Bangladesh J. Bot. **46**(1): 365-371, 2017 (March) Supplementary

# INTEGRATED USE OF POULTRY MANURE AND BIOGAS SLURRY WITH CHEMICAL FERTILIZER IN RICE-OKRA CROPPING SEQUENCE

**MASUDA BEGUM[1], ARM SOLAIMAN, GKM MUSTAFIZUR RAHMAN, SM SHAMSUZZAMAN[1]* AND MM HANAFI[2]**

*Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh*

*Keywords:* Residual effect, Poultry manure, Biogas slurry, Rice, Okra, Cropping sequence

## Abstract

Residual effects of urea with poultry manure (PM) and biogas slurry (BS) on okra after Boro rice have been studied. Yield attributes and yield of rice and okra were the best in the treatment receiving 50% of recommended dose equivalent to 94 kg/ha N from urea and 50% N from PM equivalent to 4.5 t/ha. Application of 50% urea N and 50% PM N in preceding rice crop highest grain yield of rice (6.83 mt/ha) and fruit yield of okra (8.10 mt/ha) was obtained. The contents of organic matter, total N, available P, exchangeable K, available S, exchangeable Ca, exchangeable Mg and available Zn and pH in post-harvest soils increased compared to initial soil indicating the improved soil fertility. Results indicated that N at the rate of 94 kg/ha along with 4.50 mt/ha PM was the best combination for producing rice and okra in rice-okra cropping sequence.

## Introduction

Rice-vegetables cropping sequence is now being practiced in many places of Bangladesh. Generally, farmers use only chemical fertilizers with little or no organic manure for individual crop without considering cropping sequence for the whole year. As a result, large amount of fertilizers are being misused every year.

Nitrogen rate, type of nitrogen, and timing of its application are important factors to increase yield (Garrido-Lestanche *et al.* 2005). Pilled urea, the most widely used chemical N fertilizer in Bangladesh. The nitrogen efficiency especially of urea fertilizer is very low (30 - 35%) in rice cultivation (IFDC 2007). The loss of N from urea is accelerated by the quick release of available N from urea. Integration of organic with inorganic fertilizers improves the physiological system of the crop, provides adequate growth regulating substances and modifies soil physico-chemical behavior and results in augmented crop yield (Hukkeri *et al.* 1977). Nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Makinde and Ayoola 2008), supporting better root development, leading to higher crop yields (Abou El-Magd *et al.* 2006).

Okra (*Abelmoschus esculentus* (L.) Moench) is one of the most important vegetable crops grown extensively throughout Bangladesh during the whole year due to its high adaptability over a wide range of environmental conditions. The fresh fruit is a good source of vitamins, minerals and plant protein (Eke *et al.* 2008). Although the nutritional value of okra, did not achieve better returns with (2 - 3 mt/ha) and quality in tropical countries, due in part to a continuing decline in soil fertility. Karim *et al.* (2011) studied that integrated nutrient management (INM) through poultry manure along with reduced rate of recommended dose of fertilizer (RDF) performed the best in recording yields of okra and improved bulk density and organic-C in tomato-okra-stem

*Author for correspondence: <shamsuzzamansm@gmail.com>. [1]Soil Resource Development Institute, Krishi Khamar Sarak, Dhaka-1215, Bangladesh. [2]Department of Land Management, University Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia.

amaranth cropping pattern. Application of bioslurry in combination of inorganic N fertilizer increased fruit yield of tomato including increased in organic matter, available N, P, and K, total N and P in soil Yu *et al.* (2010). Srivastava *et al.* (2009) observed that the impact of integrated nutrient management on the performance of brinjal and its residual effect on rotational crops of pea and okra fruit size was positive. Hence, the present study was undertaken for the rice-okra cropping sequence to assess the residual effect of PM and BS on the yield attributes and yield okra fruit as succeeding crop of Boro rice with the changes of soil properties.

**Materials and Methods**

The study was conducted at the research farm of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh ($24.09^0$ N latitude and $90.26^0$ E longitude). The soils of the experimental field belong to the Shallow Red- Brown Terrace and classified as Inceptisols.

The experiment consisted of six treatment combinations i.e. no nitrogen ($T_1$ = Control), recommended dose of N ($T_2$ = Urea-$N_{188kg/ha}$), 75% N through urea and 25% N through PM ($T_3$ = Urea-$N_{141kg/ha}$ + $PM_{2.25t/ha}$), 50% N through urea and 50% N through PM ($T_4$ = Urea-$N_{94kg/ha}$ + $PM_{4.50t/ha}$), 75% N through urea and 25% N through BS ($T_5$ = Urea-$N_{141kg/ha}$ + $BS_{4.75t/ha}$), and 50% N through urea and 50% N through BS ($T_6$ = Urea-$N_{94kg/ha}$ + $BS_{9.50t/ha}$). Boro rice (cv. BRRI dhan 29) was used as the test crop in the first experiment. Fertilizer Recommendation Guide-2005 (BARC 2005) was followed for calculating the fertilizer dose on the basis of initial soil test value according to treatment combinations. Well decomposed PM and BS were applied as per treatments one week before final land preparation. All the treatments received recommended dose of P, K and S (16, 27 and 20 kg/ha, respectively) and were applied during final land preparation. Nitrogen from urea was top dressed in three equal splits at the time of final land preparation, maximum tillering stage and at booting i.e. panicle initiation stage of crop growth. Forty five days old seedlings were transplanted keeping distances of 25 cm from row to row and 15 cm from plant to plant. After transplanting, standing of water approximately 5 - 6 cm was maintained in each plot throughout the growing period. Precautionary measures were taken against different pest and diseases time to time. The crop was harvested plot wise at maturity and ten hills from each plot were randomly selected to keep records on yield (grain and straw yields in mt/ha) and yield contributing characters (number of tillers/hill, number of panicles/hill, panicle length, number of grains/panicle, thousand grain weight in g). The selected hills were collected before the crop was harvested and necessary information was recorded accordingly.

Okra variety BARI Dherosh-1 was used as test crop in second experiment. No manure and fertilizer were applied after Boro rice harvest. Preparing the experimental plot of first experiment 15 days old seedlings were planted in the field maintaining row to row and plant to plant spacing of 60 cm and 50 cm, respectively. Intercultural operations were done throughout the cropping period for proper growth and development of the seedlings. For controlling Jassid, Nogos @ 0.02% was sprayed four times in an interval of seven days after fruit setting. The okra field was properly irrigated an interval of 10-15 days as required. Stagnant water was drained out after heavy rain. Fruits were harvested at every alternate day at edible stage. The harvested fruits of each plot were weighed. Ten plants from each plot were selected randomly and tagged and then the following yield (mt/ha) and yield contributing characters (fruit length, fruit breadth, individual fruit weight, number of fruits per plant) were recorded. The analysis of variance for the crop characters was done following the ANOVA and the mean values were adjusted by DMRT.

## Results and Discussion

Combined use of PM or BS with urea demonstrated significant effects on the number of effective tillers/hill, panicle length, filled grains/panicle and 1000 grain weight of BRRI dhan 29 (Table 1). All the treatments gave significantly higher plant height over control ($T_1$). Except highest number of effective tillers/hill (14.42), panicle length (24.17), filled grains/panicle (131.37), and 1000 grain weight (19.22) was found in $T_4$ (50% N through urea + 50% N through PM) which was statistically similar with the treatment $T_6$ (50% N through urea + 50% N through BS). The effects of treatments $T_3$ and $T_5$ were, however, statistically similar to the treatment $T_2$ ranked second. The lowest value (10.17, 20.37, 107.00 and 17.78, respectively) was observed in $T_1$ (control). These results are well corroborated with the findings of Parvez *et al.* (2008) who found that number of effective increased with the combined use of manures and fertilizers. Verma *et al.* (2001) reported that application of FYM @ 10 mt/ha coupled with 50% recommended N recorded higher number of tillers/hill with higher panicle length and seed/panicle compared to control. Similar results were reported by Rahman *et al.* (2007) who found that panicle length and filled grains/panicle increased with the application of manures and fertilizers.

**Table 1. Effect of organic manure with urea on yield components of BRRI dhan29.**

| Treatment | Effective tiller/hill | Panicle length (cm) | Filled grains /panicle | 1000 grain weight (g) |
|---|---|---|---|---|
| $T_1$ | 10.17c | 20.37c | 107.00c | 17.78c |
| $T_2$ | 13.40b | 23.12b | 125.20b | 18.18b |
| $T_3$ | 13.49b | 23.25b | 125.43b | 18.28ab |
| $T_4$ | 13.95a | 24.17a | 131.37a | 19.22a |
| $T_5$ | 13.43b | 23.22b | 125.42b | 18.23b |
| $T_6$ | 14.11a | 24.03a | 126.90ab | 19.17a |
| CV (%) | 3.36 | 2.85 | 2.46 | 2.95 |

Means in a column followed by the same letter(s) are not significantly different at $p < 0.05$ by Fisher's protected least significant difference test.

Application of urea alone or in combination with organic manure showed a positive effect on grain, straw and biological yield of BRRI dhan29 (Table 2). The grain and straw yield ranged from 4.40 to 6.90 6.03 to 8.55 t/ha, respectively. The highest grain (6.83 mt/ha), straw (8.55 mt/ha) and biological (15.38 mt/ha) yield was recorded in $T_4$ receiving 50% N from urea and 50% N from PM which was at par with and $T_6$ (50% N through urea + 50% N from BS). Treatments $T_2$ (100% N through urea), $T_3$ (75% N through urea + 25% N through PM) and $T_5$ (75% N through urea + 25% N through BS) recorded statistically similar grain, straw and biological yield. The lowest grain (4.40 mt/ha), straw (6.09 mt/ha) and biological (10.59 mt/ha) yield were noted in $T_1$ (control).These results are in agreement with the findings of Rahman *et al.* (2007), Parvez *et al.* (2008) and Khan *et al.* (2007), who reported that grain yield was significantly increased due to application of organic manure and chemical fertilizers. Selvi *et al.* (2003) also observed that 50 per cent of N as inorganic with 50 per cent through organics (green manure) registered maximum seed yield. As per our results the highest harvest index was obtained with treatment receiving 50 per cent N through chemical fertilizer and 50 per cent N through FYM Mandal and Adhikary (2005).

Data presented in Table 3 clearly indicated that the fruits per plant, fruit length, fruit diameter and single fruit weight (g) significantly influenced by the residual effect of organic manure with inorganic fertilizers. The highest number of fruits per plant (18.00), length of fruits (12.51 cm) and diameter of fruit (1.42 cm) were noted in the treatment $T_4$ ($N_{94}P_{16}K_{27}S_{20kg/ha}$ + $PM_{4.5t/ha}$) which was statistically similar to treatments $T_6$ ($N_{94}P_{16}K_{27}S_{20kg/ha}$ + $BS_{9.5t/ha}$), but the highest single fruit weight (14.07 g) was recorded in $T_6$. The effects of treatments $T_5$ ($N_{141}P_{16}K_{27}$ $S_{20kg/ha}$ + $BS_{4.75t/ha}$) were, however, statistically similar to treatments $T_3$ ($N_{141}P_{16}$ $K_{27}S_{20kg/ha}$ + $PM_{2.25t/ha}$). The minimum number of fruit per plant (12.30), lowest length of fruits (9.46 cm), diameter of fruit (1.18cm) and single fruit weight (11.10 g) was noted in $T_1$ (control). This was might be due to the residual effect of organic manure that supplied balanced nutrient elements which was favorable for increasing the yield contributing characters. The lowest quality of fruit was in control might be due to inadequate supply of nutrients from untreated plots that has led to less growth of plant which eventually caused reduction in diameter of fruit. These results are in good agreement with that of Chattoo *et al.* (2010) who reported that the residual effect of organic manures and inorganic fertilizers increased pod number/plant of okra. Tiamiyu *et al.* (2012) investigated that poultry manure positively increased fresh pod weight of okra by 34.6% compared to control treatments.

**Table 2. Effect of organic manure with urea on the yield and harvest index of BRRI dhan29.**

| Treatment | Grain yield (mt/ha) | Straw yield (mt/ha) | Biological yield (mt/ha) | Harvest index (%) |
|---|---|---|---|---|
| $T_1$ | 4.40c | 6.093c | 10.49c | 41.92b |
| $T_2$ | 6.55b | 8.33ab | 14.88ab | 43.98ab |
| $T_3$ | 6.50b | 8.22b | 14.72b | 43.83ab |
| $T_4$ | 6.83a | 8.55a | 15.38a | 44.38a |
| $T_5$ | 6.36b | 8.21b | 14.57b | 43.62ab |
| $T_6$ | 6.75a | 8.48ab | 15.23ab | 44.23a |
| CV (%) | 2.83 | 2.41 | 2.45 | 2.71 |

Means in a column followed by the same letter(s) are not significantly different at $p < 0.05$ by Fisher's protected least significant difference test.

**Table 3. Residual effect of organic and inorganic fertilizer on yield and yield components of okra in rice-okra cropping sequence.**

| Treatment | Fruits/plant (no.) | Fruit length (cm) | Fruit diameter (cm) | Single fruit weight (g) | Fruit yield (mt/ha) |
|---|---|---|---|---|---|
| $T_1$ | 12.30d | 9.46d | 1.18c | 11.10c | 4.55c |
| $T_2$ | 15.05c | 10.60c | 1.26bc | 13.06bc | 6.55bc |
| $T_3$ | 15.20c | 11.64b | 1.34b | 13.29b | 6.70bc |
| $T_4$ | 17.50ab | 12.51a | 1.42a | 13.90ab | 8.10ab |
| $T_5$ | 16.80b | 12.07b | 1.27b | 13.14bc | 7.30b |
| $T_6$ | 18.00a | 12.28a | 1.39a | 14.07ab | 8.45a |
| CV (%) | 4.36 | 4.67 | 3.46 | 4.41 | 6.70 |

Means in a column followed by the same letter(s) are not significantly different at $p < 0.05$ by Fisher's protected least significant difference test.

Residual effect of organic manure with inorganic fertilizers significantly affected the fruit yield (Table 3). The maximum fruit yield (8.45 mt/ha) was obtained from the residual effect of $T_6$

($N_{94}P_{16}K_{27}S_{20kg/ha}$ + $BS_{9.5t/ha}$) treatment. The effect of this treatment was statistically similar to treatments $T_4$ ($N_{94}P_{16}K_{27}S_{20kg/ha}$ + $PM_{4.5t/ha}$). The minimum fruit yield (4.55 mt/ha) was observed in control ($T_1$). That's why residual effect of organic manures showed better results than control in fruit yield. Similar results were reported by Chattoo *et al.* (2010) who assessed the residual effect of organic manures and inorganic fertilizers on succeeding crop pea in okra-pea rotation and revealed that integration among organic with inorganic sources in equal proportion (50:50) registered higher values of 118.84 q pod yield per ha of okra. Uwah *et al.* (2012) reported that growth and fresh pod yield of okra peaked at 10 mt/ha PM and 4 mt/ha mulch rates.

**Table 4. Changes of chemical properties of soil due to residual effect of organic manures in rice-okra cropping sequence.**

| Treatment | pH | OM (%) | TN (%) | P (ppm) | K (meq/100 g soil) | S (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 5.65b | 1.90b | 0.073d | 6.28d | 0.163c | 5.32d | 1.99d |
| $T_2$ | 5.63b | 1.84c | 0.090c | 6.51c | 0.183bc | 5.74c | 2.28c |
| $T_3$ | 5.93a | 2.15ab | 0.114b | 6.68b | 0.189bc | 6.23b | 2.49bc |
| $T_4$ | 5.99a | 2.20a | 0.123ab | 7.05a | 0.206a | 6.53a | 2.72a |
| $T_5$ | 5.77ab | 2.16ab | 0.116b | 6.72b | 0.193b | 6.18bc | 2.61b |
| $T_6$ | 5.87ab | 2.21a | 0.128a | 7.02ab | 0.203ab | 6.44ab | 2.80a |
| CV (%) | 2.27 | 1.89 | 5.34 | 2.01 | 3.40 | 1.93 | 4.57 |

Means in a column followed by the same letter(s) are not significantly different at $p < 0.05$ by Fisher's protected least significant difference test.

The pH value, organic matter, total N, available P, exchangeable K, available S and Zn content of the post-harvest soil differed significantly with the application of PM and biogas slurry in previous crop (Table 4). All the treatments receiving organic manures slightly increased the pH value and N, P, K, S and Zn compared to initial soil. The value of pH and N, P, K, S and Zn were higher and statistically similar in $T_4$ ($N_{94}P_{16}K_{27}S_{20kg/ha}$ + $PM_{4.5t/ha}$) and $T_6$ ($N_{94}P_{16}K_{27}S_{20kg/ha}$ + $BS_{9.5t/ha}$). The lowest value of pH and P, K, S and Zn were recorded for the application of only chemical fertilizers ($T_2$), but N was lowest in control ($T_1$). Total soil N decreased in $T_1$ (control) treatment and slightly increased in $T_2$ treatments and all the organic manures sources increased the total N of post-harvest soil. This might be attributed to the enhanced multiplication of microbes by addition of different sources of organic manures for the conservation of organically bound N to inorganic form. The pH value of the post-harvest soil increased, because decomposition of organic matter produced ammonium ions and humic acids (Komilis and Ham 2006) and their combined effect of these two oppositely charged ions regulates the pH towards neutrality (Pramanik *et al.* 2007). The pH was lowest mainly due to the fact that most fertilizers supply N as $NH_4^+$ first, which oxidized to $NO_3^-$ generating a proton (Enwall *et al.* 2007). The available P increased might be due to release of $CO_2$ and organic acids during decomposition which helps in solubilizing the native soil P. The organic matter may also reduce the fixation of phosphate by providing protective cover on sesquioxides and chelating cation like $Ca^{2+}$ and $Mg^{2+}$ (when applied organic manures along with inorganic fertilizer) which in enhanced the availability of P. Treatments that received organic manure showed significantly higher exchangeable K status in soil. This may be due to application of organic manure can attributed to the direct addition of potassium to the available pool of the soil. These results are well corroborated with Pathak *et al.* (2005) observed that addition of organic matter was helpful in improving organic carbon status of post-harvest soil.

Yogananda *et al.* (2004) reported that application of urban compost with inorganic NPK fertilizers increased soil available N, P, K and Zn.

Application of 50% N of recommended dose from urea and 50% N from PM resulted higher grain yield of rice and fruit yield of okra compared to other management practices. Different organic manures with urea in rice had a significant positive residual effect on succeeding crop okra. Organic manure applied along with urea slightly increased pH, organic carbon, total N, available P, exchangeable K, S and Zn in post-harvest soils compared to initial soil. For sustainable productivity of rice-okra cropping sequence and soil fertility, N at the rate of 94 kg/ha (50% N from urea) with PM at the rate of 4.50 mt/ha (50% N from PM) may be recommended.

**Acknowledgement**

Authors are grateful for funding of this research by Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka, Bangladesh.

**References**

Abou El- Magd MM, Bassiony El and Fawzy ZF 2006. Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of Broccoli plants. J. Appl. Sci. Res. **2**: 791-798.

BARC (Bangladesh Agricultural Research Council) 2005. Fertilizer Recommendation Guide. BARC, Soil pub, No. 41, Bangladesh Agril. Res. Council, Farmgate, Dhaka.

Chattoo MA, Ahmad N, Khan SH, Sidique SH and Hussain K. 2010. Residual effect of organic manures and inorganic fertilizers on succeeding crop pea (*Pisum sativum* L.) cv. Bonnevilla. The Asian J. Hort. **4**: 299-304.

Eke KA, Essiens BA and Ogbu JU 2008. Determination of optimum planting time of okra in the derived savannah. Proc. of the 42nd Conf. of ASN at Abakaliki 17th - 23rd Oct. 2008. pp. 242-245.

Enwall K, Nyberg K, Bertilsson S, Cederlund H, Stenstrom J and Hallin S 2007. Long-term impact of fertilization on activity and composition of bacterial communities and metabolic guilds in agricultural soil. Soil Biol. Biochem. **39**:106-15.

Garrido-Lestache EL and Opez-Bellido RJ 2005. Durum wheat quality under Mediterranean conditions as affected by N rate, timing and splitting, N form and S fertilization. Europ J. Agron. **23**: 265-278.

Hukkeri SB, NP Shukla and RK Rajput 1977. Effect of levels of soil moisture and nitrogen on the fodder yield of oat on two types of soils. Indian J. Agron. **47**: 204-209.

IFDC (International Fertilizer Development Centre) 2007. Mitigating poverty and environmental degradation through nutrient management in South Asia IFDC Report, March 2007.

Karim AJMS, Jahiruddin M and Islam MS 2011. Integrated nutrient management for tomato-okra-stem amaranth cropping pattern in homestead area. Journal of Food, Agriculture & Environment **9:** 438-445.

Khan MU, Qasim M and Khan IU 2007. Effect of integrated nutrient management on crop yields in rice-wheat cropping system. Sarhad J. Agril. **23**: 1019-1025.

Komilis DP and Ham RK 2006. Carbon dioxide and ammonia emissions during composting of mixed paper yard waste and food waste. Waste Management **26**: 62-70.

Makinde EA and Ayoola OT 2008. Residual influence of early season crop fertilization and cropping system on growth and yield of cassava. American J. Agril. Biol. Sci. **3**: 712-715.

Mandal S and Adhikary J 2005. Effect of integrated nitrogen management on growth and yield of rice (*Oryza sativa* L.). Agric. Sci. Digest. **25**: 136-138.

Parvez MS, Islam MR, Begum MS, Rahamanb MS and Mian MJA 2.008. Integrated use of manures and fertilizers for maximizing the yield of BRRI dhan30. J. Bangladesh Soc. Agric. Sci. Technol. **5**: 22.-31.

Pathak SK, Singh SB, Jha RN, Sharma RP 2005. Effect of nutrient management on nutrient uptake and changes in soil fertility in maze (*Zea mays*) - wheat (*Triticum aestivum)* cropping system. Ind. J. Agron. **50**: 269-273.

Pramanik P, Ghosh GK, Ghosal PK and Banik P 2007. Changes in organic - C, N, P and K and enzyme activities in vermicompost of biodegradable organic wastes under liming and microbial inoculants. Bioresource Tech. **98**: 2485-94.

Rahman MS, Islam MR, Naser HM, Hoque MM and Hossain A. 2007. Effects of combined use of manures and fertilizers on the yield and nutrient uptake by BRRI Dhan 30. J. Bangladesh Soc. Agric. Sci. Technol. **4**: 37-40.

Selvi DS, Mahimai Raja, Santhy P and Rajkannam B. 2003. Influence of integrated nutrient management on crop yield, P uptake, and available P status of soil in a rice based cropping system. Oryza **40**: 68-69.

Srivastava P, Srivastava PC, Singh U and Shrivastava M 2009. Effect of integrated and balanced nutrient application on soil fertility, yield and quality of Basmati rice. Archives of Agronomy and Soil Science. **55**: 265-284.

Tiamiya RA, Ahmed HG and Muhammad AS 2012. Effect of sources of organic manure on growth and yields of okra (*Abelmoschus esculentus* L.) in Sokoto, Nigeria. Nigerian Journal of Basic and Applied Science. **20**: 213-216.

Uwah DF, Ukoha GO and Iyango J 2012. Okra performance and soil and water conservation as influenced by poultry manure and organic mulch amendments. J. Food, Agric & Environ. **10**: 748-754.

Verma CP and Tripathi and Kedar Prasad 2001. Effect of FYM and zinc sulphate on yield and yield attributes of rice grown after paddy nursery. Crop Res. **21**: 382-383.

Yogananda SB, Reddy VC and Sudhir K 2004. Effect of Urban Compost and inorganic fertilizers on soil nutrient status and grain yield of hybrid rice. Mysore J. Agric. Sci. **38**: 454-458.

Yu FB, Luo XP, Song CF, Zhang MX and Shan SD 2010. Concentrated biogas slurry enhanced soil fertility and tomato quality. Plant Soil Sci. **60**: 262-268.

*(Manuscript received on 30 November, 2016; revised on 5 January, 2017)*