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Direct and residual effect of anthropogenic solid wastes on Growth and Yield of maize and cowpea

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Abstract
A field experiment was conducted in F block, ZARS, V.C. Farm, Mandya, Karnataka during 2014 to study the direct and residual effect of humanure, pit toilet sludge and sewage sludge application on growth and yield of maize and cowpea. In the experiment, three fecal sludges as nutrient sources along with three levels of fertilizers (75, 100 and 150 percent of recommended dose of fertilizers) were compared with FYM alone, recommended dose of fertilizer alone and recommended dose of fertilizer along with FYM were evaluated with thirteen treatments, replicated thrice in RCBD design. The results revealed that better growth and higher yield of maize and cowpea was recorded with higher the levels of manure and fertilizer application. Significantly higher plant height (203.65 cm) and number of leaves per plant (14.25) in maize were recorded with 150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P and was on par with 150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N and K (189.26cm and 13.24 respectively) and 150 % P through sewage sludge + balance N and K through fertilizers to supply 150 % N and K (183.23 cm and 12.74 respectively) at 90 DAS (days after sowing). The lower plant height (117.11 cm) and number of leaves per plant (8.19) were recorded in control. Similarly, the test weight (31.50 grams), grain yield (87.52 q ha^{-1}) and stover yield (93.93 q ha^{-1}) recorded were significantly higher in treatment which received 150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P. The increase in grain yield was to the tune of 16.99 %, 34.34% and 88.90 percent over RDF (100 % NPK + FYM), RDF alone and FYM alone treatments. The test weight (27.29 grams), grain yield (38.96 q ha^{-1}) and stover yield (42.55 q ha^{-1}) were lower in absolute control. The residual effect of anthropogenic solid wastes showed similar trend as main crop. The higher (92.51 cm and 10.28 respectively) plant height and number of branches per plant were recorded in 150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P. The lower (37.02 cm and 6.30 respectively) plant height and number of branches per plant were recorded in plots did not receive any fertilizers and manures. The yield parameters (number of pods per plant and test weight) were recorded higher (36.33 and11.92 gram) in 150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P whereas the lower (18.27 and 9.24) yield parameters (number of pods per plant and test weight) were recorded in control plot (T_{13}). The higher (1.94 and 3.2 t ha^{-1}) seed and haulm yield were recorded in150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P whereas the lower (1.0 and 1.65 t ha^{-1}) yield (seed and haulm) were recorded in plots which did not receive any fertilizers and manures (T_{13}).

Keywords: Humanure, Pit toilet sludge, Sewage sludge, growth, yield, Maize, cowpea

Introduction
The anthropogenic solid wastes generated by many countries in the world. The wastes which include food wastes, municipal wastes, sewage sludge, agricultural residues and human wastes in the form of digestive refuse material, otherwise known as faecal material and urine which pose the onerous task of their disposal. It has been estimated in India 17.9 million cubic meters of sewage and 4 million tons of sludge are produced each year with a combined nutrient contribution of 2.4 lakh tons of N, 1.3 lakh tons of P_2O_5 and 1.2 lakh tons of K_2O besides 12 lakh tons of organic carbon most of which are being wasted leading pollution of soil and water bodies. As the population density increases, this task would be more voluminous and challenging. But, due to high level of nutrients contained in these wastes, the best option would be to recycle them as an organic amendment or compost in the agricultural field. This inturn would help to reduce the gap between the nutrient demand crops and addition leading to better soil health and enhanced food production. However, the use of anthropogenic solid wastes in agriculture is not possible with the present system of sewage disposal mechanisms. The toilets and urinals in urban centers will have to be redesigned to collect the faecal matter and urine separately. In this direction an eco-friendly design of toilet called 'ECOSAN' needs to be popularized which help in the source separation of human urine and faecal matter in a hygienic way.

To exploit the huge potentiality of anthropogenic wastes as a supplement to fertilizers, research on use of anthropogenic wastes in agriculture is the need of the hour. Hence, an attempt has been made to study the direct and residual effect of humanure, pit toilet sludge and sewage sludge application on growth and yield of maize and cowpea during 2014-15 and 2015-16

Material and methods

A) Characterization of humanure, pit toilet sludge and sewage sludge.

The humanure samples were collected from ECOSAN (urine divert) toilets at community managed resource centre, near Mysore district, pit toilet sludge sample was collected from farmer's home, Devanahalli village, Chikkaballapura district and sewage sludge samples were collected from sewage plant, Jakkur, Bangalore, Karnataka. These three different kinds of samples were processed and analysed for pH, EC, total organic carbon, major, secondary, micro nutrients and heavy metals (Pb, Cd, Ni and Cr) content by adopting standard procedures**.** These manures were utilized for conducting experiment in Zonal Agricultural Research Station, V. C. Farm, Mandya near Bangalore, Karnataka.

Table 1: Initial soil properties of the experimental site

Parameters		**Content**	**Parameters**	**Content**
Physical properties			**Chemical properties**	
Particle size distribution	Sand (%)	67.10	Available phosphorus (kg ha^{-1})	40.48
	Silt (%)	17.60	Available potassium (kg ha^{-1})	212.35
	Clay (%)	15.30	Exchangeable calcium (C mol (p+) kg^{-1})	5.20
	Texture	Sandy loam	Exchangeable magnesium (C mol (p+) kg^{-1})	3.21
Bulk density (g cc^{-1})		1.42	Available sulphur (mg kg^{-1})	12.58
Particle density (g cc^{-1})		2.68	DTPA-Iron (mg kg^{-1})	16.11
Pore space (%)		47.01	DTPA-Manganese (mg kg^{-1})	12.08
Maximum water holding capacity (%)		30.87	DTPA-Copper (mg kg^{-1})	3.85
Chemical properties			DTPA-Zinc (mg kg^{-1})	2.81
pH (1:2.5)		6.80	Hot water soluble Boron (mg kg^{-1})	0.56
EC (dS m^{-1})		0.13	DTPA- Pb (mg kg^{-1})	0.83
OC (g kg^{-1})		0.60	DTPA-Cd (mg kg^{-1})	0.06
CEC (c mol (p+) kg^{-1})		13.36	DTPA-Cr (mg kg^{-1})	ND
Available nitrogen (kg ha^{-1})		341.94	DTPA-Ni (mg kg^{-1})	0.53

B) Field Experiment:

1. Main crop (direct effect)

A field experiment was conducted during late kharif-2014-15 with maize (variety: Hema) as test crop in a ZARS, V.C. Farm, Mandya near Bangalore to study the direct effect of different levels of fecal manures with graded levels of fertilizers on growth and yield of maize.

The soil of the experimental site was red sandy loam with slightly acedic to neutral pH (6.80), electric conductivity (0.13 dSm^{-1}) was within the safe limits respectively. The experiment was laid out in a Randomized Complete Block Design with thirteen treatments replicated thrice with a spacing of 60 cm x 30 cm. The treatment tried were: T_1 - 75 % K through Humanure + balance N and P through fertilizers to supply 75 % N & P, T_2 - 100 % K through Humanure + balance N and P through fertilizers to supply 100 % N & P, T_3- 150 % K through Humanure + balance N and P through fertilizers to supply 150 % N & P, T_4- 75 % P through pit toilet sludge + balance N and K through fertilizers to supply 75 % N & K, T5- 100 % P through pit toilet sludge + balance N and K through fertilizers to supply 100 % N & K, T_6- 150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N & K,T_7- 75 % P through Sewage sludge + balance N and K through fertilizers to supply 75 % N & K, T_8- 100 % P through Sewage sludge + balance N and K through fertilizers to supply 100 % N & K, T_9 - 150 % P through Sewage sludge + balance N and K through fertilizers to supply 150 % N & K, T_{10}- Recommended dose of NPK + FYM,T_{11} - Recommended dose of fertilizer alone, T_{12} - Recommended dose of FYM alone and T_{13}- Control.

The calculated quantities of three different types of manures were applied and incorporated two week before sowing of maize seeds, the full dose of phosphorous and potash fertilizers were applied at the time of transplanting where as nitrogen was applied in two split doses, half dose at the time of transplanting and another half dose at one month after sowing. During growth stages of the plant and at harvest, the growth and yield observations were recorded and were statistically analyzed.

2. Residual crop (residual effect):

After harvest of maize, each plots were prepared for conducting residual experiment by sowing of cowpea (variety: KBC-2) seeds as a test crop with a spacing of 45 cm X 10 cm during summer 2015-16 in ZARS, V.C. Farm, Mandya near Bangalore to study the residual effect of different levels of anthropogenic solid wastes with graded levels of fertilizers on growth and yield cowpea. During growth stages of the plant and at harvest, the growth and yield observations were recorded and were statistically analyzed.

Results and Discussion

A) Characterization of humanure, sewage sludge and pit toilet sludge:

Lab tests conducted so far reveal that the manure samples did not have any toxin. Among the nutrients, nitrogen was low in all three types of manures but phosphorus content (0.77 % and 1.06 %) was high in pit toilet sludge and sewage sludge where as potassium content (2.27 %) was high in humanure samples. This high potassium content in humanure may be due to the fact that in ecosan dry toilets, after each use, a handful of ash or saw dust is sprinkled on the excreta which may be responsible for higher potassium content in humanure as both ash and saw dust are rich in potassium (Sugden S, 2010). The secondary nutrients and micro nutrients were high but heavy metal contents were within the critical limits (Table

1). This may be due to the consumption of different types of food and medicine which contain small amount of heavy metals by human being and also the pressence of heavy metals in various industrial wastes which are also discharged in to sewage system in most places. The heavy metals contents were within the limits of USEPA standard 1994.

B) Field experiment to study the direct and residual effect of anthropogenic solid wastes on growth and yield of Maize and Cowpea

Growth parameters of maize and cowpea

The growth parameters like plant height and average number of leaves per plant in maize, plant height and number of branches per plant in cowpea were significantly higher at higher fertilizer and manure applied plots compared to plots receiving recommended doses of fertilizer, only fertilizer or FYM treated plots and no fertilizer treated plot (control).

Table2: Chemical properties of humanure, pit toilet sludge and sewage sludge

Parameters	Humanure	Pit toilet sludge	Sewage sludge
pH (1:5)	8.47	6.01	5.95
EC (1:100) (dS/m)	4.47	1.62	1.12
Total carbon (%)	15.66	14.62	7.13
Total N (%)	0.03	0.45	0.44
Total P (%)	0.58	0.77	1.06
Total K (%)	2.27	0.13	0.21
Total Ca (%)	3.63	3.08	0.13
Total Mg (%)	5.34	4.65	2.54
Total S (%)	1.21	1.52	1.61
Total Fe (ppm)	9243.61	9921.50	6717.00
Total Mn (ppm)	432.43	469.51	308.86
Total Zn (ppm)	476.62	457.19	400.72
Total Cu (ppm)	114.60	107.44	98.85
Total B (ppm)	309.5	263.00	218.00
Total Cd (ppm)	19.91	17.92	13.13
Total Cr (ppm)	62.64	56.38	54.25
Total Pb (ppm)	73.89	66.50	59.60
Total Ni (ppm)	82.40	74.16	53.25

The higher plant height (203.65 cm and 9.51 cm) of both maize and cowpea were recorded in 150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P (T_3) applied plots and was on par with 150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N and K (189.26cm and 91.89 cm respectively) and 150 % P through sewage sludge + balance N and K through fertilizers to supply 150 % N and K (183.23 cm and 85.56 cm respectively) at 90 DAS (days after sowing). The lower plant height (117.11 cm and 37.02 cm) of both maize and cowpea were recorded in control plots at 90 DAS. The trends were similar at 60 and 30 days after transplanting (Table 3 and 4).

The number of leaves per plant in maize and number of branches per plant in cowpea recorded higher (14.25 and 10.28 in treatment T_3 which received 150 % K through humanure + balance N and P through fertilizers to supply 150 % N and P whereas the lower values (8.19 and 6.30) of number of leaves per plant in maize and number of branches per plant in cowpea were recorded in treatment T_{13} which did not receive any fertilizers and manures. This higher plant growth was due to higher application of manures along with balanced higher (150%) application of NPK fertilizers resulted in increased availability of nutrients which enabled increased plant growth. The organic matter functioned as a source of energy for soil micro flora which brings about transformation of inorganic nutrients held in the soil to readily available forms which can be utilized by plants (Surendra *et al*., 2007 and Balyan *et al*., 2006) [6, 1] and other reasons could be stem elongation and enhanced vegetative growth. Similar types of result were reported by Morgan Peter (2002) [4] and Jogdand *et al*., (2008) [3].

Similarly, chlorophyll content of both maize and cowpea leaves recorded higher at T_3 (41.79 and 25.78) followed by T_6 (41.36 and 24.25) and T_9 (40.94 and 24.21). This may be due to higher nitrogen (150%) application to maize crop responses well along with manures application (Table 3 and 4).

Table 3: Effect of humanure, pit toilet sludge and sewage sludge on plant height, number of leaves per plant and chlorophyll content of maize

Treatments	Plant height(cm)			Number of leaves plant^{-1}			Chlorophyll content(SPAD value)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	53.51	149.81	154.31	6.96	10.09	10.79	19.40	31.52	35.68
T_2	57.65	161.42	166.26	7.49	10.87	11.63	20.49	33.30	37.34
T_3	70.62	197.72	203.65	9.18	13.31	14.24	22.93	37.26	41.79
T_4	52.49	146.97	151.38	6.82	9.89	10.59	19.18	31.17	34.95
T_5	57.62	161.34	166.18	7.49	10.86	11.62	19.84	32.24	36.16
T_6	65.62	183.75	189.26	8.53	12.37	13.24	22.69	36.88	41.36
T_7	48.74	136.47	140.56	5.81	8.42	9.01	18.35	29.82	33.44
T_8	57.17	160.09	164.89	6.84	9.92	10.62	18.81	30.56	34.28
T_9	63.53	177.89	183.23	8.21	11.91	12.74	22.28	36.21	40.94
T_{10}	59.74	167.27	172.28	7.79	11.30	12.09	20.68	33.61	37.69
T_{11}	55.50	155.39	160.05	7.12	10.33	11.05	19.71	32.04	35.93
T_{12}	42.70	119.56	123.14	6.22	9.01	9.64	17.70	28.76	33.26
T_{13}	40.61	113.70	117.11	5.28	7.65	8.19	16.58	26.94	29.19
S. Em ±	3.84	10.76	11.08	0.46	0.66	0.71	0.46	0.96	1.17
C. D. at 5 %	11.52	32.26	33.23	1.37	1.99	2.13	1.37	2.86	3.50

Treatments details: T_1: 75 % K through Humanure + balance N and P through fertilizers to supply 75 % N & P, T_2:100 % K through Humanure

+ balance N and P through fertilizers to supply 100 % N & P, T_3:150 % K through Humanure + balance N and P through fertilizers to supply 150 % N & P, T_4:75 % P through pit toilet sludge + balance N and K through fertilizers to supply 75 % N & K, T_5:100 % P through pit toilet sludge + balance N and K through fertilizers to supply 100 % N & K, T_6:150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N & K, T_7:75 % P through Sewage sludge + balance N and K through fertilizers to supply 75 % N & K, T_8:100 % P through Sewage sludge + balance N and K through fertilizers to supply 100 % N & K, T_9:150 % P through Sewage sludge + balance N and K through fertilizers to supply 150 % N & K, T_{10}:Recommended dose of NPK + FYM, T_{11}:Recommended dose of fertilizer alone, T_{12}:Recommended dose of FYM alone and T_{13}:Control.

Table 4: Residual effect of humanure, pit toilet sludge and sewage sludge on plant height, number of branches per plant and chlorophyll content of cowpea

Treatments	Plant height(cm)			Number of branches plant^{-1}			Chlorophyll content (SPAD value)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	19.44	40.35	68.60	3.64	7.57	7.72	16.99	22.91	19.75
T_2	24.21	48.41	79.24	3.93	8.44	8.61	17.95	25.51	22.00
T_3	29.66	56.52	92.51	4.81	10.08	10.28	20.09	29.90	25.78
T_4	19.15	39.26	64.26	3.57	7.47	7.61	16.80	22.75	19.62
T_5	24.20	45.72	74.83	3.92	8.41	8.58	17.38	24.51	21.14
T_6	27.56	56.14	91.89	4.47	9.99	10.19	19.88	28.12	24.25
T_7	19.14	36.45	59.67	3.32	6.80	6.93	16.08	22.17	19.12
T_8	24.01	42.76	69.99	3.89	8.01	8.17	16.48	24.19	20.86
T_9	26.68	52.27	85.56	4.33	9.62	9.81	19.52	28.07	24.21
T_{10}	26.09	52.15	85.36	4.07	9.12	9.31	18.12	26.10	22.51
T_{11}	23.31	41.51	67.94	3.78	8.34	8.51	17.27	23.82	20.54
T_{12}	17.93	31.94	52.27	2.91	7.28	7.42	15.51	21.39	18.44
T_{13}	13.99	23.00	37.02	2.77	6.18	6.30	14.52	18.20	15.70
S. Em±	1.45	2.23	1.50	0.26	0.46	0.47	0.79	0.65	0.56
C. D. at 5 %	4.34	6.67	4.49	0.78	1.39	1.42	2.37	1.96	1.69

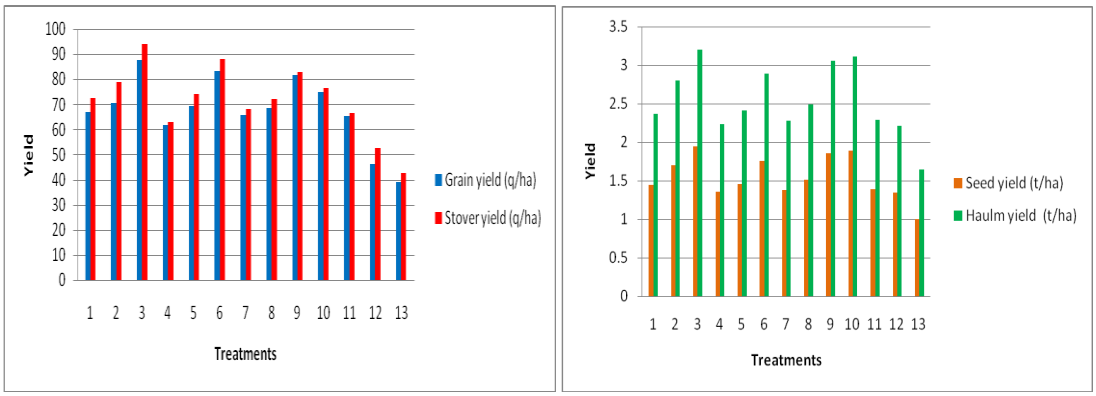
Treatments details: T_1: 75 % K through Humanure + balance N and P through fertilizers to supply 75 % N & P, T_2:100 % K through Humanure + balance N and P through fertilizers to supply 100 % N & P, T_3:150 % K through Humanure + balance N and P through fertilizers to supply 150 % N & P, T_4:75 % P through pit toilet sludge + balance N and K through fertilizers to supply 75 % N & K, T_5:100 % P through pit toilet sludge + balance N and K through fertilizers to supply 100 % N & K, T_6:150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N & K, T_7:75 % P through Sewage sludge + balance N and K through fertilizers to supply 75 % N & K, T_8:100 % P through Sewage sludge + balance N and K through fertilizers to supply 100 % N & K, T_9:150 % P through Sewage sludge + balance N and K through fertilizers to supply 150 % N & K, T_{10}:Recommended dose of NPK + FYM, T_{11}:Recommended dose of fertilizer alone, T_{12}:Recommended dose of FYM alone and T_{13}:Control.

Yield parameters and yield of maize and cowpea

Yield attributes of both maize and cowpea also recorded higher at higher application of manures and fertilizers applied plots than the only fertilizer and only manure applied plots (Table 5 and 6).

In maize, significantly higher yield parameters like No of cobs per plant, Cob length (cm), No of rows per cob, No. of grains per cob, Cob weight per plant (g), Test weight (g), grain yield (q ha^{-1}) and stover yield (q ha^{-1}) were recorded in treatment T_3 (1.20,18.47cm, 16.42, 468.91, 221.07 g, 31.50 g, 87.52 q ha^{-1}, 93.93 q ha^{-1}) followed by T_6 and T_9 which were on par with T_{10} (1.20, 17.02 cm,15.29, 436.82, 173.33 g, 30.60 g, 74.81 q ha^{-1}, 76.66 q ha^{-1}). The increase in grain yield was to the tune of 16.99 %, 34.34% and 88.90 percent over RDF (100 % NPK + FYM), RDF alone and FYM alone treatments. The test weight (27.29 grams), grain yield (38.96 q ha^{-1}) and stover yield (42.55 q ha^{-1}) were lower in absolute control (Table-5). The trend is similar in case of cowpea yield attributes due to the residual effect of nutrients present in anthropogenic solid wastes which was applied during main crop cultivation. The higher (36.33, 11.92 gram, 1.94 t ha^{-1} and 3.20 t ha^{-1}) number of pods per plant, test weight, seed yield and haulm yield were recorded in 150 % K through Humanure + balance N and P through fertilizers to supply 150 % N & P whereas lower (18.27, 9.24 gram, 1.00 t ha^{-1} and 1.65 t ha^{-1}) values were recorded in control plot (Table 6).

This increase in yield in humanure, pit toilet sludge, and sewage sludge treated plots may be due to higher level of manures and fertilizer application (150%) may be attributed to the release of nutrients in available forms from manures and FYM during its decomposition and the absorption of the same by the crops and also due to its nutrient and moisture retention functions. These results corroborate with the observations made by Jagadeeshwari and Kumaraswami (2000) [2]. It reflects better source sink relationship, translocation of metabolites to reproductive organs leading to improved grain yield. These findings are in line with Sahoo *et al.* (2001) [s]. The increased biomass yield was observed in treatments which received 150% manures along with balanced fertilizer applied plots than the imbalanced fertilizer and manure applied plots was due to increased nutrient availability through manures application and more microbial activity and also influenced the biomass production by growth promoting substance like IAA present in anthropogenic liquid waste.



a) Maize (main crop) b) cowpea (Residual crop)

Fig 1. Direct and residual effect of anthropogenic solid wastes (humanure, pit toilet sludge and sewage sludge) on growth and yield of maize and cowpea

Table 5: Effect of humanure, pit toilet sludge and sewage sludge on yield parameters and yield of Maize

Treatments	No of cobs per plant	Cob length (cm)	No of rows per cob	No. of grains cob^{-1}	Cob weight per plant (g)	Test weight (g)	Yield (q ha^{-1})	
							Grain	Stover
T_1	1.13	16.75	13.90	397.03	153.13	29.53	67.00	72.48
T_2	1.13	16.95	15.00	428.45	168.93	30.13	70.37	78.86
T_3	1.20	18.47	16.42	468.91	221.07	31.50	87.52	93.93
T_4	1.00	16.55	13.71	391.60	133.60	28.52	61.81	69.77
T_5	1.13	16.92	14.78	422.26	165.33	30.11	69.48	74.16
T_6	1.20	18.40	16.19	462.53	214.07	31.40	83.19	88.24
T_7	1.00	16.27	13.80	394.17	126.53	28.47	65.74	68.00
T_8	1.07	16.77	14.50	414.16	165.73	29.85	68.52	72.13
T_9	1.13	17.92	15.99	456.82	181.20	30.67	81.67	82.78
T_{10}	1.20	17.02	15.29	436.82	173.33	30.60	74.81	76.66
T_{11}	1.27	14.85	12.44	355.32	161.33	29.95	65.15	66.68
T_{12}	1.00	14.04	11.09	316.67	123.95	27.34	46.33	52.66
T_{13}	1.00	12.30	8.80	251.35	96.67	27.29	38.96	42.55
S. Em ±	NS	0.27	0.09	2.69	26.45	1.17	1.92	1.84
C. D. at 5 %		0.82	0.28	8.06	79.30	3.50	5.77	5.51

Treatments details: T_1: 75 % K through Humanure + balance N and P through fertilizers to supply 75 % N & P, T_2:100 % K through Humanure + balance N and P through fertilizers to supply 100 % N & P, T_3:150 % K through Humanure + balance N and P through fertilizers to supply 150 % N & P, T_4:75 % P through pit toilet sludge + balance N and K through fertilizers to supply 75 % N & K, T_5:100 % P through pit toilet sludge + balance N and K through fertilizers to supply 100 % N & K, T_6:150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N & K, T_7:75 % P through Sewage sludge + balance N and K through fertilizers to supply 75 % N & K, T_8:100 % P through Sewage sludge + balance N and K through fertilizers to supply 100 % N & K, T_9:150 % P through Sewage sludge + balance N and K through fertilizers to supply 150 % N & K, T_{10}:Recommended dose of NPK + FYM, T_{11}:Recommended dose of fertilizer alone, T_{12}:Recommended dose of FYM alone and T_{13}:Control.

Table 6: Residual effect of humanure, pit toilet sludge and sewage sludge on yield parameters and yield of cowpea

Treatments	No of pods per plant	Test wt (g)	Seed yield (t ha^{-1})	Haulm yield (t ha^{-1})
T_1	24.08	10.74	1.44	2.37
T_2	29.46	11.04	1.70	2.80
T_3	36.33	11.92	1.94	3.20
T_4	23.62	10.50	1.35	2.23
T_5	29.00	11.01	1.46	2.41
T_6	35.01	11.80	1.90	3.16
T_7	23.36	10.47	1.38	2.28
T_8	28.12	11.08	1.51	2.49
T_9	34.80	11.79	1.89	3.13
T_{10}	31.46	11.06	1.85	3.06
T_{11}	24.97	10.49	1.39	2.29
T_{12}	19.21	10.45	1.34	2.21
T_{13}	18.27	9.24	1.00	1.65
S. Em ±	1.32	0.22	0.05	0.08
C. D. at 5 %	3.94	0.66	0.15	0.24

Treatments details: T_1: 75 % K through Humanure + balance N and P through fertilizers to supply 75 % N & P, T_2:100 % K through Humanure + balance N and P through fertilizers to supply 100 % N & P, T_3:150 % K through Humanure + balance N and P through fertilizers to supply 150 % N & P, T_4:75 % P through pit toilet sludge + balance N and K through fertilizers to supply 75 % N & K, T_5:100 % P through pit toilet sludge + balance N and K through fertilizers to supply 100 % N & K, T_6:150 % P through pit toilet sludge + balance N and K through fertilizers to supply 150 % N & K, T_7:75 % P through Sewage sludge + balance N and K through fertilizers to supply 75 % N & K, T_8:100 % P through Sewage sludge + balance N and K through fertilizers to supply 100 % N & K, T_9:150 % P through Sewage sludge + balance N and K through fertilizers to supply 150 % N & K, T_{10}:Recommended dose of NPK + FYM, T_{11}:Recommended dose of fertilizer alone, T_{12}:Recommended dose of FYM alone and T_{13}:Control.

Plate 1 a): Comparision of higher doses of fertilizers with RDF

Plate 1 b): Comparision of RDF and Control

Plate 2: Comparision of anthropogenic solid applied plot and absolute control

Conclusion

From the above data, it can be inferred that three different sources of anthropogenic wastes like humanure, pit toilet sludge and sewage sludge are wholesome nutrient sources. These wastes should be recycled and used as an organic amendment in the agricultural field to crop production. It also helps to rejuvenate soil fertility, enhance the yield of crops help to save money on fertilizers and helps in solving the problems of unscientific sanitation leading to environmental pollution.

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