International Journal for Research in Applied Sciences and Biotechnology

ISSN: 2349-8889
Volume-8, Issue-5 (September 2021)

www.ijrasb.com

https://doi.org/10.31033/ijrasb.8.5.28

Response of Industrial Solid Wastes on Maize *(Zea mays* L.: cv. PHI 1899) Growth and on Soil Characteristics

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ABSTRACT

Greenhouse pottrial experiment was conducted on maize (cv. Phi-1899) crop to find out the effects of sugar and yeast industry solid wastes viz. Sugar industry sludge, sulphitation pressmud and yeast industry sludge on germination and growth of maize. The post-harvest soil analysis was also conducted to determine their effects on various soil chemical properties. Germination of maize was stimulated (from 50.0% to 73.3%) with the addition of sugar industry sludge, sulphitation pressmud and yeast industry sludge @ 8% in soil. All the treatments of sugar industry sludge (upto 8% application in soil) caused a statistically significant increase in plant growth. The dry weight of root and shoot at both the stages was found to increase up to 4% pressmud application then significantly decrease at 8% level of addition. The plant height and dry weight of shoot also increased significantly due to sludge application. The sludge and pm registered a significant increase in soil EC, organic carbon, available potassium, available phosphorus, total nitrogen and the C:N ratio of soil. It was concluded that sludge and pm of the sugar industry could be used as source of plant nutrients in an integrated nutrient management system, up to a level as high as 4% addition to the soil.

Keywords- sugar industry sludge, pressmud, yeast industry sludge, *Zee mays* L.

I. INTRODUCTION

Solid industrial wastes disposal is a current problem as the availability of landfill sites has been reduced or quite diminished. The requirements for making landfills are though environmentally acceptable but for these costs have been substantially escalated. Land spreading of organic wastes remains an environmentally acceptable option for recycling of nutrients. In addition to major plant nutrients like N, P and K, the solid wastes also contain micronutrients that may serve in correcting plant deficiencies. The beneficial agronomic effects of pressmud application in cropping system have been reported by many workers (Rai *et al.* 1980; Patil and Kale, 1983; Borde *et al*., 1984 and Yaduvanshi and Yadav, 1990), Singh et al., (2015). Further, reports on improvement of soil properties are also shown by Kanwar and Chawla (1963), Patil and Kale (1983), Kumar and Chopra (2016) and Mohammad et al., (2019) among others citations. Information in respect of sludge of sugar and yeast industries and tolerance to higher doses of Pm application to soil as well as plant growth is lacking. Hence, the present project was undertaken in order to study the effects on growth of maize after addition of graded doses of such recyclable matter.

II. MATERIALS AND METHODS

A greenhouse pot experiment was conducted in alluvial soil with silty clay loam texture. After air drying, the soil samples were processed and sieved through 2-mm pore size after which 400 g soil was filled in each earthen pot (9 cm. high x 8.5 cm. diameter). The moisture content was maintained under standard conditions, by adding distilled water to soil. The treatments included three industrial wastes viz., sugar industry sludge (SIS), sulphitation pressmud (Pm) and yeast industry sludge (YIS) each applied @ 8.0, 4.0, 2.0, 1.0 and 0.5 % with control and all in triplicates. Following these treatment, 10 seeds of maize cv. PHI-1899 were sown in each pot. The chemical composition of soil and solid wastes used in the experiment were determined and are summarized in Table 1. The whole experiment was conducted in a complete randomized design. After harvest of the maize plants (at time of 60 days), the soil samples were collected and analyzed again by using standard methods (Jackson, 1958 and AOAC 1985).

ISSN: 2349-8889
Volume-8, Issue-5 (September 2021)

www.ijrasb.com
https://doi.org/10.31033/ijrasb.8.5.28

Table 1: Physicochemical properties of soil and solid wastes used in the study.

Parameters	Symbol	Sugar Industry sludge	Pm	Yeast industry sludge	Experimental soil
Colour/texture	-	Dark brown	Faun	Dark brown	Silty clay loam
Colour unit	-	1801.3	9059.9	1977.2	-
pH (1:2)	-	6.32	8.04	7.11	7.17
Electrical conductivity (1:2), μSm^{-1}	EC	4.8	1.8	1.95	0.36
Chemical oxygen demand	COD	5800	5722	3894	-
Bio chemical oxygen demand	BOD	539	980	615	-
Total nitrogen %	TN	0.016	0.044	0.013	0.011
Total phosphorus %	TP	0.78	0.73	0.075	0.12
Total potassium %	TK	0.86	0.55	0.95	2.7
Total sulphur %	TS	0.085	2.13	0.19	0.13
Total calcium %	TC	0.0145	0.024	0.010	-
Total magnesium %	TM	0.0065	0.087	0.0025	-
Total Mn. %	TMn	0.04	0.036	0.024	0.035
Total Zn. %	TZ	0.04	0.026	0.014	0.004
Total sodium %	TNa	5.0	2.5	3.7	2.5
Org. Carbon %	OC	58.27	57.24	57.52	5.43
Available potassium ppm	AK	-	-	-	60
Available phosphorus ppm	AP	-	-	-	30
Chlorides. %	Cl	0.037	0.019	0.023	-
Total alkalinity	TA	182.0	877.0	204	-
Carbonate + Bicarbonates	C+B	12.60	21.12	12.42	-
Esch. WS Na		-	-	-	625

III. RESULTS AND DISCUSSION

The effects of sugar industry sludge on physiological parameters of maize are given in Table 2. The maximum germination was recorded with the highest 8.0% rate of sludge application and it was 46.6% higher than that in control. The plant height at 25 DAS was maximum at 2% sludge application, though all the treatments increased plant height significantly over the control. The dry weight was positively and significantly higher and maximum with the 4% sludge application. All the treatments at 55 DAS caused a significant increase in plant height over the control maximizing 24.67% in 1% of SIS application. The dry weights (55 DAS) varied 1.97-2.97 $mg/plant^{-1}$ and was maximum at 8.0% rate of SIS application recording an increase of 50.76% over the control. The root dry weight likewise ranged from 1.40 to 0.92 g pl^{-1} in different treatments with maximum in the control and lowest with 8 % of sludge treatment. The treatment of 8.0% sludge caused a 34.29% decrease in root dry weight as compared to control. The moisture % in shoot and root ranged from 78.6 to 80.72 and 46.01 to 55.83, respectively. The differences in the shoot moisture content among different treatments were in significant. The shoot to root ratio ranged from 2.24 (in control) to 3.22 (at 8% rate) and all the shoot-root ratio were significantly higher in the treated pots than control.

Clearly that SIS had a positive effect on maize crop in terms of increasing germination percentage, plant height at various stages, fresh and dry weights of shoot and root, moisture % and shoot to root ratio. This may be attributed to the enhanced nutrient supply and improved soil physical properties like aeration and soil structure. The reduction in the root weight due to the addition of sludge may possibly be due to enriched nutrient regime of the root zone and some organic toxins that may have adversely affected the root proliferation. In all 4% SIS application was optimum without any harmful effect on plant growth the and soil properties, despite higher dose were found to be detrimental on maize growth.

The data on the effect of sulphitation pm on growth of maize presented in table 2B reveal that the germination was unaffected up to 2.0% rate of Pm application but with higher doses it increased with maximum with the 8% level. The Pm showed a

International Journal for Research in Applied Sciences and Biotechnology

ISSN: 2349-8889
Volume-8, Issue-5 (September 2021)

www.ijrasb.com

https://doi.org/10.31033/ijrasb.8.5.28

stimulatory effect on plant height up to 4% level while at 8% it had inhibitory effect on plant growth. The 8% Pm application showed the height of plant was significantly lower than control. Dry weight of plant at 25 DAS showed an increasing trend up to 1% while it decreased thereafter but lower than control. Plant height at 55 DAS ranged from 120 to 153 cm, maximum up to 2% of Pm application and reduced beyond this level. All the treatments registered increase an in the plant height over the control. Shoot dry weights were at par to control up to 4% Pm application, beyond which significant decrease was observed.

Table 2: Effect of Sugar and yeast industry sludge and Pm on growth of maize under greenhouse conditions in a mollisol.

Air dry sludge treatments to the soil (%)	Germination (%)	Plant height at 25 DAS (cm)	Dry weight at 25 DAS (mg plant^{-1})	Root dry weight (mg pl.$_{-1}$)	Plant height at 55 DAS (cm)	Dry weight at 55 DAS (mg pl^{-1})	Root dry weight, (mg pl^{-1})	Moisture in shoot (%)	Moisture in root (%)	Shoot root ratio
Sugar Industry sludge (A)										
Control	50.0	42.35	308.0	-	76.90	1.97	1.40	80.72	55.83	2.24
0.5	50.0	48.48	370.0	-	87.13	2.81	1.19	78.61	49.45	2.35
1.0	56.7	53.42	404.0	-	95.87	2.72	1.19	79.52	47.84	2.29
2.0	56.7	54.42	414.0	-	94.47	2.72	1.19	79.62	46.01	2.29
4.0	66.7	50.38	492.0	-	93.23	2.74	1.02	79.77	46.75	2.68
8.0	73.3	48.56	365.0	-	90.33	2.97	0.92	80.08	46.28	3.22
LSD (0.05)	1.827	1.051	0.168	-	0.62	0.026	0.021	NS	0.63	0.076
Sulphitation Pm (B)										
Control	40.00	29.41	364.0	60.0	52.60	1.62	670.0	75.08	55.31	2.42
0.5	36.70	30.37	368.0	78.0	53.80	1.24	420.0	81.66	65.25	2.96
1.0	40.00	30.60	370.0	82.0	55.67	1.26	510.0	81.95	63.33	2.47
2.0	40.00	37.72	251.0	95.0	56.40	1.29	710.0	81.81	53.89	1.82
4.0	43.30	33.41	216.0	89.0	51.13	1.49	540.0	81.74	62.21	2.76
8.0	50.00	25.77	149.0	80.0	31.83	0.32	140.0	86.88	76.67	2.29
LSD (0.05)	0.937	1.603	0.020	0.004	2.489	0.063	1.01	2.531	3.12	0.08
Yeast Industry Sludge (C)										
Control	50.0	32.16	180.0	-	68.37	1.01	732.0	85.57	53.99	1.38
0.5	53.3	36.67	210.0	-	75.73	1.18	801.0	83.22	58.92	1.47
1.0	56.7	41.72	217.0	-	80.43	1.30	816.0	82.49	59.78	1.60
2.0	73.3	41.29	243.0	-	83.27	1.81	936.0	79.01	69.10	1.93
4.0	70.0	42.27	348.0	-	79.67	1.76	885.0	78.88	65.24	1.99
8.0	66.7	41.49	265.0	-	77.07	1.36	649.0	82.93	70.39	2.09
LSD (0.05)	NS	1.33	0.03	-	2.07	0.13	0.01	2.06	1.77	0.14

The moisture % in shoot and root ranged from 75.1 to 86.9 and 55.9 to 76.7, respectively. The shoot to root ratio ranged from 1.82 (2%) to 2.96 (1% Pm application). The effect of Pm application was found stimulatory for maize plants only up to 4 % on germination, plant growth, shoot and root weight. It may he because of its positive effect on soil physical conditions like soil aeration, soil water holding capacity and bulk density besides supplying essential and beneficial nutrients to the maize plant. Raman et al. (1996) also reported similar results. Interestingly Pm application @ 8% caused a great reduction in the maize plant height, shoot and root dry weights. It may be due to the fact that at higher rates of Pm application (8%.) there will be almost double quantity of nutrients as compared to the 4 % level of application which may be toxic to plant development and may create adverse changes in the physical properties of soil not conducive to adequate plant root growth due to poor anchorage.

ISSN: 2349-8889
Volume-8, Issue-5 (September 2021)

www.ijrasb.com
https://doi.org/10.31033/ijrasb.8.5.28

Maximum germination was observed at 2% application of yeast industry sludge (YIS) while subsequent higher doses caused a reduction in germination in spite it remained higher than control (Table 2C). Plant height showed 4% and 2% rates of application caused a maximum increase. The dry weight of shoot ranged from 180 (in control) to 348 (4%) mg pl^{-1} at 25 DAS. The 4 % YIS treatment caused a 93.33 % increase in dry weight of shoot. The maximum plant height at 55 DAS was recorded in the treatment with YIS @ 2% and it was 21.79% more over the control. The dry weight of shoot ranged from 1.01 (in control) to 1.81 g $plant^{-4}$, after 55 DAS. Comparing with control, dry weight of shoot significantly increased in all the treatments. All the treatments caused a statistically significant increase in root fresh and dry weight and maximum was due to 2% sludge application. Moisture content in shoot and mot ranged from 79.01 (2% YIS) to 85.57 (control) and 53.99 (control) to 70.39 (8% YIS) %, respectively. Shoot: root ratio ranged from 1.38 in control to 2.09 in 8 % YIS with maximum at 8% of YIS application. YIS @ 8% caused a significant increase in the germination, plant height and dry matter accumulation of maize but 2.0 % application rate resulted in maximum positive effect. It may be attributed to the increased nutrient supply through the sludge as well as improvement in the soil physical properties. The higher doses (@ 4.0% and 8.0%) of YIS application were also beneficial but the reduction in the growth (as compared to lower doses) may be due to organic phytotoxic materials contained in this sludge.

Chemical properties of soil as affected by various doses of SIS application to maize plants during the experiment is presented in Table 3. The reduction in pH value from 7.22 (in control) to 6.50 (8% sludge) may be due to the low pH (6.32) of the added sludge itself. The electrical conductivity (1:2) increased from 0.36 (in control) to 2.35 μS/cm (in 8% sludge) and it was 6.52 times higher than the unamended soil. It may be due to the presence of high content of chemical electrolytes in the SIS (EC 4.8 μSm^{-1}). All the treatments caused a significant increase in organic carbon (OC) content of soil over the control 8% of sludge application increased OC by about 2.77 times than control. All the treatments, except 0.5% sludge application, caused a significant increase in available potassium and phosphorus. The highest rate of sludge application (8%) caused 116.67% increase in available potassium and 57.64 % increase in available phosphorus over the control. The sludge application @ 0.5 % was found at par with the control and rest of the treatments caused significant increase in the total nitrogen content. The carbon nitrogen (C: N) ratio increased from 10.59 (in control) to 19.28 in 8% rate significantly and @ 8.0 % caused an 82.05 % increase in C: N ratio of soil. Overall, all the treatments were found to increase the EC, C: N ratio, contents of OC, total nitrogen, available P and available K at the end of the harvest of maize plants.

Table 3: Effect of sugar and yeast industry sludge and Pm on growth of maize under greenhouse conditions in a mollisol.

Air day sludge treatments to the soil (%)	pH (1:2)	EC (μSm^{-1})	O.C. ($g.kg^{-1}$)	Available K (ppm)	Available P (ppm)	Total N ($g\ kg^{-1}$)	C:N ratio
Sugar Industry sludge							
Control	7.22	0.360	5.50	60.0	29.18	0.519	10.59
0.5	7.08	0.360	6.08	60.0	30.08	0.524	11.60
1.0	6.94	0.450	7.75	80.0	35.00	0.536	13.94
2.0	6.80	0.495	13.57	84.0	37.00	0.764	17.76
4.0	6.65	0.495	14.59	90.5	39.00	0.783	18.63
8.0	6.50	2.35	15.25	130.0	46.00	0.791	19.28
LSD (0.05)	0.11	0.15	0.080	6.86	3.63	0.04	0.24
Sulphitation Pm							
Control	7.17	0.360	6.31	60.0	30.0	0.598	10.55
0.5	7.86	0.384	7.81	65.3	30.0	0.658	11.87
1.0	8.22	0.463	8.42	69.0	32.0	0.675	12.47
2.0	8.76	0.499	9.84	75.0	33.0	0.711	13.83
4.0	8.87	0.538	14.90	83.0	37.5	0.877	16.99
8.0	9.02	0.700	19.03	98.0	45.0	0.878	21.68
LSD (0.05)	0.06	0.004	0.18	5.32	1.85	0.02	0.28
Yeast Industry sludge							
Control	7.12	0.35	5.38	60.0	30.0	0.508	10.59
0.5	7.63	0.37	9.01	80.0	60.0	0.566	15.91
1.0	7.74	0.42	0.96	80.0	87.5	0.587	16.97
2.0	7.80	0.435	10.63	90.0	105.0	0.612	17.36

ISSN: 2349-8889
Volume-8, Issue-5 (September 2021)

https://doi.org/10.31033/ijrasb.8.5.28

4.0	7.99	0.463	12.46	100.0	105.0	0.689	18.08
8.0	8.08	0.839	15.74	160.0	110.0	0.692	22.75
LSD (0.05)	0.04	0.022	0.68	5.18	2.18	0.127	1.60

The effects of Pm application on soil chemical properties are presented in table 3. All the treatments of Pm application significantly increased soil pH by 1.85 at while highest dose. All the treatments significantly increased the EC of soil over the control. The Pm application caused a 94.44 % increase in EC when applied @ 8.0 %. The pressmud caused a significant increase in OC content of the soil at each of study level. All the treatments except 0.5 % Pm application case of available K and except 0.5 & 1.0% Pm application in case of available phosphorus caused a significant increase over the control. The highest rate (8%) of Pm application registered 63.33% and 50.0% increase in available potassium and available phosphorus respectively over the control. All treatments registered a significant increase in TN content in soil, over the control. The C: N ratio of soil varied from 10.55 (in control) to 21.68 (in 8% of Pm application). All the treatments resulted in a significant increase in pH, EC. OC, TN, C: N ratio, available P and K of soil. This is obviously due to the presence of high contents of organic carbon, phosphorus, potassium, calcium and other nutrients besides being alkaline in nature. Kapur (1995) also reported that soil treated with sulphitation cane filter cake increased OC, and available N significantly.

The changes in soil chemical properties due to application of YIS to soil during experiment with maize are presented in table 3. All the treatments significantly increased the pH value and EC over the control. The electrical conductivity (1:2) of post-harvest soil increased from 0.35 (in control) to 0.839 μSm^{-1} (in 8% sludge application). All the successive doses significantly differed with respect to their effect on the soil. The YIS application @ 8 % registered 139.7 % increase in EC over the control. The increase in soil pH value and electrical conductivity may be due to slightly alkaline nature of YIS and its high electrical conductivity. The OC content of post-harvest soil ranged from 5.38 to 15.74 g kg^{-1}. The YIS application @ 8.0% caused a 192.56% increase in organic carbon content over control. Both available potassium and phosphorus increased from 60.0 to 160.0 ppm and 30.8 to 110.0 ppm as a result of sludge application, respectively. The YIS application @ 8.0% caused a 166.67 and 266.67 % increase in available potassium and available phosphorus over their respective controls. All the treatments significantly increased OC content, available potassium and phosphorus in the treated soil.

IV. CONCLUSION

Green house pot trial experiments of SIS, pressmud and YIS application to maize (cv. PHI 1899) growth showed enhanced physiological growth parameters and soil physical & chemical parameters at an optimized 4% treatment out of 0.5, 1.0, 2.0, 4.0 & 8.0% levels selected. Increase values of EC, OC, TN, C: N and available nutrients was observed in post-harvest soil samples reflecting a nutritive uptake by the experimental maize crop. So, further with a scope for future to optimize maize growth and recycling of earthen matter from industries, significant with respect to upcoming requirements by fast moving consumer goods companies to foray in the forthcoming maize & millets products for mankind in society as an alternate to traditional grains and routine agricultural practices using conventionally natural or chemical fertilizers.

ACKNOWLEDGEMENT

The authors are deeply thankful to The Principal Bareilly College, Bareilly for his esteemed guidance and kind assistance to run this research work smoothly.

REFERENCES

[1] A.O.A.C. (1985). Association of official analytical chemists. Official methods of analysis, Washington.
[2] Borde. B.K., Kadarn, J.R. and Patil. N.D. 1984. Effect of Pm cake and phosphatic fertilizer on yield and uptake of nutrient by greengram. *J. Indian Soc. Soil Sci.* 32: 516-518.
[3] Jackson. M.L. 1958. *Soil Chemical Analysis* Prentice Hall Inc. N.J. Kanwar, J.S. and Chawla. V. K. 1963. Comparative study of the effect of gypsum and press mud on the physico-chemical properties of saline-alkali soils. J. Soil. *Water Conserv,* India 11: 95-106.
[4] Kapur, M.L. 1995. Direct and residual value of sulphitation cane filter cake as a nitrogen source for crops. *J. Indian Soc. Soil Sci.* 43: 63-66.
[5] Mohammad, B., Adnan, M., Musif, F., Fahad, S., Saeed, M. (2019). Substituting area by organic waste for improving maize yield in alkaline soil. *J. Plant Nutrition* 42(19): 2423-2434.
[6] Patil, S.P., and Kale, S.P. 1983. Residual effect of Pm cake (PMC) on 1. Yield and quality of sugarcane *(Saccharum officinarum L.). Indian Sugar* 32: 905-908.
[7] Rai, Y., Singh D., Singh. K.D.N., Prasad, C.R. and Prasad, M., 1980. Utilization of waste product of sugar industry as a soil amendment vis-a-vis for reclamation of saline-sodic soils. *Indian Sugar* 30: 241-244.
[8] Raman. S.. Patel. A.M., Shah. G.B. and Kaswala, R.R., 1996. Feasibility of some industrial wastes for soil improvement and crop production. *J. Indian Soc. Soil Sci.* 44: 147-150.
[9] Singh, N.J., Athokpam, H.S., Devi, K.N., Chonatham, N., Singh, N.B., Sharma, P.T. (2015). Effect

ISSN: 2349-8889
Volume-8, Issue-5 (September 2021)
https://doi.org/10.31033/ijrasb.8.5.28

of farm yard manure and press mud on fertility status of alkaline soil under maize-wheat cropping sequence. *African J. Agri. Res.* 10(24): 2421-2431.

[10] Vinod Kumar & A.K. Chopra 2016. Effects of sugar cane pressmud on agronomical characteristics of hybrid cultivar of eggplant (Solanum Melongena L.) under field condition. *Int. J. of recycling of organic wastes in Agriculture* 5: 149-162.

[11] Yaduvanshi, N.P.S. and Yadav, D.V., 1990. Effects of combined application of sulphitation Pm and fertilizer nitrogen on the economy and recovery of added nitrogen in sugarcane. *Fert. News* 36(4): 49-51.

