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Residual effect of distillery effluent on morphological and physical properties of inceptisol soil solum

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Abstract
An investigation was conducted on farmers field with an objective to study the "Residual effect of distillery effluent spent wash on properties of soil solum" in the jurisdiction of Padmashri Vitthalrao Vikhe Patil Sahakari Sakhar Karkhana, Pravaranagar, Taluka-Rahata, Dist- Ahmednagar during 2007-08. Ten farmers from factory area of Pravaranagar and Gogalgaon village were selected, where spent wash was applied @ 70-75 m^3 ha^{-1} before kharif season. Soil profiles were dug in the treated farms at harvest of the crop to study the effect of post biomethanated spent wash application on soil profile characteristics. The untreated fields were selected, adjacent to treated fields, where no spent wash was applied and were treated as control check to assess the effect of spent wash treated profiles in comparison to untreated soil profiles. The effect of spent wash application was assessed for pearl millet which was grown as test crop.
The result revealed that post biomethanated spent wash was neutral in reaction with high concentration of soluble salt. The application of post bio-methanated spent wash showed improvement in bulk density and hydraulic conductivity and water retention, while no residual effect on soil texture was observed. Slightly build-up salinity with distillery effluent application. The application of distillery effluent showed significant improvement in physical properties of soil. The Mean Weight Diameter (MWD), saturated hydraulic conductivity, water retention of field capacity and available water content were significantly higher, while bulk density (BD) and penetration resistance of the surface soil were significantly lower (Hati, 2003).

Keywords: Residual effect, morphological, physical properties

Introduction
With the development of agriculture, agro-based industries have contributed enormously to boost economy of the nation. Distilleries are one of the most important agro-based industries in India produced ethyl alcohol. They generate large volume of foul smelling red coloured waste water known as spent wash. The post biomethanated spent wash that comes out after bio-methanation is neutral in pH (7.6), contains high organic loads (43 dSm^{-1}). Since the colour of effluent is dark brown, it induces immediate reaction of fear amongst the farmers. However, the colour has nothing to do with the toxicity as it is primarily the colour of the sugar produced due to burning of starch during sugar manufacturing process.
If post biomethanated spent wash used for irrigating follow land or for pre sowing irrigation, a good amount of organic carbon and nutrients would be added to the soil for increasing fertility and at the same time, the effluent would be disposed off safely to enrich the soil health.

Results and Discussion
Morphological Properties
To study the residual effect of post bio-mthanated spent wash on soil solum, five pedons (P. No. 12, 14, 16, 18 and 20) were opened in treated field and five pedons (P. No. 11, 13, 15, 17 and 19) were opened in untreated field (control pedons). The layer wise soil samples were collected and analyzed for its morphological properties are presented in Table 12.
From the data, it was observed that the soil pedon (No. 11 to 16) recorded 0-15, 15-30, 30-45 and 45-60 cm depth with the notation of Ap, Bw1, Bw2, Bw3 horizon however pedons (No. 17 to 20) recorded 0-15, 15-30, 30-45 cm with notation of Ap, AB and Bw1 horizon indicating that the soil horizons are well developed. Similar results were also noted by Basava Raju *et al*. (2005) [2].
The data presented in Table 12 revealed that the boundary width of soil pedons opened in field (P. No. 11 to 20) varies with soil depth from 0-15, 15-30, 30-45 and 45-60 cm was changed from clear smooth (0 to 15, 15 to 30 cm) to gradual wavy (30-45 cm) and finally gradual irregular (45 to 60 cm).

The change in boundary width at Ap and Bw1 horizon recorded clear and smooth, however at Bw2 horizon (P. No. 11 to 16) recorded gradual wavy and at Bw3 recorded gradual and irregular.

From the observations noted it was seen that there was no residual effect of post biomethanatedspent wash on boundary width of treated fields. The post biomethanated spent wash does not have any effect on weathering of parent material, indicates no change in boundry width

The colour of soil in moist condition was varying with depth in all pedons opened in treated as well untreated area except pedon No. 15 and 16. The colour was found to be changed from 10YR3/2 to 10YR3/3 in respect of pedons No. 15 and 16. The results indicate that the application of post biomethanatedspent wash resulted to change in soil colour from 10YR3/2 to 10YR3/1 i.e. very dark grayish brown to very dark gray in dry condition only might be due to the colour of post biomethanated spent wash and presence of organic load do not have any effect on soil colour at all soil depth in moist condition. Similar results were observed by Pilai *et al.* (1996) in soils of Deccan plateau of Nagpur district of Maharashtra.

Soil structure of treated field pedons (P. No. 12, 14, 16, 18 and 20) at Ap horizon was medium sub angular blocky with grade 3 and untreated field pedons (P. No. 11, 13, 15, 17 and 19) shows sub-angular blocky with grade 3. At Bw1 and Bw2 horizon (P. No. 12, 14, 16, 18 and 20) recorded medium sub angular blocky with grade 2 indicate no change in structure and texture.

The horizon Ap recorded wet and sticky appearance and horizon Bw1 recorded wet and slightly sticky and horizon Bw2 and Bw3 recorded non-sticky appearance. The change in consistency from wet non-plastic to wet slightly plastic at Ap horizons in all the pedons indicate that the post biomethanated spent wash have affected the plastic soil consistency only. This might be due to wax (0.21 %) which was left in the post biomethanated spent wash during the process of sugar production in the factory. Similar results have been recorded by Singh, I. S. (2005).

The data presented in Table 12 revealed that at horizon Ap and Bw1 (P. No. 11 to 16) recorded moderate effervescence horizon Bw2 recorded strong and horizon Bw3 recorded very strong effervescence. At Ap horizon of pedon No. 17 to 20 recorded moderate effervescence, Bw1 recorded strong effervescence and Bw2 recorded very strong effervescence.

The soil pedons opened in treated and untreated fialds showed typic contact.

Physical Properties

Five soil pedons were opened in untreated field (control pedons) and five in treated field. The layer wise soil samples were collected and analysed for physical properties. The data in respect of physical properties was presented in Table the results obtained it can conclude that application of post biomethanatedspent wash decrease bulk density of soil might be due to addition of organic matter through post biomethanatedspent wash. A decrease in bulk density at 15-30cm layer of treated soil was observed which indicate seepage of post biomethanated spent wash in lower layer of Inceptisol, which is result in organic manure addition leading to decrease.Similar results have been recorded by Bouwer and Chenoy (1994).

The particle size analysis data indicate that the soil observed at 0-15, 15-30, 30-45 cm was sandy clay loam and at 45-60 cm in recorded sandy loam. Similar results have been recorded by Devarajan *et al*. (1996) [5].

It was concluded that the mean values of water retention at field capacity moisture (33 kpa) and at permanent wilting point (1500 kpa) in treated field at 0-15 and 15-30, 30-45 and 45 to 60 cm in treated 28.14 and 15.81, 30.24 and 16.87, 29.21 and 16.14, 25.04 and 14.84 and in untreated field it was 28.57 and 15.83, 30.17 and 16.28, 28.23 and 15.15, 28.66 and 15.37 respectively indicate that there was no residual effect of post biomethanatedspent wash. An increase in water retension capacity in treated soil at 0to 15 cm at 33 and 1500 kpa may be due to an increase in pore space and micro capillaries due to addition of organic load. Similar results have been recorded by Bouwer and Chenoy (1994).

It was noted that hydraulic conductivity of soil was improved at 0-15 cm layer while no effect on sub-surface layer, in indicate that there was no seepage of post biomethanated spent wash at lower depth. Increase in hydraulic conductivity might be due to addition of organic matter leads to increase in pore space.

Summary and Conclusions

The minimum soil depth of Inceptisol was recorded to 50 cm and 100 cm respectively. Inceptisol soil depth of 0-15, 15-30, 30-45 and 45-60 cm with notation Ap, Bw1, Bw2 and Bw3.

The boundary width of Inceptisol, it varied with increase in soil depth from clear smooth to gradual wavy and finally gradual irregular. The colour of soil in dry condition was varying with depth from 10YR 3/1 to 10YR 3/4. In moist condition it varied from 10YR 3/2 to 10YR 3/4 in Entisol and Inceptisol respectivel. The soil texture of all horizon in Inceptisol was observed to be sandy clay loam. While, the soil structure was observed to be medium sub-angular blocky with varying grade. The application of post biomethanated spent wash caused change in plasticity only and there was no change in dry, moist and sticky consistency. The strong effervescence was observed might be due to calcite horizon in control as well as in treated field. The application of post biomethanated spent wash did not show any effect on effervescence. The soil showed typic contact in all soil pedons.

The bulk density of Entisol and Inceptisol varied from 1.36 to 1.35 mgm^{-3} and from 1.35 to 1.32 mgm^{-3} at 0-15 cm, but did not show any change in sub-surface horizon. The application of post biomethanated spent wash resulted decrease in bulk density in surface layer. The bulk density increased with depth indicating compactness in sub-surface.

The per cent sand, silt and clay fractions were ranged from 37.5-57.65, 28.29-35.21 and 16.7-29.53 respectively. Therefore, the particle size analysis data indicate that the soil was of sandy clay loam. The application of post biomethanated spent wash did not show any effect on particle size distribution.

In Inceptisol, the application of post biomethanated spent wash resulted slightly increase in water retention in surface layer at both 33 kpa and 1500 kpa but does not show any effect of sub-surface layer. In Entisol and Inceptisol, hydraulic conductivity increased according to depth. The application of post biomethanated spent wash results slightly increase in hydraulic at surface level but does not show any effect on sub-surface layer of soil.

Table 1: Effect of post biomethanated spent wash on Morphological properties in Inceptisol.

Treat.	Harizon	Depth in cm	BW	Soil colour		Text.	Structure	Consistency				Efferve	Contact
				Dry	Moist			Dry	Moist	Sticky	Plasticity		
Pedon 11 and 12													
Control	AP	0-15	cs	10YR3/3	10YR 3/2	scl	m3sbk	ds	mfr	ws	wpo	em	
	BW1	15-30	cs	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfi	wss	wps	em	
	BW2	30-45	gw	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfr	wso	wps	es	
	BW3	45-65	gi	10YR3/1	10YR 3/2	scl	m1sbk	dh	mfr	wso	wpo	ev	Typic
Treated	AP	0-15	cs	10YR3/2	10YR 3/2	scl	m3sbk	ds	mfr	ws	wps	em	
	BW1	15-30	cs	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfi	wss	wps	em	
	BW2	30-45	gw	10YR3/1	10YR 3/2	scl	m1sbk	dsh	mfr	wso	wps	es	
	BW3	45-60	gi	10YR3/1	10YR 3/2	sl	m1sbk	dh	mfr	wso	wpo	ev	Typic
Pedon 13 and 14													
Control	AP	0-15	cs	10YR3/3	10YR 3/2	scl	m3sbk	ds	mfr	ws	wpo	em	
	BW1	15-30	cs	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfi	wss	wps	em	
	BW2	30-45	gw	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfr	wso	wps	es	
	BW3	45-60	gi	10YR3/1	10YR 3/1	scl	m1sbk	dh	mfr	wso	wpo	ev	Typic
Treated	AP	0-15	cs	10YR3/2	10YR 3/2	scl	m3sbk	ds	mfr	ws	wps	em	
	BW1	15-30	cs	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfi	wss	wps	em	
	BW2	30-45	gw	10YR3/1	10YR 3/2	scl	m2sbk	dsh	mfr	wso	wps	es	
	BW3	45-60	gi	10YR3/1	10YR 3/1	scl	m1sbk	dh	mfr	wso	wpo	ev	Typic
Pedon 15 and 16													
Control	AP	0-15	cs	10YR3/2	10YR 3/2	scl	m3sbk	ds	mfr	ws	wp	em	
	BW1	15-30	cs	10YR3/2	10 YR 3/2	scl	m2sbk	dl	mfi	wss	wps	em	
	BW2	30-45	gw	10YR3/3	10YR 3/2	scl	m2sbk	dsh	mfr	wso	wpo	es	
	BW3	45-60	gw	10YR3/4	10YR 3/2	sl	m1sbk	dh	mfr	wso	wpo	ev	Typic
Treated	AP	0-15	cs	10YR3/1	10YR 3/2	scl	m3sbk	ds	mfr	ws	wp	em	
	BW1	15-30	cs	10YR3/2	10YR 3/2	scl	m2sbk	dl	mfi	wss	wps	em	
	BW2	30-45	gw	10YR3/3	10YR 3/2	scl	m2sbk	dsh	mfr	wso	wpo	es	
	BW3	45-60	gw	10YR3/4	10YR 3/2	sl	m1sbk	dh	mfr	wso	wpo	ev	Typic
Pedon 17 and 18													
Control	AP	0-15	cs	10YR 3/2	10YR 3/2	scl	m3sbk	ds	mfr	ws	wpo	em	
	BW1	15-30	cs	10YR 3/1	10YR 3/2	scl	m2sbk	dl	mfi	wss	wps	es	
	BW2	30-45	gi	10YR 3/1	10YR 3/2	sl	M2sbk	dsh	mfr	wso	wpo	ev	Typic
Treated	AP	0-15	cs	10YR 3/1	10YR 3/2	scl	m3sbk	ds	mfr	ws	wps	em	
	BW1	15-30	cs	10YR 3/1	10YR 3/2	scl	m2sbk	dl	mfi	wss	wps	es	
	BW2	30-45	gi	10YR 3/1	10YR 3/2	sl	m1sbk	dsh	mfr	wso	wpo	ev	Typic
Pedon 19 and 20													
Control	AP	0-15	cs	10YR3/3	10YR 3/2	scl	m3sbk	ds	mfr	ws	wp	em	
	BW1	15-30	cs	10YR3/1	10YR 3/2	scl	m2sbk	dl	mfi	wss	wps	es	
	BW2	30-45	gi	10YR3/1	10YR 3/2	scl	M2sbk	dsh	mfr	wso	wpo	ev	Typic
Treated	AP	0-15	cs	10YR3/2	10YR 3/2	scl	m3sbk	ds	mfr	ws	wp	em	
	BW1	15-30	cs	10YR3/1	10YR 3/2	scl	m2sbk	dl	mfi	wss	wps	es	
	BW2	30-45	gi	10YR3/1	10YR 3/2	scl	M2sbk	dsh	mfr	wso	wpo	ev	Typic

Table 2: Residual effect of post biomethanated spent wash on Physical properties in Inceptisol.

Treatment	Depth (cm)	B.D. (Mg /m^{-3})	Sand (%)	Silt (%)	Clay (%)	water retention		Hyadralic conductivity (cm/hr)
						33 kpa	1500 kpa	
Pedon 11 and 12								
Untreated	0-15	1.38	45.7	28.32	24.72	27.25	15.23	1.16
	15-30	1.42	42.5	29.45	26.72	29.84	16.72	1.12
	30-45	1.39	40.34	31.27	20.9	30.27	17.85	1.02
	45-60	1.37	47.3	31.89	21.4	26.34	15.73	1.2
Treated	0-15	1.36	43.5	28.97	27.34	27.34	15.17	1.17
	15-30	1.39	47.82	30.17	24.27	28.72	15.57	1.05
	30-45	1.37	42.73	33.47	22.37	28.94	16.27	1
	45-60	1.52	52.32	37.42	21.73	26.42	14.89	1.42
Pedon 13 and 14								
Untreated	0-15	1.27	47.62	32.52	20.54	26.79	15.37	1.11
	15-30	1.25	42.72	30.89	19.32	32.47	15.89	1.08
	30-45	1.25	50.82	27.92	18.32	30.45	14.78	1.07
	45-60	1.38	52.32	25.34	17.34	21.34	14.24	1.42
Treated	0-15	1.24	48.73	37.21	22.42	26.24	14.8	1.24
	15-30	1.2	46.32	38.23	20.32	29.56	15.78	1.18
	30-45	1.32	52.31	38.37	18.59	27.34	14.89	1.21
	45-60	1.4	54.43	25.34	16.73	31.78	17.23	1.34
Pedon 15 and 16								
Untreated	0-15	1.29	40.54	34.53	27.34	28.58	14.37	1.27
	15-30	1.34	48.83	32.27	24.32	28.92	15.04	1.2
	30-45	1.32	48.32	38.72	22.78	30.47	16.72	1.17
	45-60	1.53	50.37	39.98	20.42	27.45	14.57	1.25
Treated	0-15	1.24	42.87	35.72	25.78	29.42	15.24	1.25
	15-30	1.37	46.27	37.42	23.82	31.72	16.79	1.14
	30-45	1.34	45.34	39.73	21.45	28.08	14.03	1.18
	45-60	1.62	52.83	40.83	20.78	27.78	14	1.2
Pedon 17 and 18								

Untreated	0-15	1.36	42.32	32.73	25.72	30.76	18.37	1.37
	15-30	1.32	40.79	33.72	27.37	31.25	19.89	1.13
	30-45	1.4	45.24	30.17	22.72	28.42	16.12	1.42
Treated	0-15	1.32	42.24	34.58	24.82	29.43	18.02	1.24
	15-30	1.28	48.72	30.24	20.34	30.72	15.82	1.18
	30-45	1.43	47.34	37.73	17.38	28.27	14.32	1.32
Pedon 19 and 20								
Untreated	0-15	1.49	48.93	32.83	26.17	27.32	15.72	1.24
	15-30	1.53	42.37	30.17	28.32	28.72	16.84	1.13
	30-45	1.63	50.34	31.45	21.27	26.47	15.25	1.37
Treated	0-15	1.46	47.32	30.54	24.14	30.43	15.93	1.17
	15-30	1.48	42.72	31.74	27.32	32.79	17.45	1.07
	30-45	1.68	53.34	31.83	24.27	28.52	16.25	1.17
Range								
Untreated	0-15	1.27-1.49	40.53-48.93	28.32-32.83	20.54-27.34	26.79-30.76	14.37-18.37	1.1-1.27
Treated	0.15	1.24-1.46	42.24-48.73	28.97-37.21	22.42-27.37	26.24-30.43	14.8-18.02	1.17-1.25
Untreated	15-30	0.25-1.53	40.79-48.83	39.45-38.72	19.32-28.32	28.62-32.47	14.04-19.89	0.05-1.18
Treated	15-30	1.2-1.48	42.72-48.72	30.17-38.23	20.32-27.79	28.75-32.79	15.75-17.45	1.05-1.18
Untreated	30-45	1.25-1.63	40.34-50.82	27.92-38.72	18.32-22.78	26.47-30.47	14.78-17.85	1.02-1.42
Treated	30-45	1.32-1.68	42.73-53.34	31.83-39.73	17.38-24.27	27.34-28.98	14.03-16.25	1.0-1.3
Untreated	45-60	1.37-1.53	47.3-52.37	39.89-25.34	17.34-21.4	21.34-27.45	14.24-15.73	1.2-1.42
Treated	45-60	1.4-1.62	52.32-54.43	40.83-25.34	16.73-21.73	26.42-31.78	14.00-17.23	1.0-1.42
Mean								
Untreated	0-15	1.35	45.02	32.18	24.89	28.14	15.81	1.23
Treated	0.15	1.32	44.93	33.40	24.90	28.57	15.83	1.21
Untreated	15-30	1.36	43.44	31.30	25.21	30.24	16.87	1.13
Treated	15-30	1.34	46.37	33.56	23.21	30.70	16.28	1.12
Untreated	30-45	1.39	47.01	31.90	21.19	29.21	16.14	1.21
Treated	30-45	1.42	48.21	36.22	20.81	28.23	15.15	1.17
Untreated	45-60	1.42	49.99	32.40	19.72	25.04	14.84	1.29
Treated	45-60	1.51	53.19	34.53	19.74	28.66	15.37	1.32

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