



Studies on Physico-Chemical Characteristics of Waxed and Dewaxed Pressmud and its effect on Water Holding Capacity of Soil

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Abstract

Pressmud is a by-product of sugar industry. For every 100 tonnes of sugarcane crushed about 3 tonnes of pressmud cake is left behind as by-product. It is used as both a soil reclamation agent as well as a soil conditioner. But presence of wax in pressmud stimulates a decrease in soil quality and porosity after its repeated applications. Present study was undertaken to analyze the physical and chemical characteristics such as pH, NPK organic carbon, organic matter, moisture content etc. of raw pressmud as well as pressmud from which the wax is extracted by solvent recovery, and also water holding capacity of Loam soil by applying different percentage of waxed and wax extracted pressmud. It was found that the water holding capacity of soil containing dewaxed pressmud was high as compared to waxed pressmud and in the range of 58.39 to 92.43 % in the dewaxed pressmud where as for wax containing pressmud it was 49.39 to 86.63 %. The C: N ratio of dewaxed pressmud was high, and was 18.54 % as compared to that of waxed pressmud. The composting processes improve the physical structure and lower the C: N ratio of the pressmud and leads to reduction in C: N ratio i.e. 16.53 % of dewaxed pressmud after composting. However the physico- chemical parameters of the composted waxed pressmud were not significantly higher than those of composted dewaxed pressmud. So it can be conclude that dewaxed pressmud are used as fertilizer in agriculture field.

Keywords: Sugar industries, pressmud, physico-chemical characterization, water holding capacity.

Introduction

In India, sugar industry with 400 sugar factories rank as the second major agro-industry in the country. The cane-sugar industry has several co-products of immense potential value. The co products include pressmud (filter cake), molasses and spent wash. Out of which pressmud is produced during clarification of sugarcane juice. About 3.6 - 4% of sugarcane crushed end up as pressmud i.e. 36 - 40 kg of pressmud is obtained after 1 ton of cane crushing.

Pressmud is a soft, spongy, amorphous and dark brown material containing sugar, fiber and coagulated colloids including cane wax, albuminoids, inorganic salts and soil particles. It consists of 80 % water and 0.9 -1.5 % sugar, organic matter, nitrogen, phosphorus, potassium, calcium, sulphur, coagulated colloids and other materials in varying amounts. The time when cost of chemical fertilizer is skyrocketing and not affordable by farmers, pressmud has promise as a source of plant nutrient and as medium for raising sugarcane seedlings and leguminous inoculants¹ The advantages of using sugarcane pressmud for soil application is its low cost, slower release of nutrients, presence of trace element, high water holding capacity and mulching properties².

Pressmud like other organic materials affects the physical, chemical and biological properties of soil³ However, the

disadvantages of pressmud are that due to its bulky nature and wax content it causes some problems. If pressmud is directly applied to soil as manure, the wax present might deteriorate the physical properties such as permeability, aeration, soil structure and composition etc. and with the passage of time the deterioration might get worsen. Also, if it is freshly applied to the soil directly from the factory, it has the tendency to burn the plants as a result of the rapid decomposition of the new sugarcane pressmud which liberates heat and ammonia in high concentrations⁴. The aim of present study is to determine the water holding capacity of soil by using wax containing pressmud and dewaxed pressmud and its compost which would helps to give idea which pressmud increases the water holding capacity of soil. It also aims of this work were to study the Physico-chemical parameters of wax containing pressmud and dewaxed pressmud and its compost. Extraction of wax from pressmud will be helpful to enhance the quality of pressmud as organic manure.

Material and Methods

Material: i. Soxhlet Extractor was used for extraction of wax from pressmud. ii. The solvents like toluene, benzene, methanol and acetone were used for extraction of wax. iii. Isopropyl alcohol i.e. propan-2-ol was used for purification of wax having weight per ml at 20°C is 0.783 - 0.786 gm and minimum assay by GC is 99%. iv. Sugarcane pressmud was obtained from

Kumbhi Kasari S.S.K, Kuditre from Kolhapur district, Maharashtra. India. v. All the physical and chemical characteristics were analyzed by standard methods.

Extraction procedure: Sugarcane pressmud waste was collected from Kumbhi Kasari S.S.K, Kuditre present in Kolhapur district. Sugarcane pressmud waste was extracted with different solvent such as toluene, benzene, methanol and acetone under a reflux system for 4 - 6 hrs at a stretch. The extract was filtered under mild vacuum and solvent recovered by distillation. After recovering the solvent the solid mass containing wax mixtures and resins thus obtained was dissolved in hot isopropyl alcohol and filtered. The resin portion was separated and the total wax portion obtained which was yellow or light cream in colour.

Composting: Pressmud may be composted without using any other inputs but it is usually composted with spent wash and followed by windrows methods. In this method the moisture content reduces below 50 % and addition of spent wash restore it to 70 %. After 5 days the temperature will rise to 60-70°C and this is maintained for at least one week. After third week the temperature will continue to decrease towards 45°C as the decline trend is noticed stop spraying spent wash. Finally after 30 days leave the windrow as such for curing without adding spent wash. The composted pressmud so obtained was analyzed for physical and chemical parameters.

Analysis of physico-chemical properties of Press mud: The physico-chemical properties of pressmud (PM), dewaxed pressmud (DPM), composted pressmud (CPM) and composted dewaxed pressmud (CDPM) were analyzed. It includes pH, moisture content, Total nitrogen, phosphorus, potassium, organic matter, organic carbon, calcium, magnesium and C: N ratio. All the procedures were followed from⁵ APHA.

Analysis of Water holding capacity of soil by using different percentage of Pressmud: Water holding capacity of soil was analyzed by using different percentage of pressmud (PM), dewaxed pressmud (DPM), composted pressmud (CPM), composted dewaxed pressmud (CDPM).

All the components were measured dry, then allowed to sit overnight. They were then drained for 15 minutes and measured wet. Then water holding capacity of soil was calculated by formula:

$$\text{Water holding capacity in \%} = \frac{W_3 - (W_2 + W_4)}{W_2 - W_1} \times 100$$

Where, wt. of box + wt. of filter paper (W_1), wt. of Soil + wt. of filter paper + wt. of box (W_2), wt of box + wt. of water saturated soil (W_3), wt of wet filter paper (W_4).

Results and Discussion

The advantages of using sugarcane pressmud for soil application is its low cost, slower release of nutrients, presence of trace

element, high water holding capacity and mulching properties. However, a major disadvantage, in its usage as soil conditioner is the high wax content in sugar cane pressmud which remains not only unutilized, but also reduces the fertility of the soil due to its accumulation⁶. In recent years, intensive research on the process for the recovery of wax from sugarcane pressmud for industrial exploitation, now a days extraction by solvent is a major unit operation used for solvent recovery⁷ and further use of dewaxed sugarcane pressmud for recovery of useful products is being carried out. The resulting spent sugarcane pressmud then can be used for biocomposting as the extraction of wax improves its manorial value and results in good manure⁸.

The physico-chemical parameters of pressmud (PM), dewaxed pressmud (DPM), composted pressmud (CPM), composted dewaxed pressmud (CDPM) are given in table no.1. The present study shows that the pH of wax containing pressmud (PM) and dewaxed pressmud (DPM) doesn't show any variation, it was 6.83, while pH of composted wax pressmud (CPM) was 8.30 and composted dewaxed pressmud (CDPM) was 8.50. Pressmud has capacity to decrease the soil pH slightly⁹. The moisture content of pressmud (PM), composted pressmud (CPM) and composted dewaxed pressmud (CDPM) were recorded as 73.07, 30, 25.79 % where as there was no moisture content in dewaxed pressmud (DPM) because of the solvent treatment¹⁰ has reported on the significant quantities of plant nutrients in the form of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and micronutrients that have been measured in samples of filter cake from all South African sugar mills. Total Nitrogen percentage of pressmud (PM) and dewaxed pressmud (DPM) were recorded as 2.67 % and 2.33 % and for composted pressmud (CPM) it was 2.76 % and for composted dewaxed pressmud it was 2.54 %. Total phosphorus of composted waxed pressmud (CPM), 2.9 % was observed higher than pressmud (PM), Dewaxed pressmud (DPM), composted dewaxed pressmud (CDPM) 1.38, 1.26, 2.5 % respectively. Composting process helps to increase the amount of phosphorus due to mineralization of organic matter¹¹. The potassium percentage of pressmud (PM) and dewaxed pressmud (DPM) doesn't shows any variation, it was 0.6 %, where as that of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) were 2.8% and 2.7 % respectively. Even though after dewaxing pressmud the amount of NPK is slightly reduced, but after composting the high amount of NPK contents of pressmud has made it a valuable organic resource¹². The percentage of organic carbon and organic matter of pressmud (PM), dewaxed pressmud (DPM) were 43.78 %, 43.2 %, 75.47 % and 74.48 % respectively. The deficiency in organic carbon reduces the storage capacity of soil nutrient and reduction in soil fertility¹³. Because of high organic content i.e. organic carbon and organic matter pressmud can serve as good source of organic manure¹⁴ an alternate source of crop nutrients and soil ameliorates¹⁵. In case of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) the percentage of carbon content and organic matter were recorded 40.65 %, 42 %, 70.08 % and 72.41% respectively. So the percentage of carbon content and organic

matter of raw pressmud decreases after composting process¹⁶. The concentration of exchangeable cations such as calcium of pressmud (PM), dewaxed pressmud (DPM), composted pressmud (CPM) and composted dewaxed pressmud were recorded as 2.6 %, 2.94%, 4.13%, 3.2% respectively and for magnesium were recorded as 1.3%, 1.56 %, 0.83% and 1.7% respectively. Sodium percentage of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) were recorded to be higher than pressmud (PM), dewaxed pressmud (DPM). They were recorded as 0.54%, 0.52% and 0.12%, 0.08% respectively. C:N ratio was significantly decreased after composting process. C:N ratio of pressmud (PM) and dewaxed pressmud (DPM) were recorded as 16.397 % and 18.54 % while C: N ratio of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) were recorded as 14.72% and 16.53 % respectively. According to¹⁷ C:N ratio has been considered an important parameter dictating the efficacy and duration of composting. The water holding capacity of soil measured by using different percentage of (PM), dewaxed pressmud (DPM), composted pressmud (CPM), composted dewaxed pressmud (CDPM) are given in table no.2 while graph 5 shows the water holding capacity of soil measured by using different percentage of (PM), dewaxed pressmud (DPM). To check the efficiency of pressmud (PM) and dewaxed pressmud (DPM), water holding capacity of loam soil was tested by using different percentage of pressmud (PM) and dewaxed pressmud (DPM), here the soil was used as control, it shows 40.93 – 42.63 % of water holding capacity. It was observed that at 10 % of pressmud (PM) soil shows 49.36 % of water holding capacity while for dewaxed pressmud (DPM) soil shows 58.39 % of water holding capacity. At 20 % of pressmud (PM) water holding capacity of soil was 54.25 % and for dewaxed pressmud (DPM) it was 68.79 %. For 30% of pressmud (PM) and dewaxed pressmud (DPM) water holding capacity of soil were recorded as 65.76% and 72.77 % respectively. At 40 % of pressmud (PM) soil shows 75.33 % of water holding capacity and for dewaxed pressmud (DPM) soil shows 81.36 % of water holding capacity. In case of 50 % of pressmud (PM) and dewaxed pressmud (DPM) the water holding capacity of soil were recorded as 86.63 % and 92.43 % respectively. After composting the porosity or interstitial space of material decreases due to decrease in size distribution of the particle by decomposition and mixing¹⁸ which result ,if the composted pressmud applied to the soil will be reduce water holding capacity of soil. Graph 6 shows the water holding capacity of soil measured by using different percentage composted pressmud (CPM), composted dewaxed pressmud (CDPM). At 10 % of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) the water holding capacity of soil were recorded as 41.68 % and 42.69 % respectively. When 20 % of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) were applied to the soil then soil shows 51.36% and 62.29 % of water holding capacity respectively. At 30 % of composted pressmud (CPM) and composted dewaxed pressmud (CDPM) the water holding capacity of soil were recorded as 54.25% and 69.67 % respectively. At 40 % of composted pressmud (CPM) and

composted dewaxed pressmud (CDPM) soil shows 65.83% and 72.76 % of water holding capacity and for 50 % of composted pressmud (CPM) and composted dewaxed pressmud soil shows 69.39 % and 75.33 % water holding capacity respectively. Application of pressmud to the soil is reported to improve its physical and chemical properties. When pressmud mixed with the spent wash generated by the distilleries, the resultant product was the enriched organic manure, which can be used to improve farm yields. However; the fertilizer value of dewaxed pressmud is reported to be better than that of the ordinary pressmud¹⁹.

Conclusion

Pressmud is a byproduct of sugar industries. These waste products are used as fertilizer in agriculture field, but the presence of sugarcane wax in pressmud deteriorates the physical property of soil and therefore the extraction of wax is necessary. This extracted wax has several applications in various industries which can bring products in national and international market. The results of present study suggests that the extraction of wax from pressmud improves the physical structure and quality of pressmud and helps to increase water holding capacity of soil. After composting process there was improvement in physico chemical parameter of dewaxed pressmud (CDPM) which were not significantly lower than that of composted pressmud (CPM).

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Table – 1

Physico-chemical parameters of pressmud (PM), Dewaxed pressmud (DPM), Composted pressmud (CPM), Composted Dewaxed pressmud (CDPM)

S.No	Parameters	Waxed pressmud (PM)	Dewaxed pressmud (DPM)	Composted waxed pressmud (CPM)	Composted dewaxed pressmud (CDPM)
1	pH	6.83 ±0.048	6.83 ±0.047	8.30 ±0.043	8.50 ±0.053
2	Moisture content	73.07 ±0.56	Nil	30 ±2.89	25.79 ±5.99
3	Total Nitrogen (%)	2.67 ±0.24	2.33 ±0.04	2.76 ±0.10	2.54 ±0.44
4	Total Phosphorus	1.38 ±0.26	1.26 ±0.45	2.9 ±0.15	2.5 ±0.35
5	Total Potassium	0.6 ±0.09	0.6 ±0.10	2.8 ±0.03	2.7 ±0.28
6	Organic matter (%)	75.47 ±1.82	74.48 ±1.03	70.08 ±1.52	72.41 ±0.34
7	Total Organic Carbon (%)	43.78 ±0.06	43.2 ±0.85	40.65 ±0.64	42 ±0.59
8	Calcium	2.6 ±0.015	2.94 ±0.28	4.13 ±0.72	3.2 ±1.53
9	Magnesium	1.3 ±0.11	1.56 ±0.57	0.83 ±0.63	1.7 ±0.72
10	Sodium	0.12 ±0.05	0.08 ±0.09	0.54 ±0.12	0.52 ±0.30
11	C:N Ratio	16.397	18.54	14.72	16.53

Table – 2

Water holding capacity of soil using different percentages of pressmud (PM), Dewaxed pressmud (DPM), Composted pressmud (CPM), Composted Dewaxed pressmud (CDPM)

S.No	% of Pressmud	Soil	Soil+Pressmud	Soil+dewaxed pressmud	Soil+Composted waxed pressmud	Soil+Composted dewaxed pressmud
1	10%	40.93±1.19	49.36±1.61	58.39±1.58	41.68±1.39	42.69±0.28
2	20%	41.67±0.85	54.25±1.08	68.79±1.77	51.36±0.33	62.29±0.54
3	30%	41.83±0.78	65.76±1.26	72.77±1.66	54.25±2.45	69.67±1.23
4	40%	42.63±1.20	75.33±1.78	81.36±1.48	65.83±0.56	72.76±1.60
5	50%	42.41±1.00	86.63±1.85	92.43±1.23	69.39±0.69	75.33±2.15

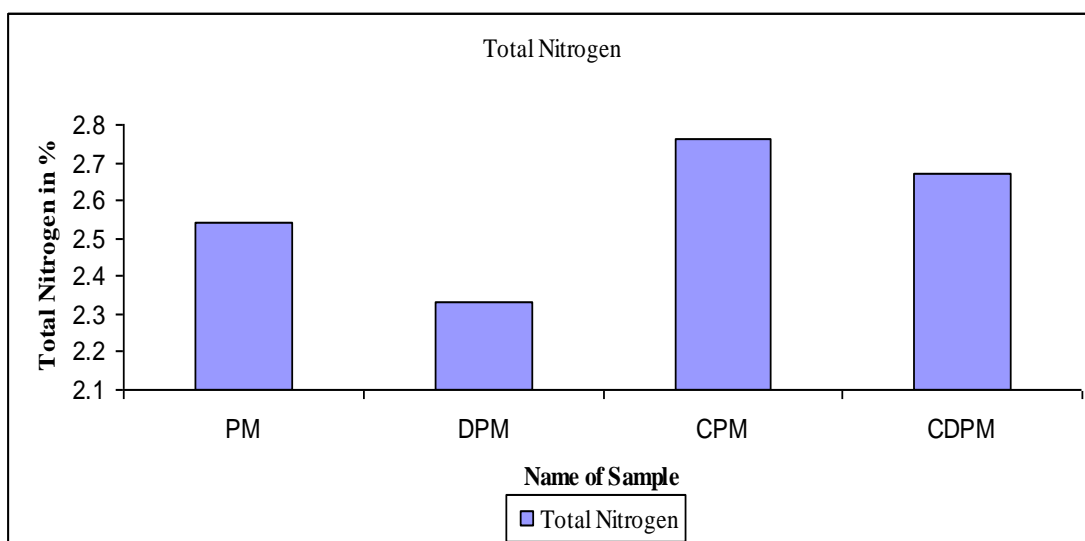


Figure -1

Total Nitrogen in Pressmud (PM), Dewaxed pressmud (DPM), Composted Pressmud (CPM) and Composted Dewaxed Pressmud (CDPM)

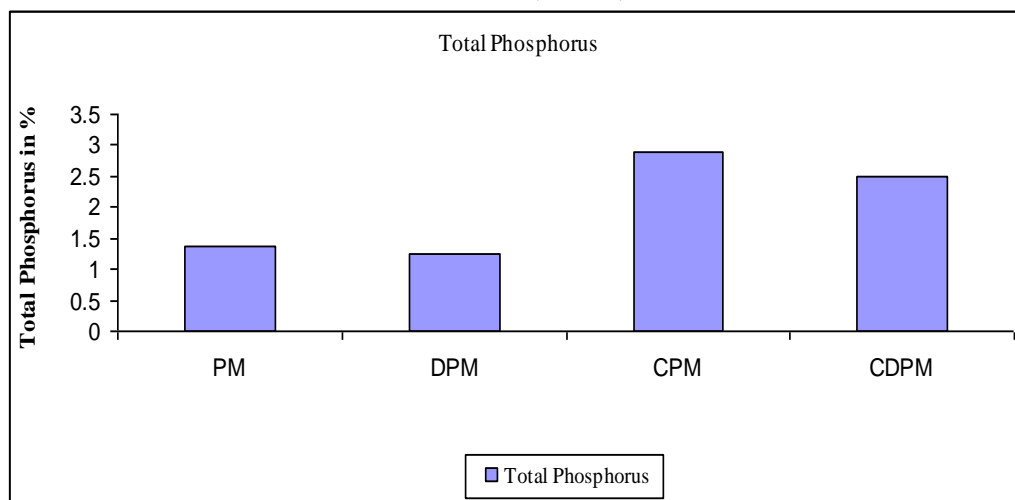


Figure – 2

Total Phosphorus in Pressmud (PM), Dewaxed pressmud (DPM), Composted Pressmud (CPM) and Composted Dewaxed Pressmud (CDPM)

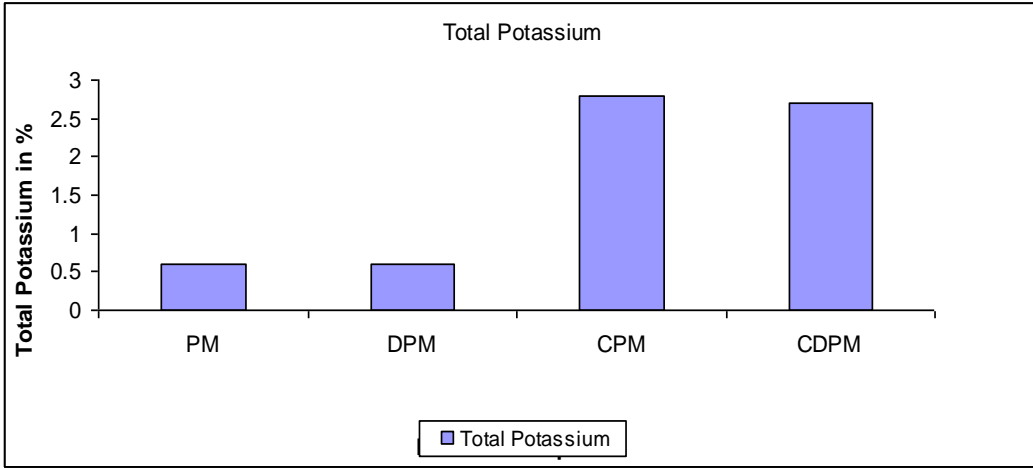


Figure – 3

Total Potassium in Pressmud (PM), Dewaxed pressmud (DPM), Composted Pressmud (CPM) and Composted Dewaxed Pressmud (CDPM)

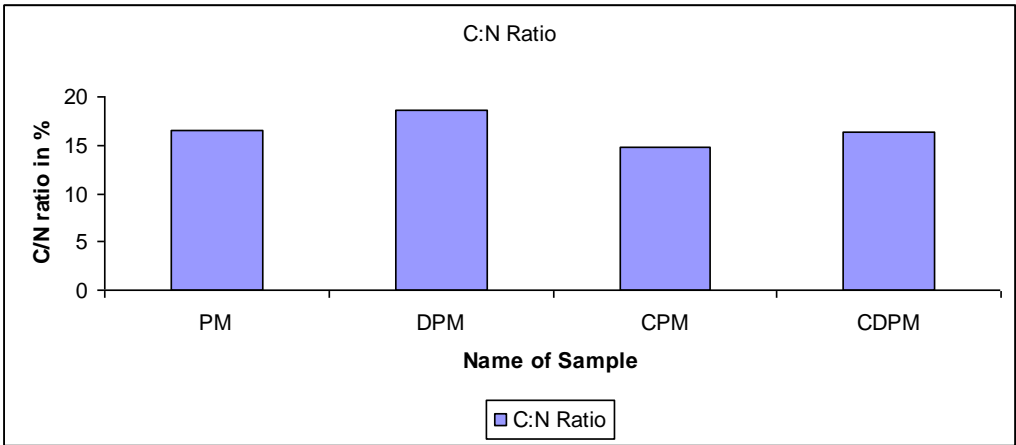


Figure – 4

C: N ratio in Pressmud (PM), Dewaxed pressmud (DPM), Composted Pressmud (CPM) and Composted Dewaxed Pressmud (CDPM)

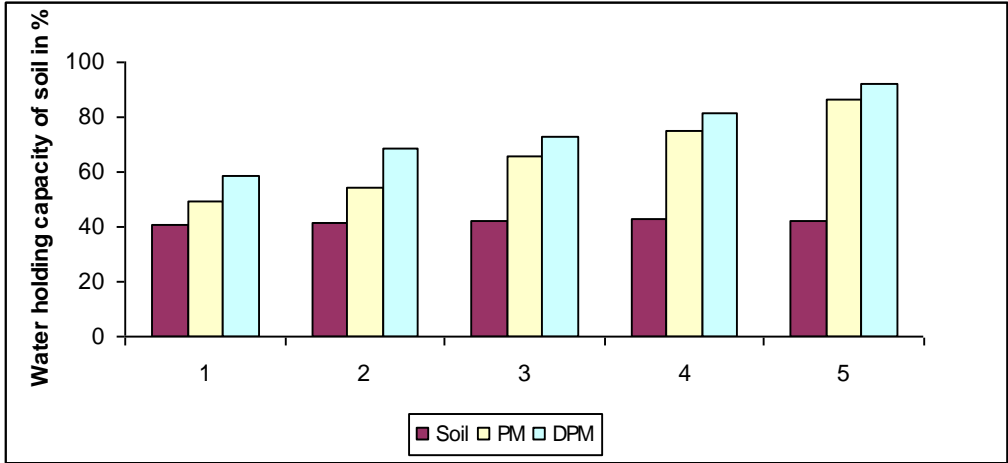


Figure – 5

Water holding capacity of soil measured by using different percentage of Pressmud (PM), Dewaxed pressmud (DPM)

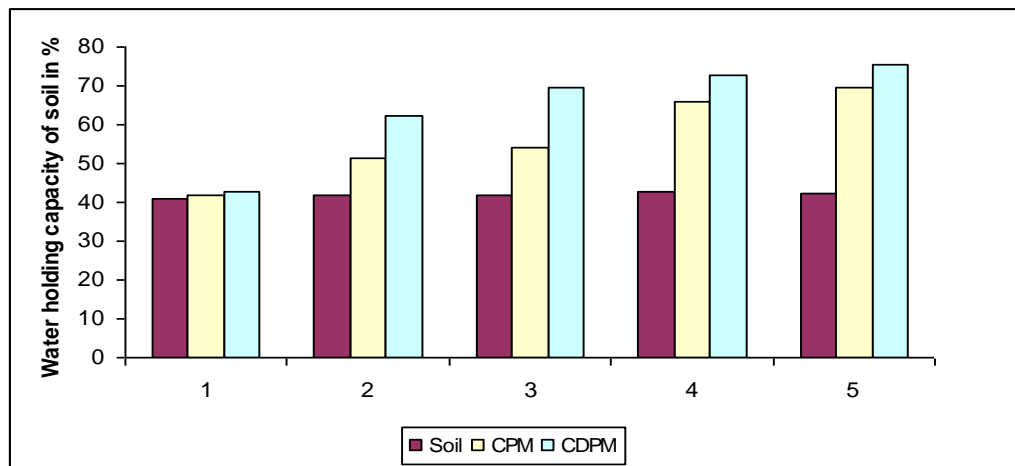


Figure - 6

Water holding capacity of soil measured by using different percentage of Composted pressmud (CPM), Composted dewaxed pressmud (CDPM)