COMPARITIVE STUDY OF BIOGAS SLURRY WITH FARMYARD MANURE AS FERTILIZER ON MAIZE CROP

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ABSTRACT: A field experiment was conducted at JK farms Jhumra Road Faisalabad, to evaluate the potential of Bio-slurry as a fertilizer in contrast with farmyard manure and also with recommended chemical fertilizer to improve the yield, growth and nutritive value of maize crop. Six different treatments were applied to check the efficiency under field conditions. Two Different levels of Biogas Slurry were used to evaluate its efficiency in relation with its quantity. Biogas slurry was taken from biogas plant of JK farms from a floating drum of 35 m^3. The experiment was conducted by using complete block design with six treatments and three replications. The crop was harvested manually at its physiological maturity at the ground level using a sickle and tied into separate bundles. Data regarding plant height, fresh biomass, cob yield, grain yield and 1000-grain weight were recorded. Plants samples were analyzed for NPK concentrations in straw and grain. The results showed that T_2, (Recommended Chemical fertilize) showed maximum yield. This treatment increases plant height, cob yield, grain yield, and 1000-grain weight, compared with control. The concentration of Nitrogen, Phosphorous and Potassium and their uptake were also increased over control. The treatment T_3 (Biogas Slurry was applied @ 20t/ha) showed next better results as compared with rest of treatments. It increased the plant height, cob yield, grain yield, 1000-grain weight and NPK level significantly as compared with control and plants treated with farmyard manure.

INTRODUCTION

Pakistan produces about 50 million metric tones of crop, animal and poultry waste annually, which can be used as feeding material for the biogas plants. This material can serve dual purpose by producing energy as well as providing valuable crop manure. After anaerobic fermentation organic nutrients of these materials become more soluble to the soil with no decrease in nutritional values [1].

Biogas plant is basically designed to allow the anaerobic digestion of organic materials which produces mainly methane gas along with traces of H_2S, CO_2, NH_3, H_2, CO and biogas slurry (BGS). The organic fertilizer obtained as a by-product from this technology encourages farmers to consider its acceptance as a multipurpose technology.

The chemical fertilizers have undesirable effects in long term. For long period sustained agriculture, organic manure is very important [2]. The slurry produced by a biogas plant is considered to be an effective fertilizer and soil conditioner.

Farmyard manure is not as rich in micro-nutrients as BGS (Gupta, 2007)[2]. The term farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with the litter (bedding material and leftover material from roughages or fodder fed to cattle). On an average well decomposed FYM contains 0.5 %N, 0.2 % P_2O_5 and 0.5 % K_2O [3].

The use of BGS as manure gives double advantage of biogas plant. The fibrous material, inorganic solids which cannot digest or convert into methane either settle down in the plant or come out with slurry liquid through outlet. This contains many rich and nutritive elements including nitrogen, phosphorous, Potassium, iron and trace elements (Zn, Fe Ni, Cu, Cd, Cr, Boron, Calcium, Sodium, etc.) [2].

The processing of manure in an anaerobic digester is only a partial manure degradation process (Sweeten et al., 1990)[4]. Therefore, material remaining after digestion must be utilized in some manner, most logically land-applied as a crop nutrient resource. In addition, BGS is free of weed seeds because anaerobic digestion kills more seeds than any manure processing system.

On the other hand, FYM, itself, (open pool manure) looses nutrients, most importantly, nitrogen, and thus possess relatively lower manorial value than biogas slurry. Nitrogen is an important element for crop growth. The nitrogen in animal manure is normally available in an organic form but after passing through the fermentation process in a biogas digester it is changed (by bacteria) to inorganic form mostly ammonia nitrogen (NH4+) which is easily soluble and utilized by crop plants.

Currently, biogas effluents are either disposed off into drains or directly mixed in water to irrigate the fields. Unfortunately in some locations large volumes of animal waste are disposed into drains & thus causing environmental concerns, especially in area with large number of dairy cattle. Such disposition can result into inclusion of biogas slurry to water systems such as canals, rivers and other water channels. There is an urgent need to find ways and means to use it more efficiently

Due to a potential increase in the use of anaerobic digestion systems for energy production, there is need for a reliable estimate of plant-available N and P in digested manure. By studying positive effects of slurry on soils it will be easy to convince the farmers to use it as a fertilizer. It can also provide a basis for the future study of different aspects of BGS.

MATERIAL AND METHODS

To fulfill the objective of this study the experiment was conducted at JK farms Jhumra Road Faisalabad. The field was divided into eighteen portions; every portion represented one experimental unit. Two different dozes of Biogas-slurry were used as a fertilizer in contrast with two different dozes of farmyard manure. They were further studied in contrast with the

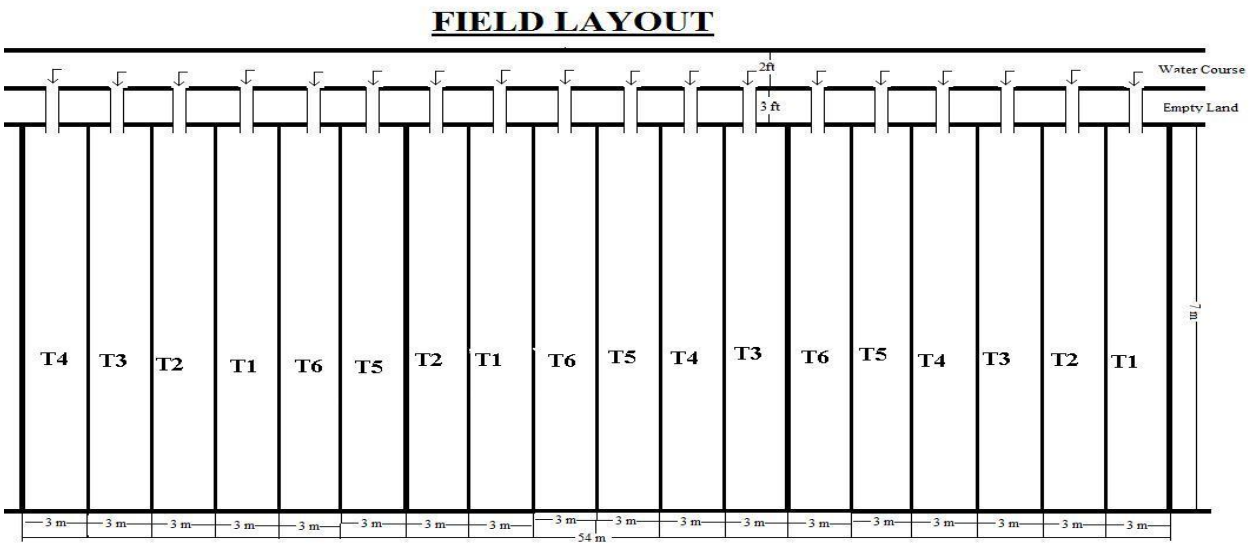

Figure 1. The field layout and experimental design of the treatments

results obtained by the application of recommended chemical fertilizer. All the results obtained were finally compared with the control, where no application was made. Maize crop was selected for the study. The experiment was conducted by using Randomized Complete Block Design (RCBD) with six treatments and three replications as presented in Figure 1. Following treatments was made to the six $21m^2$ (7m*3m) plots. Three replications were made for each treatment.

T_1 =Control (without any application)
T_2 =Recommended Chemical Fertilizer
T_3 =Biogas Slurry @ 20 tons/hectare
T_4 =Biogas Slurry @ 40 tons/hectare
T_5 =Farm yard manure @ 20 tons/hectare
T_6 =Farm yard manure @ 40 tons/hectare

Three soil samples were taken before the application of the treatments and averages of samples were taken to study the initial physical and chemical condition of soil. Later, before the time of harvesting 54(3 from each plot) soil samples were taken. Out of which 18 composite soil samples were studied in the laboratory.

Urea, Single Super Phosphate (SSP) and Sulphate of Potash (SOP) were used as the source of nitrogen, phosphorous and potash, @100-100-50 Kg per acre, respectively. Whole of the phosphorous and potash was applied before sowing in the plots representing T_2. Nitrogen was applied in two split doses first after emergence of the seeds and the remaining half of nitrogen were top-dressed at early flowering with irrigation. Biogas slurry was taken from the outlet of a 35 m^3 floating biogas plant present at the JK farms. It was installed almost 18 months before and was working in excellent condition. The Slurry was applied with the help of gardening shower. Slurry was distributed evenly in respective treatment plots at the rate of 20t/ha (42 kg/$21m^2$) and 40 t/ha (84 kg/$21m^2$). Biogas slurry was applied 3 weeks before the sowing.

Farmyard manure (FYM) was applied at 20 t/ha (42 kg/$21m^2$) and 40 t/ha (84 kg/$21m^2$) in the respective treatment plots. The FYM was two to three days sun dried and was collected from the nearby JK dairy Farms. The first irrigation was given two weeks after the emergence of the crop, second after twenty days, third at flower initiation followed by the final irrigation at seed formation stage. The crop was kept free of weeds by giving one hoeing with Khurpa before the first irrigation in the plots. Plant protection measure against aphids was followed by spraying twice with Carbofuron @ 1000 ml per acre. All other agronomic practices were kept uniform and normal for all the treatments.

The crop was harvested manually at the ground level using a sickle and tied into separate bundles. These bundles were weighed separately for fresh biomass and cob weight was also recorded, these bundles and cobs were kept in the field for about two-three weeks for sun drying. Then the sun-dried cobs were threshed with maize Sheller for separating seeds. The following observations were recorded:

1. Plant height at maturity (cm)
2. No. of cobs per treatment
3. Fresh biomass (t ha^{-1})
4. Grain yield (t ha^{-1})
5. 1000-grain weight (g)
6. Weight of cobs(t/ha)
7. NPK contents of the straw

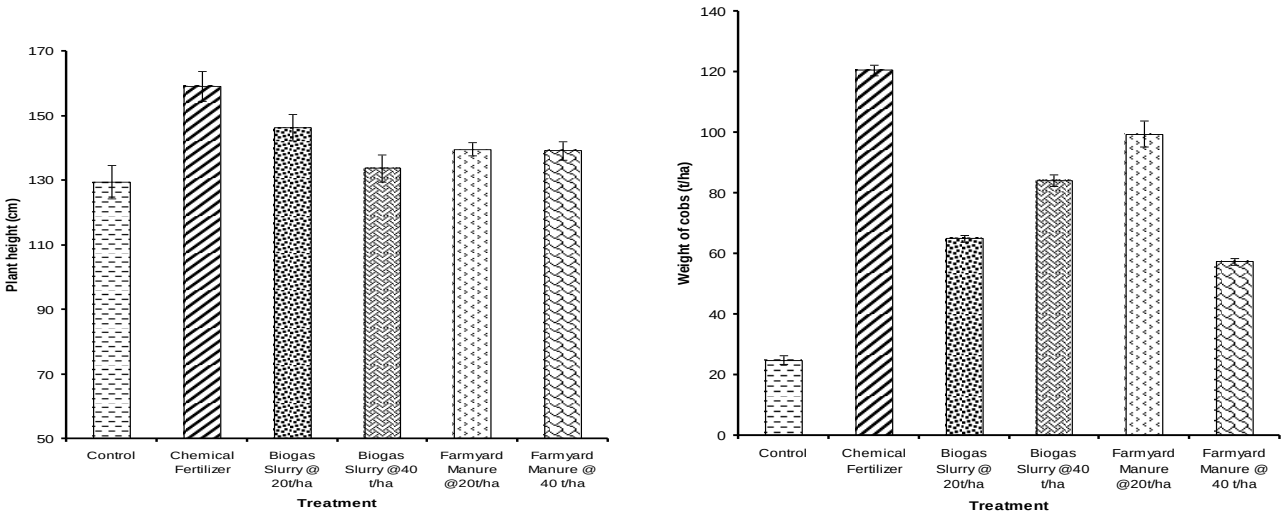

Figure2: Effect of treatments on Plant Height (cm) and Weight of Cobs (t/ha)

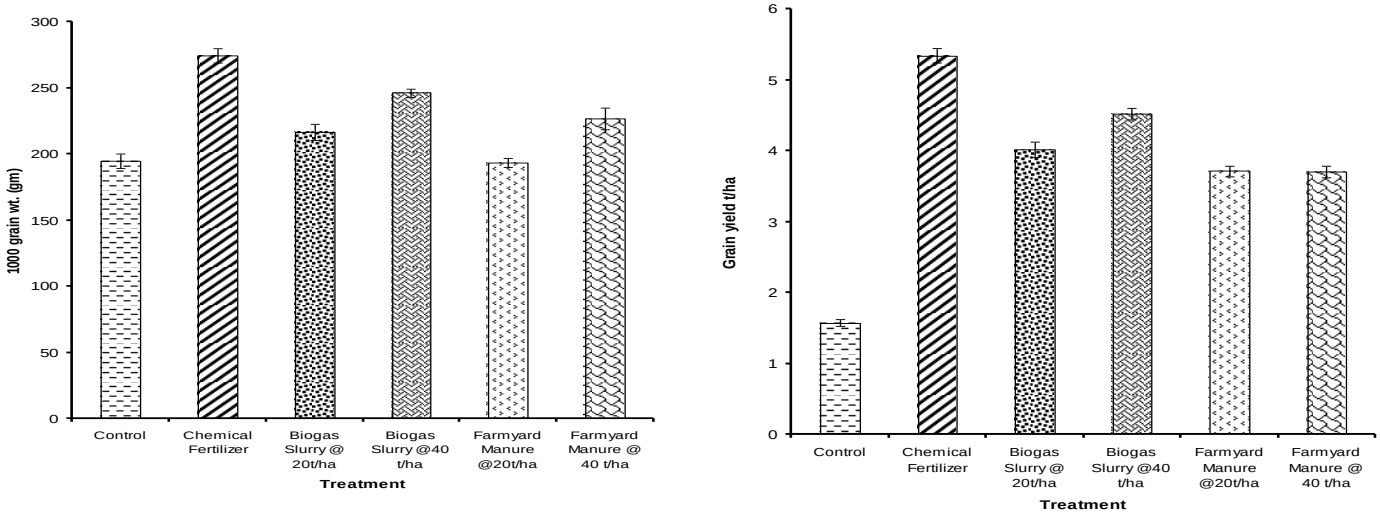

Figure3: Effect of treatments on as 1000 grain wt. (gm) and Grain Yield t/ha.

RESULTS AND DISCUSSION

The statistically analyzed data for maize plant height shows T_2 has the highest value (159.12 cm) followed by T_3(146.43 cm) ,T_5(139.62 cm), T_6(139.12 cm) and T_4(133.75 cm). The treatment T_1 (Control) showed the minimum mean value (129.44 cm) for the plant height as shown in figure 2. The result is in agreement of the study carried out by Morsy [5] who concluded that organic waste materials increased the plant height.

The weight of the cobs indicates that fertilizer application has the maximum value (120.50 t/ha) followed by T_5 (99.50 t/ha), whereas the least value was observed in T_1 (24.86 t/ha). T_4 also showed significant results (84.20 t/ha).The mean results for the cob yield/m^2 have showed the maximum yield in T_2(14.66 cobs/m^2) followed by T_5(13.00 cobs/m^2) ,T_4(12.33 cobs/m^2) and T_3(12.33 cobs/m^2). T_4 and T_3 showed similar mean results in this respect. The least value was observed in T_1(5 cobs/m^2).

The results for 1000 grain wt.(gm) shows that maximum increase (48.42%), as compared to control, was observed in 1000 grain wt. (gm) when recommended chemical fertilizers(T_2) was applied. T_2 differed significantly from control and was followed by the treatment T_3 where Biogas slurry was applied @ 20t/ha . It produced 35.93% higher yield than control.

Maximum mean value for Grain Yield (t/ha) was observed in T_2 (5.34 t/ha). The plants treated with Biogas slurry T_3 and T_4 (4.02 and 4.52 t/ha) showed relatively high yield of grains as compared to plants treated with farmyard manure in T_5 and T_6 (3.71 and 3.70 t/ha) as shown in figure 3. The mean value for control remained least (1.47 t/ha). The results regarding maize grain yield in the present study has been in accordance with the study made by Dwivedi and Thakur [6].

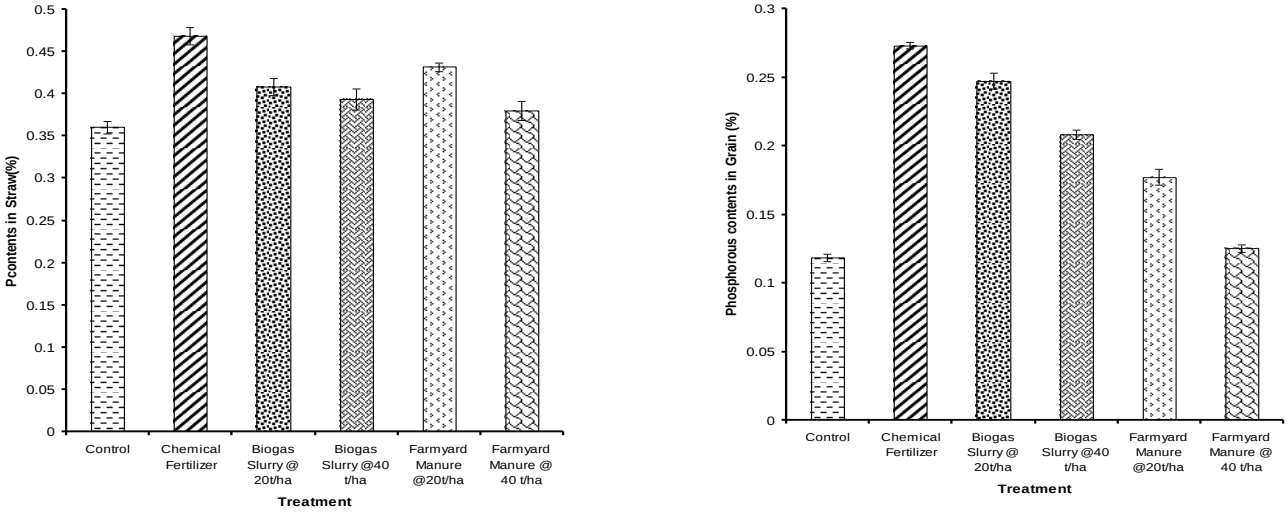

Figure 4: Phosphorous contents present in Straw (%) and Maize Grains (%)

Their study also yields that BGS recorded significantly higher grain yield of wheat. However the present study shows the suitability of the treatments for the maize grain yield. The application of treatments significantly increased the yield of maize as compared to the control. However maximum yield was observed in the treatment plots where chemical fertilizer was applied in recommended amounts. This finding is in agreement of the finding of Garg *et al.* [7] who stated that amendments of soil with biogas slurry increased the yield of wheat over the non amended control.

It is evident from ANOVA Table that all the treatments showed significant increase in nitrogen contents of straw in maize. Maximum increase was observed in T_6 where the mean value is 21.50 % as compared to 11.67 % of control. T_2 (20.17 %) and T_6 (21.50%) remained non significant to each other as presented in figure 4. The result is in agreement of the study carried out by Morsy [5] who concluded that organic waste materials increased the plant height compared with untreated control.

The table for mean values shows that the maximum value of the N (%) contents in grain i.e. 3.67 %, was observed in T_2 (Chemical fertilizer) which showed significant results as compared to the control i.e. 0.78 %. T_3 and T_4 remained non significant to each other but showed significant change in results as compared to all other results. Farmyard manure (T_5, T_6) has shown a better N (%) in grains as compared to the biogas slurry. These results are in accordance with Singh [8]. He stated that organic treatments resulted in enhanced soil microbial biomass nitrogen followed by chemical fertilizer application and control.

Data regarding potassium contents in straw shows significantly high concentration in straw of treated plots over control. T_2 where recommended chemical fertilizer was applies showed maximum Potassium contents in straw i.e. 2.5%. T_2 gave 45.02% increase over control. T_4, T_5 and T_6 showed non significant result. However they showed significant results with other treatments. Biogas slurry showed relatively higher percentage of potassium contents in straw as compared with farmyard manure. Untreated control showed minimum percentage of potassium in straw i.e. 1.7% as shown in figure 4.

Data regarding Potassium contents in grain showed that all the treatments have better potassium contents then control. T_2 where recommended chemical fertilizer was applied showed maximum percentage of potassium contents in grains i.e. 0.47% and it gave 23.86% increase over control. Next better results i.e.0.41%, were observed in T_3 where Biogas slurry was applied @20t/ha, which gave 19.06% increase over control. Treatments T_4 and T_6 were statistically non-significant with each other but significantly differed from untreated control. T_4, T_5 and T_6 were statistically non significant to each other.

It was observed that T_2 where recommended chemical fertilizer was applied had better percent content of Phosphorous in straw i.e. 0.47%. The farmyard manure @ 20t/ha (T_5) gave next better results i.e.0.43%. It was statistically at par with T_2 and significantly differed with control (T_1). The increase in Phosphorous contents found in T_3 Biogas slurry @20t/ha was 22.8% greater than control. It was followed in descending order by T_6 and T_4.Untreated control showed lowest Phosphorous contents (0.36%).

The ANOVA table for P contents in grain shows that the results were statically highly significant in case of treatments. It was observed that T_2 had better percentage content of Phosphorous in grains i.e. 0.273%. The biogas slurry @ 20t/ha (T_3) gave next better results i.e.0.247% and remained statistically at par with T_2 and significantly differed with control (T_1) as shown in figure 5. It was followed in descending order by T_4, T_5 and T_6. Untreated control showed lowest Phosphorous contents in grain (0.118%). T_1 and T_6 remained non significant with each other. These results are in accordance with the study carried out by Mathers and Stewart and Juiliana [9,10]. They stated that fertilization with slurry increased the organic matter and phosphorus in soil.

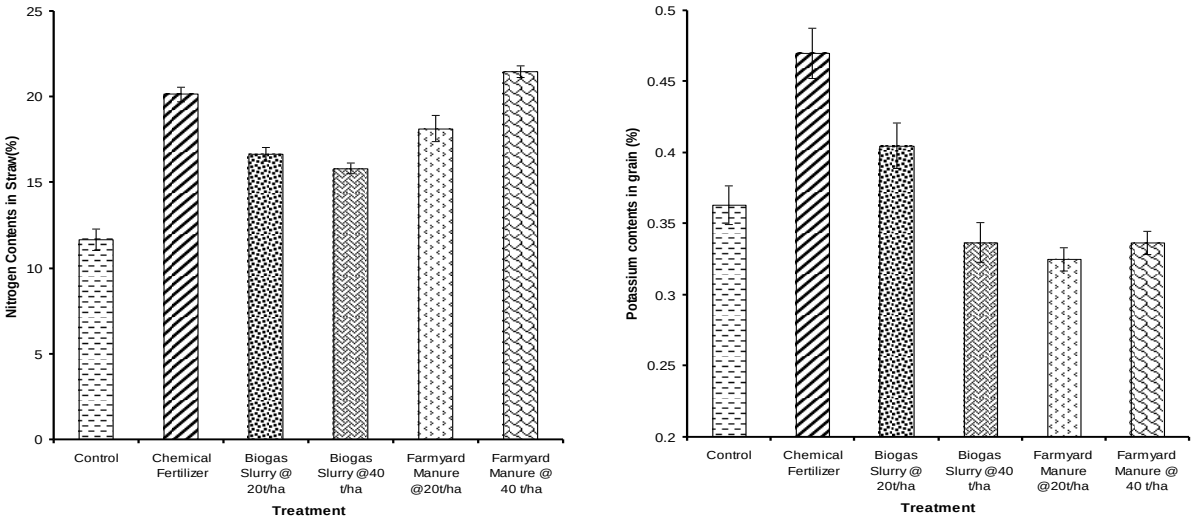

Figure 5: Potassium contents in Straw (%) and in grain (%)

The significant results of N, P, and K have been observed in the treatment plots where BGS was applied. In the present study NPK value increased in soil of Biogas slurry treated plot because BGS have the potential of appropriate soil conditioner and also improve NPK contents in rice crop, sunflower, black gram and on vegetables [11]

CONCLUSIONS:

Biogas slurry is an effective fertilizer as compared to the farmyard manure because of the following reasons.

1. The significant results of N, P, and K have been observed in the treatment plots where BGS was applied. BGS gave better yield as compared to FYM. However the best results were observed in case of recommended chemical fertilizer.
2. The BGS is an-aerobically fermented and is ready to apply, whereas FYM needs at least three weeks to decompose under certain atmospheric conditions.
3. Results have shown that crops where BGS was applied were less affected by pests and weeds as compared to the crops where FYM was applied. The fermentation chamber of the biogas plant kills the pests and digests weed seeds.

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