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Effect of pressmud incorporation on physiology of *Cicer arietinum*

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Abstract

Pressmud also known as filter cake or filter mud produced as a by product by sugar mills has been used as a fertilizers and ameliorant in sodic and saline sodic soils. In the present study, different concentrations of sulphitation pressmud with soil were taken i.e., 20%, 40%, 60% and 80%. Equal number of seeds were sown in each pot and irrigated daily. Effect of different concentrations of pressmud was observed on the physiology of *Cicer arietinum* after 21 days of sowing. The percentage of seed germination, vigour index, root length, shoot length, root:shoot ratio, chlorophyll a, chlorophyll b, total chlorophyll, ascorbic acid, fresh biomass and dry biomass were found to be maximum in 20% concentrations of pressmud as compared to control, though high concentration of pressmud result in reduction of growth.

Keywords: *Pressmud, Cicer arietinum, filter cake, biomass*

Introduction

Sugarcane is grown in different parts of the world since middle of the 19th century, primarily for the production of sugar. It was only after the global energy crisis of 1973, that the scientists and technologists realized the value of sugarcane, its by products and co-products. The main by products of sugar industry which have greater economic value:

i. Baggasse
ii. Molasses
iii. Pressmud or Filter Press Cake

The sugar industry by-products are vast potential reserves for human and animal consumption as well as capable of providing energy as renewable source. Bagasse is the fibrous residue left over after sugarcane is crushed. Molasses is a byproduct in the manufacture of sugar. Commercial products made by fermentation of molasses are ethyl alcohol, CO_2, Citric acid, Baker's yeast, butyl alcohol, etc. a mixture of bagasse and molasses is burnt and the ash as used as fertilizers. Pressmud is the residue obtained from sedimentation of the suspended materials such as fiber, sugar, wax, ash, soil and other particles from the cane juice. For every tonne of sugarcane crushed 30-40 Kg pressmud is produced. It is reported that 9 million tones of pressmud is generated in India (Bakthavatsalam, 1999).

Pressmud is produced at the rate of around 3% of weight of cane in sulphitation factories and 7% in carbonated factories. It contains sugar, fiber, coagulated colloids including cane wax, albuminoids, inorganic salts and soil particles. On an average, each ton of sulphitation pressmud contains 17, 36,14, 23 Kg of nitrogen, phosphorus, potassium and sulphur respectively. One of the best and cheapest alternative for chemical fertilizers is organic manure. Pressmud like other organic manures has great potential to supply nutrients in addition to its favourable effects on physico-chemical and biological properties of soil. The organic matter is highly soluble and readily available to the microbial activity and so to the soil for plants (Gaikwad, 1996; Rangaraj et. al., 2007). Filter cake when applied to the land, increase soil fertility by providing nitrogen and phosphorus for crops or ground cover growth (Ossom et. at. 2009). It improves soil nutrient availability and uptake by plants. It is a useful fertilizer, especially when applied to phosphate deficient soil and to fields in which the top soil has

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been removed or re-distributed for any reason. It is useful as a conserver of moisture and as a soil conditioner. Pressmud is also hotbed of microbial population. About 14 sp. of bacteria, 13 sp. of fungi, 5 types of yeast, 5 species of actinomycetes and a few protozoans were identified in pressmud (The Hindu, 2000). Thus, keeping all the above points in view, "Effects of Pressmud Incorporation on Physiology of *Cicer arietinum*" has been studied.

Materials and Methods

The materials and methods include the following aspects:

1. Description of sampling sites
2. Collection and storage of samples
3. Preparation of pots for experiment
4. Physico-chemical parameter of pressmud and soil
5. Mycological parameters
6. Plant parameters

1. Description of sampling sites

Sampling sites for pressmud and soil wereb Sugar factory, Saraswa, Saharanpur and backyard of Kanya Gurukul Mahavidyalaya, Haridwar respectively.

2. Collection and storage of samples

Sampling was carried out for 3 months i.e, February to April, 2010. Soil trower was used for soil sampling. For the present study, five randomly distributed sites over the field was selected, for each composite samples. Samples of soil were thoroughly mixed and for analysis purpose, soil and pressmud was air dried or oven dried and then stored in clean polythene bags.

3. Preparation of pots for experiment

Different concentrations of suphitation pressmud and soil were taken, i.e, 20% (200 gm pressmud+800 gm soil), 40% (400 gm pressmud+600 gm soil), 60% (600 gm pressmud+400 gm soil), 80% (800 gm pressmud+200 gm soil). Ten seeds of the *Cicer arietinum* were sown in each pot and irrigated daily. Effect of different concentrations of pressmud was observed on the physiology of *Cicer arietinum*. After 21 days of sowing i.e., percentage of seed germination, root-length, shoot-length, vigour index, root: shoot ratio, chlorophyll a, chlorophyll b, total chlorophyll, fresh biomass and dry biomass.

4. Physico-chemical parameter of pressmud and soil

Analysis of pressmud and soil were done according to the method as prescribed by Trivedy and Goyal (1998). Physico-chemical parameters analyzed were Moisture content, Porosity, Water holding capacity, pH, EC, Organic carbon, Organic matter, Total Nitrogen, Nitrate Nitrogen, Sulphate, Ferrous iron, Phosphate, Calcium, Sodium, Potassium and Carbon:Nitrogen ratio.

5. Mycological parameters

Five different dilutions were made and numbers of colonies and percentage occurrence of fungal proportions were observed in each dilutions (Aneja, 1993).

6. Plant parameters

Various plant parameters were studies on the *Cicer arietinum* after 21 days of sowing in pots i.e., percentage of seed germination, vigour index, chlorophyll a, chlorophyll b, total chlorophyll, ascorbic acid, biomass estimation by harvest method.

Results and Discussion

Results are presented in tables given below. Table-1 contains results of physico-chemical parameters of sulphitation pressmud and soil. Table-2 shows, total number of colonies in different dilutions. Table-3 shows, percentage occurance of fungal proportions in different dilutions and table-4 contains results of physiological parameters of *Cicer arietinum*(Black Gram).From table-1, it is evident that pressmud has high value of moisture content, porosity and water holding capacity i.e., 39.56±0.41, 0.36±0.01, 78.56±0.06 respectively. High moisture content of pressmud is due to water absorbing capacity of pressmud. 10-30% moisture is favourable for crops. Yaduvanshi and Yadav (1990) reported that 10t/ha sulphitation presssmud having 40% moisture was applied with 75 kgN/ha produced cane yield equal to that by 150 kgN/ha. Water holding capacity of soil is governed by porosity or soil structure.

Table-1: Values of some selected physico-chemical parameters of sulphitation pressmud. (Values are mean±S.E. of 10 observations each).

S. No.	Parameters	Sulphitation pressmud	Soil
1	Moisture content (%)	39.56±0.41	9.66±0.53
2	Porosity(Sec^{-1})	0.36±0.01	0.24±0.01
3	Water Holding capacity(%)	78.75±0.06	43.0±0.91
4	pH	6.8±0.08	7.1±0.03
5	Conductivity(S/cm)	1.65±0.092	0.053±0.007
6	%Carbon	24.3±0.11	0.166±0.09
7	Organic matter (%)	41.89±0.19	0.287±0.18
8	Total Nitrogen (%)	1.72±0.16	0.052±0.06
9	Nitrate Nitrogen (mg/l)	33.3±1.36	26.9±2.11
10	Sulphate (mg/l)	79.75±0.21	41.25±2.16
11	Ferrous Iron (mg/l)	2.89±0.27	0.18±0.03
12	Phosphate (%)	1.45±0.05	0.53±0.23
13	Calcium (%)	0.504±0.015	0.035±0.004
14	Sodium (ppm)	20.00±0.001	14.25±0.002
15	Potassium (ppm)	21.40±0.003	5.00±0.020
16	C:N ratio	14.12	3.19

Gaikwad (1996) reported that addition of pressmud increases the water holding capacity of soil that certainly promotes the growth of plants. pH of sulphitation pressmud and soil were 6.8±0.08 and 7.1±0.03 respectively. According to Muhammad and Khattak (2009), the mean value of pH decreased with increasing levels of presumed. Patel and Singh (1993)reported that application of pressmud reduced the soil pH. The decrease in soil pH with pressmud was possibly due to replacement of exchangeable Na during Na-Ca exchange (Kumar and Abrol, 1984) and subsequent leaching of biocarbonates or the effect of salts on pH (Khattak and Jarrell, 1988). Electrical conductivity of pressmud and soil were 1.65±0.092 and 0.053±0.007 respectively. According to Omar Hattab (1998), pressmud increases the EC because decomposition process of organic matter favours the accumulation of CO_2 and release of large amounts of salts in solution which result in high Electrical Conductivity. Mathakiya and Meiseri (2003) also reported that application of pressmud increases the EC of soil. Organic matter and organic carbon of pressmud were 41.89±0.19 and 24.3±0.11 which is very high as compared to that of soil i.e., 0.287±0.18 and 0.166±0.09 respectively. The amount of organic carbon and available N, P, K increases with increasing with increasing rate of application of pressmud. Gaikwad (1996) reported that addition of pressmud increases the soil organic matter of soil that certainly promotes growth of plants. Nitrogen and Nitrate nitrogen in pressmud accounts for 1.72±0.16 and 33.3±1.36 while in soil it is 0.052±0.06 and 26.9±2.11 respectively.

The increase in available soil nitrogen on account of the pressmud application indicate that nitrogen present in the pressmud was immediately available for crop nutrition (Indiraraj and Raj, 1979). Pressmud also show high value of Sulphur 79.75±0.21, Phosphate 1.45±0.05, Iron 2.89±0.27, Calcium 0.504±0.015, Sodium 20.00±0.001 and Potassium 21.40±0.003 as compared to that of soil. According to Partha and Sivasubramanian (2006), pressmud contains about 1.15 to 3.0% nitrogen, 0.6 to 3.50% phosphorus and 0.30 to 1.80% potassium.

Table-2: Number of colonies present in different dilutions.

S.No.	Dilution	Number of colonies
1	10^{-1}	45.5±0.35
2	10^{-2}	29.5±0.35
3	10^{-3}	21.5±0.53
4	10^{-4}	6.75±0.17
5	10^{-5}	2.75±0.17

(Values are mean±S.E. of 2 observations each).

Table-3: Percentage occurrence of fungal proportions in different dilution.

S.No.	Name of fungi sp. occurrence	Dilutions				
		10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}
1	*Aspergillus* sps.	23.63±0.57	27.12±0.32	32.89±0.84	29.66±0.77	45.00±3.53
2	*Penicillium* sps.	18.67±0.41	19.48±0.36	18.76±1.19	25.82±1.94	39.66±3.3
3	*Mucor* sps.	15.93±0.72	16.95±0.21	15.35±1.21	18.40±1.15	-
4	*Rhizopus* sps.	13.18±0.14	12.69±0.44	11.77±0.41	10.98±0.98	-
5	*Alternaria* sps.	8.77±0.70	6.77±0.07	4.70±0.11	-	-
6	*Fusarium* sps.	8.78±0.01	5.08±0.05	4.70±0.11	-	-
7	*Cladosporium* sps.	11.53±0.29	11.86±0.14	10.64±1.09	15.10±1.01	18.33±1.18

(Values are mean±S.E. of 2 observations each).

Table-4: Physiological parameters of *Cicer arietinum* after 21 days in different concentrations.

S.No.	Physiological parameters	Concentrations used				
		Control	20%	40%	60%	80%
1	Seed germination (%)	80	90	90	90	90
2	Root length (cm)	5.3±0.49	8.45±0.03	6.6±0.63	7.2±0.21	7.5±0.11
3	Shoot length (cm)	13.6±0.56	18.36±0.39	15.4±0.35	16.1±0.26	17.9±0.14
4	Vigour index	1504	2407.5	1980	2097	2286
5	Root:Shoot ratio	0.38	2.71	0.42	2.23	2.38
6	Chlorophyll a (mg/g) Fresh weight	4.17±0.07	6.69±0.05	4.86±0.06	5.96±0.05	6.49±0.02
7	Chlorophyll b (mg/g) Fresh weight	1.70±0.01	2.44±0.08	1.59±0.04	2.08±0.09	2.05±0.07
8	Total Chlorophyll (mg/g) Fresh weight	5.87±0.08	9.13±0.13	6.45±0.10	8.05±0.14	8.54±0.09
9	Ascorbic Acid (mg/g) Fresh weight	1.29±0.03	1.56±0.10	1.36±0.08	1.46±0.19	1.53±0.11
10	Fresh Biomass (gm/m^2)	119.4	230.5	138.8	170.0	184.3
11	Dry Biomass (gm/m^2)	16.9	26.4	17.1	20.0	21.3

(Values are mean±S.E. of 2 observations each).

Table 2-3 shows the mycological study of sulphitation pressmud. From table-2, it is evident that the total colony counted in different dilutions 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} were 45.50±0.35, 29.5±0.35, 21.25±0.53, 6.75±0.17 and 2.75±0.17 respectively. 10^{-1} dilution showed high concentration of fungal colony while 10^{-5} showed low concentration of fungal colony, hence the occurrence of fungal colony is inversely proportional to concentration of dilutions.

From table-3, it is evident that percentage occurrence of *Aspergillus* species and *Pencillium* species were found abundantly in all dilutions because these are fast growing species. These species achieve good growth when moisture content is more than 14%. Pressmud has high moisture content, appropriate pH range and high organic matter with N, P, and K favourable for growth of fungi (Barnett and Hunter, 1999) .Table-4, assess the effect of sulphitation pressmud on *Cicer arietinum* after 21 days of sowing. Percentage of seed germination was observed same in all different concentrations of pressmud i.e., 90% as compared to control i.e., 80%. Raman and Sundram (1996) found that the application of pressmud compost in the soil has significantly increased the germination of tomato seedlings. The maximum root length and shoot length were observed in 20% pressmud i.e., 8.45±0.03 cm and 18.3±0.39 cm and minimum was observed in control i.e., 5.3±0.49 cm and 13.6±0.5 cm respectively. According to the Arvind and Pushpalata (2006), there is an increase in root growth and shoot growth of the *Cicer arietinum* plant by addition of rhizobium and pressmud in the soil. The maximum total chlorophyll content was calculated in 20% pressmud i.e., 9.13±0.13 mg/gm and minimum was in control i.e., 5.87±0.08 mg/gm respectively. An increasing trend of chl.a, chl.b and total chlorophyll was reported in farmyard manure incorporated treatment followed by pressmud and inorganic fertilizer treated plots alone (Bokhtiar and Sakurai, 2005). Ascorbic acid in the present study was highest in 80% pressmud i.e., 1.53±0.11 mg/g and lowest in control i.e., 1.29±0.03 mg/g. Ascorbic acid content increases with increase in level of pressmud. The fresh and dry biomass of *Cicer arietinum* was highest in 20% pressmud i.e., 230.5 g/m^2 and 26.4 g/m^2 respectively against control i.e., 119.4 g/m^2 and 16.9 g/m^2 respectively. All growth parameters showed maximum results in 20% pressmud as compared to control which indicated that this concentration is favourable for plant growth.

Conclusion

Present study showed that application of pressmud improves the soil structure and provide better aeration for exchange of gases. It also increases the soil organic matter and water holding capacity of soil that promotes the growth of plant. Pressmud has great potential of increasing nutrient content, thereby improving the yield of crop upto significant extent. The values of root length, shoot length, vigour index, root:shoot ratio, chl.a, chl.b, total chlorophyll, fresh biomass and dry biomass were maximum in 20% pressmud which may be due to its high organic matter, adequate nitrogen and phosphorus content. This indicates that 20% pressmud is most favourable for plant growth.

Hence, the physico-chemical and mycological study of pressmud suggests that pressmud is a useful organic fertilizer which helps to reduce the use of chemical fertilizer and its application improves the soil structure that promotes the growth of plant.

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