

## EVALUATION OF BIO-FERTILIZER APPLICATION TO AMELIORATE THE ENVIRONMENT AND CROP PRODUCTION

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An experiment was conducted during 2011-2012 to evaluate the effect of mechanically dried bio-slurry on cabbage growth, productivity, and soil health in terms of nutrients availability at field conditions. To achieve these objectives, a Golden Acre cabbage field was selected at University of Agriculture Faisalabad. The soil type was sandy loam and canal water was used for irrigation. Randomized complete block design was used in experiment with four treatments replicated four times. The bio-slurry was taken from Al-Hamd Exports at Sutyana road, Faisalabad. During the growing period of cabbage, data regarding biometric features of cabbage crop was taken. The results showed 20-30% increase in plants density, plants height and root depth, and 10% reduction in unfold leaves per plant in bio-slurry treated plots. It was followed by the treatment in which bio-slurry was applied in combination with chemical fertilizers. The treatment with 100% chemical fertilizers showed least significant effect in improving these characteristics of the crop. The fertilization effect of bio-slurry was evaluated by measuring residual amount of NPK and organic matter (OM) in soil after harvesting of the crop. The bio-slurry treated plots showed better results as it reside 15% more amount of OM and NPK in the soil in relation with chemical fertilizer treated plots. A reduction of about 15% in EC of soil was also recorded in the plots where bio-slurry was applied. This showed that bio-slurry application on saline soil can reduce the salinity of soil. The cabbage yield was measured from each plot. It showed minimum yield 45 t/ha and maximum 79.25 t/ha from control and bio-slurry treated plots respectively. It was followed by chemical fertilizer treated plots as 68 t/ha. The results revealed that bio-slurry mobilize the nutrients in soil better than chemical fertilizers. Bio-slurry can be affectively used in contrast with chemical fertilizers and can be proved as an efficient soil conditioner as well.

**Keywords:** Bio-slurry, cabbage, biometric feature, soil health, soil conditioner

### INTRODUCTION

Pakistan is an agricultural country and its soil is of great importance as a natural resource. The organic matter in the soil is alarmingly low unfortunately. Intensification of agriculture is the main cause of this loss. Increase in the demand of food in the last three decades is met by the immense use of mineral and chemical fertilizers. On the other hand it is not a good practice to use chemical fertilizers due to their adverse effects on environment and soil conditions. Under such situations, there is no alternative besides to add organic fertilizer into the soil to sustain crop productivity and to increase soil fertility. A vast range of organic fertilizers is available in different forms in our surroundings including cow dung, farmyard manure (FYM), farmyard slurry, composted FYM, and digested biogas slurry.

Bio-slurry is an anaerobic fermented organic material released as a byproduct from the biogas plant after production of combustible methane gas. It may be considered as an effective source of organic fertilizer as it

contains considerable amount of nutrients and organic matter (Islam, 2006). Bio-slurry is rich in micro and macro nutrients compared with both FYM and composted FYM. The fermentation process in a biogas digester is brought anaerobically by *Methanogenic Bacteria*. The fibrous material and inorganic solids which cannot digest or convert into methane either settle down in a plant or come out with slurry liquid through an outlet. It is very rich in nutritive elements including nitrogen (N), phosphorous (P), potassium (K) and trace elements as zinc (Zn), nickel (Ni), iron (Fe), cobalt (Co), cadmium (Cd), chromium (Cr), boron (B), calcium (Ca) and sodium (Na) (Gupta, 2007). Nitrogen is an important element for crop growth. It is available in animal manure normally in organic form, however after fermentation it is changed into inorganic form mostly ammonia nitrogen (NH<sub>4</sub>) which is easily soluble in soil and used by crop plants (Sanmaneechai, 1992). The availability of nitrogen from bio-slurry is significant. The phosphate in soil also increases with continuous application of organic fertilizers like biogas slurry. It influences the plant root system. The other

important nutrient is potassium which is present in bio-slurry insignificant amount. It plays a significant role in plant stem improvement. The bio-slurry is significantly proved as a catalyzing organic fertilizer for the vegetables, as they required low dose of macro and micro nutrients (Islam, 2006).

It is evident that bio-slurry could be used as a soil conditioner to improve soil health via giving up OM0 and sharing other salt decreasing cations, as bio-slurry has cation exchange capacity (Rahman, 2008). Soil health means the enrichment of soil in terms of availability of nutrients nitrogen, phosphorous, and potassium. It is necessary to maintain soil health for better crop yield, which can be achieved by applying organic substitutes.

There is an increasing trend in installing biogas plants in Pakistan to meet energy requirements. It is necessary to conduct this type of work for the result oriented techniques in the use of digested biogas slurry and it will be also helpful in convincing the farmers to use it as a fertilizer. If a nearby land is not available or the slurry generated is in excess, the method of preservation of slurry (drying) can help farmers to use it later and conveniently. It can also provide a basis for the future study of different aspects of bio-slurry.

An experiment was conducted to evaluate the affectivity of bio-slurry on cabbage growth parameters, productivity, and soil health. The experimental site ( $31^{\circ} 26' 18''$  N and  $73^{\circ} 04' 32''$  E) was selected in University of Agriculture, Faisalabad with an altitude of 186 meters (611 ft) from the mean sea level. The mechanically processed dry biogas slurry was applied alone as well as in combination with the chemical fertilizers.

## MATERIALS AND METHODS

Soil health affected by dry bio-slurry application was one of the major objectives of this study. The nutrients mobilization and residual effect of bio-slurry on soil was evaluated by conducting soil tests. Soil samples were taken from depth 0-45 cm to see the nutrients variation and mobility in the field. There were 48 soil samples from which 12 composite soil samples were tested for the values of pH, EC, N, P, K, organic matter and relative proportion of sand, silt & clay (soil texture). The soil of the study area was found sandy loam, best suited for the cabbage crop. The experiment was statistically designed in randomized complete blocks. The experimental unit was taken  $4\text{ m} \times 5\text{ m}$  and total were 16 units at field. The four treatments were applied namely  $T_1$  (control; without any fertilizer application),  $T_2$  (application of 50% bio-slurry + 50% chemical fertilizer),  $T_3$  (100% bio-slurry), and  $T_4$  (100% chemical fertilizer; recommended). The layout plan used is shown in Figure 1.

The chemical fertilizers were applied in the relevant plots in

following pattern. Di-Ammonium Phosphate (DAP) was mixed into the soil at land preparation stage. Urea was applied within first irrigation. The fertilizer was applied two times,  $\frac{3}{4}$  at time of land preparation and  $\frac{1}{4}$  at the stage of maturity of cabbage plants (about at 40 days after transplanting). It was according to recommended dose of nitrogen, phosphorous, and potassium as 160, 120 and 60 kg/ha respectively (Malik, 1994).

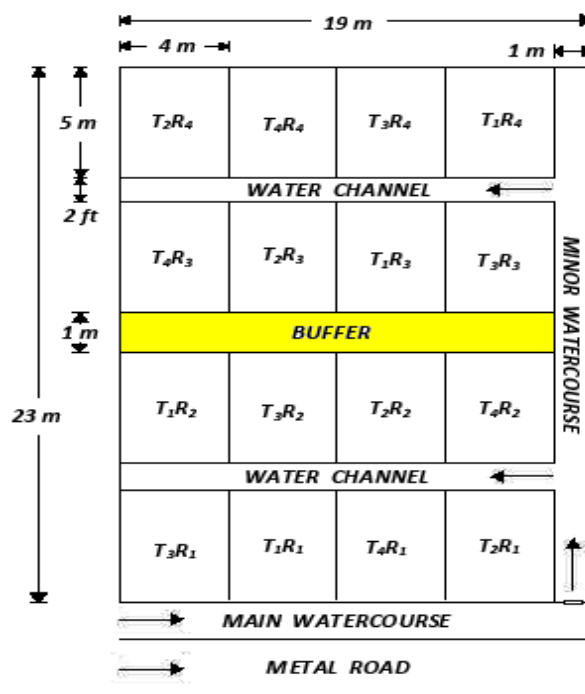


Figure 1. Field Layout

The dried bio-slurry was also applied in relevant plots two times,  $\frac{3}{4}$  was mixed into the soil at time of land preparation and  $\frac{1}{4}$  after weeding and hoeing (after 40 days of transplanting) in accordance to recommended dose of nitrogen, phosphorous, and potassium in kg/ha. The slurry was applied at a rate of 10 t/ha (20 kg/20 m<sup>2</sup>) in the plots within treatment  $T_3$ , and 5 t/ha (10 kg/20 m<sup>2</sup>) in the plots within treatment  $T_2$ .

Five weeks old seedlings were transplanted to the experimental field by ridge and furrow planting method. The seedlings were 30 to 40 cm apart at ridges, while the ridges were given a clear space of 2.5 ft between each other. The seedlings were transplanted at both sides of the ridges in order to get the maximum yield. Cabbage requires frequent and light irrigations. First light irrigation was applied soon after transplanting for better establishment of seedlings. Thereafter, it was irrigated at an interval of about 15 days. The management and intercultural practices such as weeding, hoeing, and insecticides, and pesticides were made according to requirements. The evaluation of biometric

characteristics of cabbage crop was the second major objective of this study. The parameters observed were plants density per meter square area, plant height (inches), the leaves intensity per plant and root depth of cabbage plants (inches).

Cabbage head yield per meter square from area under each treatment was taken. However, all the heads were not taken at a time from the entire field. Though to obtain maximum yield, heads were harvested time to time at attaining marketable size and firm enough. However, entire yield was taken from 75-90 days after transplanting and results were analyzed statistically.

The nursery of cabbage variety “Golden Acre” was used in the experiment to see the fertilization efficiency of the bio-slurry. The yield from area under each treatment was used to make a comparison by using statistical design. The growth parameters of the cabbage crop were observed including plants density per meter square area, plant height from bottom to tip of the plant, the leaves intensity per plant and root depth of the cabbage plants. Bio-slurry showed the significant influencing affect on these parameters.

## RESULTS AND DISCUSSION

The results of biometric characteristics against respective treatments were as described in graphical form.

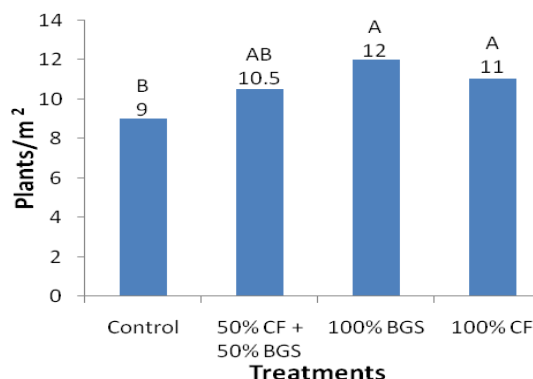


Figure 2. Mean values of treatments for plants/m<sup>2</sup>

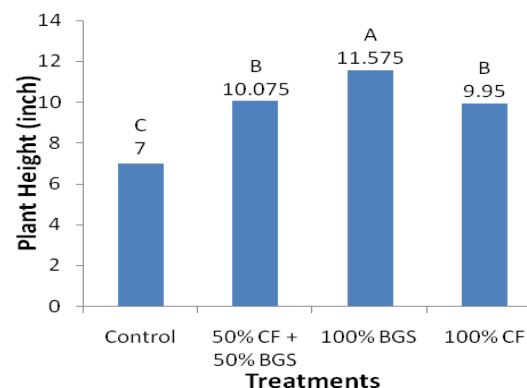


Figure 4. Mean values of treatments for plant height

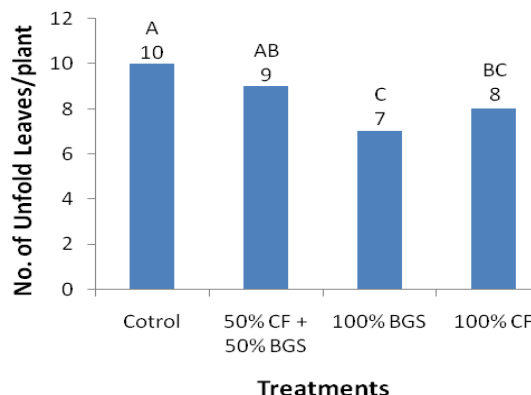


Figure 3. Mean values of treatments for unfold leaves/plant

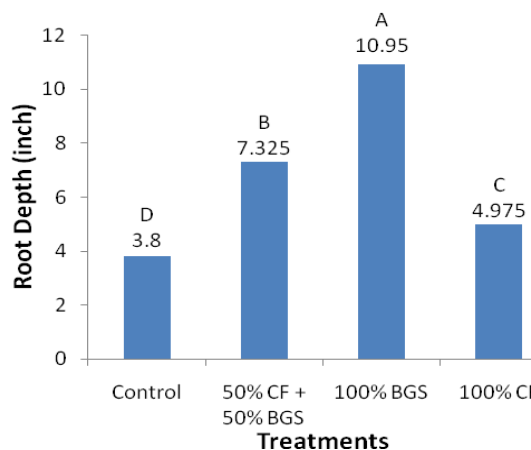


Figure 5. Mean values of treatments for root depth

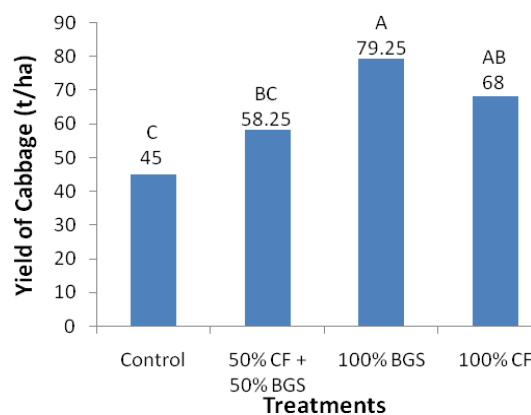


Figure 6. Mean values of treatments for cabbage yield

During the growing period of cabbage the biometric features including plants density per square meter, plant height, number of unfold leaves/plant, and root depth of plant were

taken from each plot. The results showed in Figures 2, 3, 4 and 5 for respective parameters against treatment means. The graphs showed maximum number of plants per square meter, a significant increase in plant height and root depth, and reduction in unfold leaves per plant in bio-slurry treated plots. It was followed by treatment T<sub>2</sub>. While treatment T<sub>4</sub> showed least significant effect in improving these characteristics of the crop. These results were in line with findings by Joshi *et al.* (1994) who reported increase in plants density in cow dung slurry and poultry manure slurry treated plots. The results were in accordance with the findings of Rahman *et al.* (2008) who stated that plant height increases and number of unfolded leaves per plant of cabbage decreases significantly by the application of cow dung slurry.

The cabbage yield results are shown in Figure 6. There was significant difference between the treatments T<sub>1</sub> and T<sub>3</sub>. T<sub>3</sub> showed maximum yield 79.25 t/ha. It showed 34.25 t/ha increases in yield as compared to control. It was followed by T<sub>4</sub> and T<sub>2</sub> as 68 t/ha and 58.25 t/ha respectively. These treatments were not significantly different from each other, but showed increase in yield 23 t/ha and 13.25 t/ha respectively as compared to control. These results showed that bio-slurry application increases the plant growth and ultimate yield as compared to controlled as well as chemical fertilizer treatments in case of cabbage crop significantly. The bio-slurry application gave higher yield in vegetables were reported by Joshi *et al.* (1994). The results obtained were also confirmed the findings of Tripathi (1993) who reported that dried biogas slurry affectively increased the yield of vegetables like tomato, cauliflower, cabbage, potato, and brinjal.

The statistical analysis of data for pH, EC, and OM of soil showed highly significant results at 5% probability level. The effects of each treatment on respective parameters are given in Table 1, which shows significance level between treatments by giving grades a, b, c and d. The treatment T<sub>1</sub> showed maximum value of pH (7.6), while the treatment T<sub>3</sub> has minimum value of pH (6.6). It means that bio-slurry affects soil pH. The pH values of treatments T<sub>2</sub> and T<sub>4</sub> are near about mean of T<sub>1</sub> and T<sub>3</sub>. Treatment T<sub>2</sub> was also significant as it decreased pH significantly. The findings were in agreement with Yu (2006) who stated that soil pH was decreased to 8.21 from 8.75 in the plots where bio-slurry was applied.

It can be seen from table that treatment T<sub>4</sub> gave maximum

value of electric conductivity 1.70 dSm<sup>-1</sup> which means that this treatment affects soil by increasing EC as compared to control as 1.402 dSm<sup>-1</sup>. The treatment T<sub>3</sub> has minimum value 1.2083 dSm<sup>-1</sup> of EC. Treatment T<sub>2</sub> also showed increase in EC of soil as compared to control by increasing 0.102 dSm<sup>-1</sup>. Rahman (2008) stated that the bio-slurry has cation exchange capacity which avoids salt accumulation and causes to reduce the EC of soil by influencing nutrients provision to plants.

Treatment T<sub>3</sub> showed the maximum value as 1.525% for organic mater in soil. It was increased 0.66% as compared to control, which was 0.865%. Treatment T<sub>2</sub> gave second high percentage of organic matter 1.2675 that is followed by T<sub>4</sub> as 1.065%. It is evident from results that chemical fertilizer could not increase the organic matter in soil significantly in relation with bio-slurry. These results were in line with those obtained by Mathers (1984) who stated that slurry obtained from bio fermentation process contains high concentration of plant nutrients and organic matter.

The study revealed a remarkable change in soil macro nutrients availability by applying bio-slurry. The overall results of treatment T<sub>3</sub> were significant for residual amount of NPK in soil from rest of the treatments. The treatment means for nitrogen, phosphorus and potassium are represented in table. It showed a significant increase in amount of NPK in bio-slurry treated plots. It is proved from results that bio-slurry is very effective to mobilize the nutrients in soil. The results were in agreement with the findings of Nasir *et al.* (2010) who stated that bio-slurry improves NPK contents in maize crop. The results were also evident of statement by Islam (2006) who stated that bio-slurry is an excellent organic fertilizer and a good source of plant macro and micro nutrients.

**Conclusions:** Based on all analysis of the field data following conclusions are drawn.

1. The bio-slurry can be used as an effective fertilizer in development of cabbage significantly.
2. The soil characteristics improved significantly by the application of bio-slurry, so it can be use as an effective soil conditioner.
3. The bio-slurry application on saline soil can reduce the salinity of soil from 30 to 40 percent.
4. The bio-slurry application promotes growth parameters which ultimately enhances production of the crop.
5. The results revealed that bio-slurry mobilize the

**Table 1. Residual Effect of BGS on Soil Health after Harvesting of Cabbage**

Treatments	pH	EC (dS/m)	OM (%)	N (%)	P (ppm)	K (ppm)
T <sub>1</sub> Control	7.600 a	1.402 c	0.865 d	0.032 d	5.905 d	32.50 d
T <sub>2</sub> 50% CF + 50% BGS	6.925 c	1.504 b	1.268 b	0.049 b	6.117 b	40.25 b
T <sub>3</sub> 100% BGS	6.600 d	1.208 d	1.525 a	0.051 a	6.170 a	44.25 a
T <sub>4</sub> 100% CF	7.300 b	1.703 a	1.065 c	0.045 c	6.033 c	35.75 c

nutrients in soil better than that of chemical fertilizers. So, it is more efficient to improve soil health in terms of nutrients availability.

6. It was easy to use and transport the dried biogas slurry.

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