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## Effect of biogas digest on soil physicochemical properties under chickpea cultivation in clayey soils

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**Abstract**

A field experiment was conducted during *Rabi*, 2018 in clayey soils, at Agricultural College Farm, Bapatla, to study the 'Effect of biogas digest on soil physico chemical properties under chickpea cultivation in clayey soils. Reduction in pH & Electrical conductivity (EC) of the soil was observed at all the stages of the crop with the application 100 per cent recommended dose of phosphorus (RDP) through biogas digest along with microbial consortium (T<sub>10</sub>). Significantly higher soil organic carbon of 0.91, 0.86 & 0.72 g kg<sup>-1</sup> was recorded at vegetative, reproductive and harvest stages of the crop with T<sub>10</sub> and application of 100 per cent RDP through biogas digest (T<sub>9</sub>). The cation exchange capacity (CEC) and percent base saturation is also recorded superior in application of organic manures and microbial consortium over other treatments.

**Keywords:** Chickpea, electrical conductivity, organic carbon and CEC

**Introduction**

In the current scenario, sustainability of agriculture has become a major issue of global concern as the intensive use of chemical inputs show adverse impact on the environment and the soil fertility. It is now time to switch to most sustainable and healthy practices to protect the soil fertility status and ecosystem as a whole. Replacement of inorganic fertilizers with organic materials would escalate the soil ability to hold more nutrients and water, good physicochemical conditions and other properties which play a significant role in soil capacity to a long-term crop production plan and also productivity. Organic manures when added to soil undergo microbial decomposition. During the course of decomposition several changes occur in the soil environment. The production of organic acids, release of ions and change in organic matter status bring about changes in physicochemical properties of soil. Hence, it is important to identify potential organic sources which not only supply the required nutrients to crops but also maintains healthy status of soil. Biogas slurry is one such promising source of organic fertilizer, usage of which has tremendous positive effects on soil health and crop production. With this background the present study entitled "Effect of biogas digest on soil physicochemical properties of under chickpea cultivation in clayey soils" was conducted to find out the effect of both organic and inorganic sources of fertilizer on soil physicochemical properties in chickpea cultivation.

**Material and Methods**

A field experiment conducted at Agricultural College Farm, Bapatla using chickpea variety JG-11 as a test crop. The experimental soil was moderately alkaline in soil reaction (8.26), non saline (0.42 dSm<sup>-1</sup>) with clayey texture having medium organic carbon (0.53%). For physicochemical and chemical properties, the soil samples were collected prior to experimentation, at vegetative, reproductive and at harvest up to a depth of 30cm. Collected samples were shade dried, ground with a wooden hammer, passed through 2 mm sieve labelled and finally stored in air tight poly bags for laboratory analysis.

Soil reaction was determined in 1: 2.5 soil water suspension using combined glass electrode (Jackson, 1973)<sup>[2]</sup>.

The soluble salt content of soil samples was determined in 1: 2.5 soil water suspension using electrical conductivity bridge (Jackson, 1973) [2]. The CEC was calculated and expressed as C mol (p<sup>+</sup>) kg<sup>-1</sup> soil (Bower *et al.*, 1952) [1]. Base saturation was determined by the method of ammonium acetate exchangeable bases (Soil survey staff, 2006). The soil samples were centrifuged thrice with 33 ml neutral normal ammonium acetate each time and the extract was collected into a 100 ml volumetric flask. The sodium (Na<sup>+</sup>) and potassium (K<sup>+</sup>) were determined directly aspirating it to flame photometer, whereas calcium (Ca<sup>2+</sup>) and magnesium (Mg<sup>2+</sup>) were determined by Versenate method (Kanwar and Chopra, 1976) [3]. Walkley and Black (1934) [9] wet digestion method as given by Jackson (1973) [2] was followed to determine the organic carbon content of the soil.

## Results and Discussion

### Soil pH

There was no significant effect on soil pH and at all three stages (vegetative, reproductive and harvest) of crop growth period. However, highest pH (8.24, 8.22 & 8.20) was recorded in treatment T<sub>2</sub> which received 100% RDP through inorganic source and lowest pH (8.03, 7.99 & 7.91) was recorded in T<sub>10</sub> treatment which received 100% RDP through BGD + microbial consortium at vegetative, reproductive and harvest stages respectively. pH values ranged from 8.03 to 8.24, 7.99 to 8.22 and 7.91 to 8.20 at vegetative, reproductive and harvest stages respectively (Table 1). Among different treatments, treatments which received P through organic sources recorded lower pH values compared to treatments which received P through inorganic sources. The decrease in pH of the soil in the biogas digest applied plots could be attributed to the release of organic acids in the soil rhizosphere. Similar results of lowest pH in 100% BGS applied plots were reported by Nasir *et al.* (2012) [4]. Though the effect of treatments on soil pH was non-significant, the addition of organic manures to soil is known to bring about changes in physico-chemical properties of soil.

### Electrical conductivity

Highest EC values (0.60, 0.62 & 0.65 dS m<sup>-1</sup>) were recorded in treatment T<sub>2</sub> which received 100% RDP through inorganic source and lowest values (0.43, 0.44 & 0.47 dS m<sup>-1</sup>) were recorded in treatment T<sub>10</sub> which received 100% RDP through BGD at vegetative, reproductive and harvest stages respectively. Electrical conductivity values ranged from 0.43 to 0.60, 0.44 to 0.62 and 0.47 to 0.65 dS m<sup>-1</sup> at vegetative, reproductive and harvest stages respectively.

The treatments that received only organic source of P recorded lowest EC values compared to the treatments that received inorganic source of P and combined application of both organic and inorganic sources. Similar results of decrease in EC in plots where biogas slurry was applied were also reported by Nasir *et al.* (2012) [4]. The reason for this decrease in EC in plots received BGS might be due to the fact that bioslurry has cation exchange capacity which avoids salt accumulation and causes to reduce the EC of soil by influencing nutrient provision to plants. These results were corroborated with the findings of Rahman (2008) [5]

### Organic Carbon

Significantly higher organic carbon content was recorded in treatment T<sub>10</sub> which received 100% RDP through BGD + Microbial Consortium (0.91, 0.86 and 0.74%) and this was on

par with treatment T<sub>9</sub> which received 100% RDP through BGD (0.86, 0.81 and 0.72%) during vegetative, reproductive and harvest stages, respectively. Lowest organic carbon content was recorded in T<sub>1</sub> treatment which received no P fertilizer application (0.55, 0.54 and 0.53%) during all growth stages of crop growth period (Table 2). Among the combined application of organic and inorganic sources of P, the higher amount of organic carbon content was recorded in T<sub>5</sub> treatment i.e., 50% RDP through inorganic + 50% P through BGD (0.71, 0.65 & 0.64%) during vegetative, reproductive and harvest stages, respectively. However lowest organic carbon content was recorded in treatment T<sub>8</sub> (0.56, 0.54 & 0.53%) at all growth stages of chickpea, respectively.

Among the inorganics, the highest values were recorded with the treatment T<sub>2</sub> that received 100% RDP through inorganic compared to T<sub>3</sub> that received 75% RDP through inorganics at all growth stages. At vegetative stage the organic carbon content in soil increased to the tune of 65% in T<sub>10</sub>, 56% in T<sub>9</sub>, 29% in T<sub>5</sub> and 7.2% in T<sub>2</sub> treatments compared to control. An increase in organic carbon content of 59% in T<sub>10</sub>, 50% in T<sub>9</sub>, 18% in T<sub>5</sub> & 5.5% in T<sub>2</sub> over control were recorded at reproductive stage and during harvest stage 39% in T<sub>10</sub>, 35% in T<sub>9</sub>, 18% in T<sub>5</sub> & 5.7% in T<sub>2</sub> treatments were recorded over control. Organic carbon status of the soil decreased with age of the crop. It was observed that there was improvement in organic carbon status of soil compared to control. The increase in organic carbon content of soil might be due to overall improvement in soil environment with application of biogas slurry. This was also reported by Venkata Subbaiah *et al.* (2010) [8] through the application of organics to the rabi French bean significantly improved the organic carbon content of soil.

### Cation Exchange Capacity and Percent Base Saturation

The highest CEC values (48.93, 48.85 & 48.11 cmol (p<sup>+</sup>) kg<sup>-1</sup>) were recorded with the treatment T<sub>10</sub> which received 100% RDP through BGD + microbial consortium followed by T<sub>9</sub> treatment (48.32, 48.21 & 47.88 cmol (p<sup>+</sup>) kg<sup>-1</sup>) which received 100% RDP through BGD and lowest values (47.36, 47.36 & 47.34 cmol (p<sup>+</sup>) kg<sup>-1</sup>) were recorded with T<sub>1</sub> i.e., control plot with no P fertilizer during vegetative, reproductive and harvest stages of chickpea respectively (Table 3). CEC values ranged from 47.36 to 48.93, 47.36 to 48.85 and 47.34 to 48.11 cmol (p<sup>+</sup>) kg<sup>-1</sup> at vegetative, reproductive and harvest stages, respectively. CEC of soil decreased with the advancement of the crop stage. CEC was greater in soils with great amount of organic matter and clay. The increase in CEC of the soil treated with the BGD could be attributed to humic substances present in the BGD. This observation fell in line with Vasanthi and Kumaraswamy (1999) [7] who reported increase in CEC with the addition of Vermicompost.

Data on the effect of organic source of P, inorganic source of P and their combined application on PBS at vegetative, reproductive and harvest stages of crop were presented in Table 3. The data revealed that there were no significant differences among treatments for their effect on PBS at vegetative, reproductive and harvest stages of crop, however, highest PBS values (93.31, 93.23 & 93.14) were recorded in T<sub>10</sub> treatment which received 100% RDP through BGD + microbial consortium and lowest PBS values were recorded in treatment T<sub>1</sub> during vegetative, reproductive and harvest stages of chickpea.

**Table 1:** Effect of organic manures and inorganic phosphorus fertilizer on Soil pH and EC

Treatments	pH			EC (dSm <sup>-1</sup> )		
	Vegetative	Reproductive	Harvest	Vegetative	Reproductive	Harvest
T <sub>1</sub> – Control (No P fertilizer)	8.21	8.20	8.17	0.55	0.58	0.59
T <sub>2</sub> – 100% RDP through inorganic sources	8.24	8.22	8.20	0.60	0.62	0.65
T <sub>3</sub> – 75% RDP through inorganic sources	8.23	8.20	8.19	0.59	0.61	0.63
T <sub>4</sub> – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest)	8.11	8.07	8.03	0.52	0.51	0.52
T <sub>5</sub> – 50% RDP (through inorganic) + 50% P through BGD (Biogas digest)	8.08	8.06	8.01	0.45	0.46	0.49
T <sub>6</sub> – 100% RDP (through inorganic) + Microbial Consortium	8.17	8.16	8.14	0.55	0.57	0.58
T <sub>7</sub> – 75% RDP (through inorganic) + Microbial Consortium	8.17	8.14	8.13	0.53	0.53	0.56
T <sub>8</sub> – 50% RDP (through inorganic) + Microbial Consortium	8.15	8.13	8.11	0.50	0.52	0.54
T <sub>9</sub> – 100% RDP through BGD	8.05	8.03	7.99	0.44	0.46	0.48
T <sub>10</sub> – 100% RDP through BGD + Microbial Consortium	8.03	7.99	7.91	0.43	0.44	0.47
SEm±	0.328	0.327	0.317	0.039	0.042	0.04
CD(0.05)	NS	NS	NS	NS	NS	NS
CV(%)	6.98	6.99	6.81	13.29	13.98	12.86

**Table 2:** Effect of organic manures and inorganic phosphorus fertilizers on organic carbon content of soil (g kg<sup>-1</sup>)

Treatments	Vegetative	Reproductive	Harvest
T <sub>1</sub> – Control (No P fertilizer)	0.55	0.54	0.53
T <sub>2</sub> – 100% RDP through inorganic sources	0.59	0.57	0.56
T <sub>3</sub> – 75% RDP through inorganic sources	0.56	0.55	0.54
T <sub>4</sub> – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest)	0.67	0.64	0.63
T <sub>5</sub> – 50% RDP (through inorganic) + 50% P through BGD (Biogas digest)	0.71	0.65	0.64
T <sub>6</sub> – 100% RDP (through inorganic) + Microbial Consortium	0.62	0.60	0.59
T <sub>7</sub> – 75% RDP (through inorganic) + Microbial Consortium	0.58	0.55	0.55
T <sub>8</sub> – 50% RDP (through inorganic) + Microbial Consortium	0.56	0.54	0.54
T <sub>9</sub> – 100% RDP through BGD	0.86	0.81	0.72
T <sub>10</sub> – 100% RDP through BGD + Microbial Consortium	0.91	0.86	0.74
SEm±	0.035	0.033	0.032
CD (0.05)	0.10	0.10	0.10
CV (%)	9.18	9.28	9.18

**Table 3:** Effect of organic manures and inorganic phosphorus fertilizer on Soil CEC and PBS

Treatments	CEC (cmol (p <sup>+</sup> ) kg <sup>-1</sup> )			PBS		
	Vegetative	Reproductive	Harvest	Vegetative	Reproductive	Harvest
T <sub>1</sub> – Control (No P fertilizer)	47.36	47.36	47.34	90.84	90.78	90.65
T <sub>2</sub> – 100% RDP through inorganic sources	47.46	47.42	47.40	92.30	92.25	92.19
T <sub>3</sub> – 75% RDP through inorganic sources	47.41	47.38	47.37	91.70	91.31	91.21
T <sub>4</sub> – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest)	47.88	47.81	47.71	93.10	92.80	92.69
T <sub>5</sub> – 50% RDP (through inorganic) + 50% P through BGD (Biogas digest)	47.93	48.03	47.74	93.18	93.08	93.02
T <sub>6</sub> – 100% RDP (through inorganic) + Microbial Consortium	47.50	47.44	47.43	92.32	92.26	92.21
T <sub>7</sub> – 75% RDP (through inorganic) + Microbial Consortium	47.42	47.41	47.38	91.90	91.65	91.64
T <sub>8</sub> – 50% RDP (through inorganic) + Microbial Consortium	47.37	47.36	47.35	90.88	90.81	90.73
T <sub>9</sub> – 100% RDP through BGD	48.32	48.21	47.88	93.26	93.11	93.08
T <sub>10</sub> – 100% RDP through BGD + Microbial Consortium	48.93	48.85	48.11	93.31	93.23	93.14
SEm±	2.44	2.17	2.43	3.72	3.76	3.95
CD (0.05)	NS	NS	NS	NS	NS	NS
CV (%)	6.97	6.19	6.95	6.99	7.08	7.44

## Conclusion

the physicochemical properties like pH, EC, organic carbon, cation exchange capacity and percent base saturation of soil are very important in determining the microbial activity, nutrient availability to the crop plants. The pH of the moderately alkaline clayey soil was declined due to application of organic manures. Application of organic manures also improved the other important properties of soil viz., organic carbon, cation exchange capacity and per cent base saturation.

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