 220 | 1.40 | Loam |
| Area where soyabean was used as a green manure crop | 8.1 | 1.80 | 13.1 | 0.039 | 240 | 1.61 | Loam |
| Area where jantar was used as a green manure crop | 8.1 | 1.99 | 10.3 | 0.081 | 200 | 1.61 | Loam |

**Table.4. Effect of green manuring and different NPK rates on growth, yield and yield components of maize**

| Treatments | Plant Height (cm) | Cob Length (cm) | No. of rows per cob | No. of grains per cob | 1000-grain weight (g) | Grain yield (t $ha^{-1}$) | Biological yield (t $ha^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 157.27 h | 13.89 g | 10.80 g | 307.67 g | 182.67 g | 2.99 h | 10.34 g | 28.97 e |
| $T_1$ | 226.40 ab | 19.76 b | 16.13 a | 419.07 ab | 294.00 a | 7.06 ab | 18.85 ab | 37.47 abc |
| $T_2$ | 197.87 f | 16.50 def | 13.73 e | 344.13 ef | 233.33 e | 5.23 f | 15.59 de | 33.54 cd |
| $T_3$ | 166.67 g | 15.13 fg | 12.53 f | 314.40 g | 204.00 f | 3.66 g | 12.52 f | 29.22 de |
| $T_4$ | 215.20 cd | 17.63 cd | 14.90 c | 384.67 c | 268.00 bc | 6.16 cd | 16.02 de | 38.49 a |
| $T_5$ | 223.07 b | 18.86 bc | 15.73 ab | 406.27 b | 284.67 ab | 7.03 b | 18.74 abc | 37.77 abc |
| $T_6$ | 217.60 c | 16.16 ef | 14.93 bc | 345.40 def | 263.67 c | 6.40 c | 17.12 cd | 37.96 abc |
| $T_7$ | 206.73 e | 16.66 de | 14.66 cd | 354.87 de | 261.00 cd | 5.60 ef | 14.66 e | 38.23 ab |
| $T_8$ | 200.07 f | 16.90 de | 14.0 de | 364.07 d | 246.00 de | 6.60 bc | 16.97 d | 38.90 a |
| $T_9$ | 211.93 d | 16.93 de | 14.53 cde | 335.27 f | 233.33 e | 5.80 de | 17.17 bcd | 33.89 bc |
| $T_{10}$ | 227.00 a | 21.66 a | 16.26 a | 438.00 a | 300.33 a | 7.56 a | 19.39 a | 39.04 a |
| LSD Value | 3.68 | 1.45 | 0.80 | 19.22 | 16.82 | 0.50 | 1.71 | 4.47 |

$T_0$ = Control (No fertilizer), $T_1$ = 100% NPK of RDF, $T_2$ = 75% NPK of RDF, $T_3$ = 50% NPK of RDF, $T_4$ = Cowpea + 50% NPK of RDF, $T_5$ = Mungbean+ 50% NPK of RDF, $T_6$ = Green gram + 50% NPK of RDF, $T_7$ = Mashbean+ 50% NPK of RDF, $T_8$ = Clusterbean+ 50% NPK of RDF, $T_9$ = Soyabean + 50% NPK of RDF, $T_{10}$ = Jantar+ 50% NPK of RDF