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Effect of municipal solid waste on soil properties in Visakhapatnam city

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Abstract
The survey was conducted during the year 2021-2022 at the Regional Agricultural Research Station, Anakapalle, Andhra Pradesh to study the "effect of municipal solid waste on soil properties in Visakhapatnam city". In recent times most of the farmers in developing country like India, were planning to the use of municipal solid waste as compost to repair the deteriorated soils while some are cultivating on the abandoned landfill sites due to the richness of nutrients in dumpsite soils. This study on the impact of municipal solid wastes on chemical properties of dumpsite soils was useful to asses the nutrient status of the soils near landfill sites of Visakhapatnam city. Soil samples were collected from seven dump yards at a distance of 10, 50 and 100 m from each landfill site at surface (0-30 cm) and sub surface (30- 60 cm) were analyzed for available nitrogen, available phosphorus , available phosphorous. This study has shown that impact of municipal wastes on chemical properties of soil by improving nutrient contents such as available N, available P_2O_5, available K_2O thus increasing fertility and productivity status of the soil for maximum plant growth.

Keywords: Municipal solid waste, landfill site, dumpsite, soil properties

Introduction

Municipal Solid Waste (MSW) is defined as household waste and other waste which because of its nature or composition is similar to household waste which undergoes anaerobic or aerobic decomposition, including green MSW from gardens and parks such as tree cuttings, branches, grass and wood (European Commission, 2001) [4].

Environmental contaminations by solid wastes have been a serious issue in most countries of the world owing to the waste disposal method and management. Solid wastes are being generated on daily basis due to rapid growth and continuous increase in human population, urbanization and industrial development (Karak *et al*., 2012, Akintola, 2014, Essienubong *et al*., 2019; Mouhoun-Chouaki *et al*., 2019) [7, 1, 3, 10].

Toxic substances may be released from the decomposition of the deposited wastes and this may worsen and weaken the environment (Kebede *et al*., 2016) [8]. The negative influences of improper management of solid wastes on the ecosystem have been at alarming rate in developing countries such as India.

Recent use of solid wastes as compost to replenish the deteriorated soils and growing of crops on the abandoned waste dumpsite due to their richness in organic matter by farmers is of great concern. Leachates, the liquid substances emanating from the wastes during decomposition in the dumpsite contain considerable quantity of elements, compounds and organic substances these can increase over time and may be more than the required amounts needed for environmental sustainability (Suilaman *et al*., 2016; Akintola, 2014, Essienubong *et al*., 2019) [14, 1, 3]. These leachates may enter into the soil through surface run off, leaching, percolation or infiltration and become dangerous to soils, plants, surface and groundwater over time. This may also have significant effects on the physical and chemical properties of the soil by increasing the soil moisture content, organic matter content and alkalinity nature of the soil through decomposition of organic wastes by the action of soil microorganism and climate (Kebede *et al*., 2018) [9].

Visakhapatnam is the second biggest city in Andhra Pradesh. Once a small fishing village has evolved into major Port City in South India over the decades and considered as the fastest growing city in India. The city is the biggest economic hub with both public and private sector undertaking like Visakhapatnam Steel Plant, Visakhapatnam Port, National Thermal Power Corporation, Hindustan Petroleum Corporation, Hindustan Zinc, Hindustan Shipyard, Bharat heavy Plates and Vessels and many more private companies are located in and around the city generating huge amounts of waste. As per recent estimates of Greater Visakha Municipal Corporation, around 900 metric tonnes of solid wastes are being generating daily (GVMC, 2021) in Visakhapatnam city. In Visakhapatnam, solid waste is being disposed at different land fill sites and very small quantities of wastes are recycled as composts and remaining waste is dumped in land fill sites.

Therefore, the present investigation was undertaken to evaluate the effect of municipal solid waste on soil properties.

Material and Methods

The present study area was located in Visakhapatnam district, Andhra Pradesh, bounded by the Kailasa hill in Northern side, Yarada hill in Southern side, Narava hills in Western side and Bay of Bengal in Eastern side. The study area occupies 545 km2 lies in between 17o 41' 12.5340" Northern latitude and 83o 13' 6.5388" Eastern longitude. The city has witnessed rapid industrialization and has been identified as one of the fastest growing cities in the World, economically and demographically. Soil samples were collected near each landfill sites such as Cheemalapalli, Arilova, Gajuwaka, Seethammadhara, Kapuluppada,

Bheemili and Anakapalle at a distance of 10, 50 and 100 m from each landfill site at surface (0-30 cm) and sub surface (30-60 cm). The sampling sites were geo-referred using Global Positioning System (GPS). The soil samples collected in cloth bags were dried under shade, pounded using a wooden pestle and mortar and passed through a 2 mm sieve. Soil samples were analyzed for various chemical properties like available nitrogen, available phosphorus, available potassium.

Results and Discussion

Available nitrogen

The data pertaining to the mean and range of Available nitrogen in soil samples collected near different landfill sites in and around Visakhapatnam city are presented in table 1.

The highest values of Available nitrogen in soil samples was observed at Kapuluppada landfill site ranged from 225-265 kg ha^{-1} with mean value of 248 kg ha^{-1} followed by Arilova landfill site ranged from 224-271 kg ha^{-1} with mean value of 247.3 kg ha^{-1} and Bheemili landfill site ranged from 228-267 kg ha^{-1} with mean value of 246.8 kg ha^{-1} .

The lowest mean values of Available nitrogen in soil samples was observed at Gajuwaka landfill site ranged from 189-238 kg ha^{-1} with mean value of 216.1 kg ha^{-1}. Results shown that all the soil samples collected near the landfill sites of Visakhapatnam district are low in nitrogen content as per the rating chart given by Muhr *et al*., (1965) [11].

Surface soils had higher available nitrogen than sub surface and also observed with increasing distance from landfill site available nitrogen was decreased. Higher nitrogen content at the dumping site might be due to higher organic matter content of the soil contributing to higher available nitrogen in the soil. Organic matter has always been considered as a good source of nitrogen in soil; the mineralization of organic matter releases significant amounts of nitrogen to the liable pool.

These results are in conformity with the findings of Ouled *et al.* (2014) [12]. Higher nitrogen at the dumpsite profile sample and on the surface layers of all the profile samples might be due to increased organic matter content which caused greater microbial proliferation leading to conversion of organically bound nitrogen to inorganic form.

Available phosphorus

The data pertaining to the mean and range of Available P_2O_5 in soil samples collected near different landfill sites in and around Visakhapatnam city are presented in table 1.

The highest values of available P_2O_5 in soil samples was observed at Arilova landfill site ranged from 59.4-76.4 with mean value of 66.5 kg ha^{-1} followed by Cheemalapalli landfill site ranged from 39.5-82.4 kg ha^{-1} with mean value of 62.4 kg ha^{-1} and .Anakapalle landfill site ranged from 45.6-70.2 kg ha^{-1} with mean value of 56.1 kg ha^{-1} .

The lowest values of Available P_2O_5 soil samples was observed at Kapuluppada landfill site ranged from 36.7-58.6 with mean value of 46.73 kg ha^{-1}.

Results shown that all the soil samples collected near different landfill sites contains high available P_2O_5 as per the rating chart given by Muhr *et al.* (1965) [11]. Surface soils had higher available P_2O_5 than sub surface soils and also observed with increasing distance from landfill site available available P_2O_5 was decreased.

Higher available phosphorous content at the dumpsite soil could be attributed to the presence of high amount of organic matter and its decomposition. These results are similar to the findings of Ideriah *et al.*, 2006 [5]. The dumpsite soils had higher levels of available phosphorous as compared to the non-dumpsite mainly due to variation in the availability of organic matter content. It is also noticed that the appreciable build up in available phosphorous at the dumping site as compared to non-dumpsite which were mainly due to the influence of organic matter at the dumping site increasing the labile phosphorous in soil from complexing cations like Ca2+ and Mg2+ which are mainly responsible for fixation of phosphorous.

Borkar *et al*. (1991) [2] also reported that the increase in available phosphorous content in the dumpsite soils as compared to non-dumpsite soils might be due to the organic acids released during decomposition of municipal solid waste which formed stable complexes or chelates with cations responsible for phosphorous fixation and in turn could have increased its availability.

Available potassium

The data pertaining to the mean and range of Available K_2O in soil samples collected near different landfill sites in and around Visakhapatnam city are presented in table 1.

The highest values of Available K_2O in soil samples was observed at Cheemalapalli landfill site ranged from 239-312 kg ha^{-1} with 267.8 kg ha^{-1} followed by Arilova landfill site ranged from 234-280 kg ha^{-1} with mean value of 263.5 kg ha^{-1}, Kapuluppada landfill site ranged from 215-312 kg ha^{-1} with mean value of 262.3 kg ha^{-1}.

The lowest values of Available K_2O soil samples was observed at Gajuwaka landfill site ranged from 215-264 kg ha^{-1} with mean value of 246.3 kg ha^{-1}.

Results shown that the all the soil samples collected from landfill sites of Visakhapatnam city contains medium Available K_2O as per the rating chart given by Muhr *et al.*, 1965 [11]. Surface soils had higher available K_2O than sub surface soils and also observed with increasing distance from landfill site available K_2O was decreased. There is no limiting value for potassium in soil as it is a nutrient for the plants and has no adverse effects on soil properties. But the potassium from the anthropogenic sources can contaminate the ground water (Izhar *et al*. 2014) [6].

Potassium is leached by weathering, although it is soluble in water, little is lost from undisturbed soils because it is released from dead plants and animal excretions, it quickly and strongly bounds to clay particles and it is retained ready to be re- adsorbed by the roots of other plants as reported by Schultz *et al.* (2006) [13].

An increase in available potassium at the dumpsite soil compared to non-dumpsite soil was due to increased Cation Exchange Capacity at the dumpsite soil as a result of higher organic matter which in turn increased the proportion of soil potassium present as exchangeable potassium. These results are similar to the findings of Ouled *et al.* 2014 [12] who noticed that the higher concentration of potassium was recorded in dumpsite soils as compared to non-dumpsite soils and the main source of K+in soil is weathering of potash silicate minerals, potash fertilizers and clay minerals. Low value in the non-dumpsite soil samples may be due to the resistant of potassium minerals to decomposition by weathering process.

Table 1: Impact of waste disposal on Available macro nutrient status (kg ha^{-1}) of soils in and around different landfill sites

Name of the Site	Distance from Landfill site (m)	Profile Depth (cm)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Cheemalapalli	10	0-30	263	76.5	286
		30-60	205	59.4	254
	50	0-30	256	82.4	312
		30-60	210	43.7	246
	100	0-30	255	73.4	270
		30-60	215	39.5	239
		Range	205-263	39.5-82.4	239-312
		Mean	234	62.4	267.8
Arilova	10	0-30	271	76.4	276
		30-60	224	61.5	252
	50	0-30	264	70.8	280
		30-60	230	59.4	260
	100	0-30	270	69.4	279
		30-60	225	61.5	234
		Range	224-271	59.4-76.4	234-280
		Mean	247.3	66.5	263.5
Gajuwaka	10	0-30	238	69.8	264
		30-60	215	51.2	252
	50	0-30	249	72.6	276
		30-60	205	46.7	225
	100	0-30	214	55.8	246
		30-60	189	37.6	215
		Range	189-249	37.6-72.6	215-264
		Mean	218.3	55.6	246.3
Seethammadhara	10	0-30	278	62.4	273
		30-60	220	38.7	266
	50	0-30	263	59.7	259
		30-60	189	46.8	238
	100	0-30	246	69.7	266
		30-60	189	49.8	238
		Range	189-278	38.7-69.7	238-273
		Mean	230.8	54.5	256.6
Kapuluppada	10	0-30	258	48.6	266
		30-60	243	40.4	312
	50	0-30	260	58.6	215
		30-60	225	36.7	284
	100	0-30	265	53.4	264
		30-60	237	42.7	233
		Range	225-265	36.7-58.6	215-312
		Mean	248	46.73	262.3
Bheemili	10	0-30	267	59.7	267
		30-60	228	46.4	249
	50	0-30	256	58.5	285
		30-60	243	45.6	265
	100	0-30	258	57.6	280
		30-60	229	44.3	224
		Range	228-267	44.3-59.7	224-285
		Mean	246.8	52	261.6
Anakapalle		0-30	264	64.8	298
		0-30	259	45.6	225
		30-60	212	49.8	245
		Range	189-264	45.6-70.2	225-298
		Mean	234.3	56.1	254.8

Conclusion

Results shown that all the soil samples collected near different landfill sites of Visakhapatnam city are low in available nitrogen content, high in available P_2O_5, medium available K_2O as per the rating chart given by Muhr *et al*., (1965) [11]. Surface soils had higher available nitrogen, P_2O_5 than sub surface and also observed with increasing distance from landfill site available nitrogen was decreased.

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