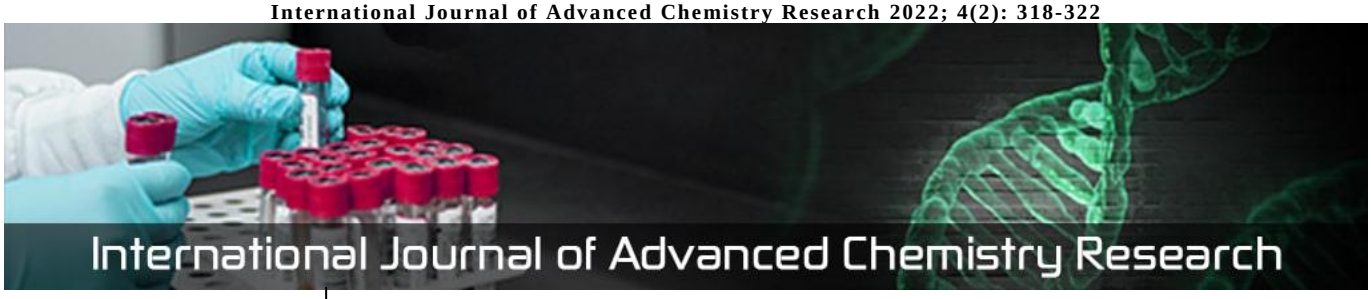

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Effect of organic raw and treated press mud with inorganic fertilizers NPK on maize (*Zea mays*) plant

Nayan P Chapane, Shridhar P Saptale and Shriganesh R Shelke

Abstract
A pot experiment was conducted to evaluate the different combinations of sugarcane raw press mud +cow dung + inorganic fertilizer NPK at a rate of (120:60:40 kg N: P2O:K2O ha^{-1}) and the same treatment with treated press mud. The raw and treated press mud can be used as organic fertilizer to increase the maize (Zea mays) plant height and number of leaves. T1- absolute Control,T2-Soil +cow dung 5 MT/ha^{-} + raw press mud (RPM) 5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1} , T3-Soil +cow dung 5 MT/ha^{-} + raw press mud (RPM) 7.5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1} , T4-Soil +cow dung 5 MT/ha^{-} + raw press mud (RPM) 10 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1} ,T5- Soil +cow dung 5 MT/ha^{-} + treated press mud (RPM) 5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}, T6- Soil +cow dung 5 MT/ha^{-} +treated press mud (RPM) 7.5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1} ,T7-Soil +cow dung 5 MT/ha^{-} + treated press mud (RPM) 10 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}. The first 30 DAS, without using the inorganic recommended dose of (RDF), show increased growth of maize plants due to the availability of plant nutrients in RPM and TPM. After 30DAS, RDF was applied and at 60 DAS increased the maize plant height and number of leaves. Significantly highest plant height and number of leaves showed in treatment T7.

Keywords: Raw press mud, treated press mud, growth, maize, organic fertilizer, inorganic fertilizer

Introduction
Maize (*Zea mays* L) is one versatile and adaptable under in agro-climate conditions and important food after rice and wheat in India (David and Adams 1985) [4]. In Maharashtra, maize is cultivated in Nashik, Aurangabad, Pune and Solapur district. As per reports, 50%of maize production in Pune district, 10 to 15% from Ahmednagar district and 3-4% in Nashik district and some parts of Solapur district (Kasabe Nanda 2020). Maize is used for the consumption of food for human being and quality feed for animals. It is used as basic raw material and ingredients of industrial products includes the making of starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, gum, package and paper industries.

The growth of maize requires essential primary macronutrients in large amounts *viz*: nitrogen, potassium, phosphorous. Maize crops need a regular supply of nitrogen, phosphorous, and calcium throughout their growing period from the seedling stage to the grain filling stage. Nitrogen plays a vital role in maize production. Nitrogen is a component of protein, nucleic acid, protoplasm, and part of the chlorophyll molecule, also essential for photosynthesis process (Shanti, K.V.P., M.R. Rao *et al* 1997) [1]. Maize is recognized for more requirement of nitrogen than other plant nutrients element. Nitrogen fertilizer has a very good effect on the growth and yield of maize (Seadh *et al* 2013) [3]. Phosphorous play's vital role in photosynthesis, respiration as well as in energy storage and transfer as ADP and ATP (adenosine di and tri-phosphate), DPN and TPN (Di and tri-phopyridine nucleotide). It helps in plant maturation, rapid growth, encourages blooming and root growth, seed and flower development. Phosphorous is involved in enzymatic reactions, necessary for cell divisions and the cell reproduction process. Potassium plays the role of enzyme activator that helps with metabolism. Regulatory of opening and closing of leaf stomates of the plant. In photosynthesis, to recover disease resistance in plants, and improve the quality of fruits and vegetables. Potassium is absorbed from soil and plays important role in plants for the formation and synthesis of amino acid and proteins from ammonium ions.

Responses of maize plant to the application of NPK depends on variety of location, environmental factors like rainfall, climatic condition, availability of the soil nutrients.

Soil is a most important, natural source and medium for food production (Biggelaar, *et al* 2003) [12]. The analysis of soil cannot be completed by the determination of the most important factors, influencing the storage potential and the availability of nutrient elements in the soil. Certainly, behaviour and the uptake of nutrients by the plant roots of fertilizer and native nutrient elements present in the soil, are determined by pH, electrical conductivity, organic matter, total nitrogen content, cation exchange capacity and oxidation -reduction conditions. The ability of plants to absorb nutrients depends on soil condition, irrigation and aeration.

Sugarcane press mud is a slow-release fertilizer and prolonged effect on plant growth (Budiyanto G.2021) [11]. Press mud is soft, spongy, amorphous and dark brown white material containing sugar, fiber, albuminoids, also inorganic salts and cane wax. Press mud prevents of disease-causing fungi and reduces the growth rate of microbes as well as useful for soil which has deficient of total N, P, K. It can provide alternative fertilizer which can replace chemical fertilizer to some extent. Press mud increases the moisture, micro and macro nutrient of the soil which are beneficial for agricultural crops. Press mud as eco-friendly and healthy manure for crops as well as for agriculture practices.

This study is aimed to examine the presence of nutrient organic sugarcane raw and treated press mud and its combination with nitrogen, phosphorus and potassium fertilizer to increase maize plant height and number of leaves of plant growth.

Materials and Methods

Description of experimental site

The cultivation of maize was undertaken during the period year 2021 in pot, in *kharif* season (September -November). A pot culture experiment was conducted at Ambegaon (BK), Pune, District -Pune, Maharashtra, India, located at NL $18^0$27’33”, EL :$73^0$49”51”.

Experimental Design

The experiment was designed in RBD with three replications and six treatments and one absolute control. Details of treatment used in this study as follows:

Details of treatment used in this study as follows:

Treatment	Details
T1	Absolute Control
T2	Soil +cow dung 5 MT/ha$^-$ + raw press mud (RPM) 5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}
T3	Soil +cow dung 5 MT/ha$^-$ + raw press mud (RPM) 7.5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}
T4	Soil +cow dung 5 MT/ha$^-$ + raw press mud (RPM) 10 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}
T5	Soil +cow dung 5 MT/ha$^-$ + treated press mud (RPM) 5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}
T6	Soil +cow dung 5 MT/ha$^-$ +treated press mud (RPM) 7.5 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}
T7	Soil +cow dung 5 MT/ha$^-$ + treated press mud (RPM) 10 MT/ha^{-1} + inorganic fertilizer NPK at rate of 120:60:40 kg N:P_2O:K_2O ha^{-1}

Planting and cultural practices

Sowing of maize was done on 13September 2021. Seed of maize species is Hy. maize (Zea mays), brand name Balram were obtained from Greco seeds, marketed by Green cross seeds and services. The treatments of inorganic fertilizer (nitrogen, phosphorous and potassium) were applied at 30DAS after planting through Urea, Single super phosphate and Muriate of potash respectively. The inorganic fertilizers were applied by placing along the lines 5 cm away and 5 cm below the maize plant. All the pots were uniformly irrigated by water and maintained field capacity.

Organic fertilizer

The sugarcane raw press mud (RPM) and treated press mud (TPM) is obtained from the Pandurang sugar factory, Shripur, district Solapur, Maharashtra, India. The organic manure was well-decomposed cow dung manure prepared onsite. The chemical fertilizers used for the present study were selected as per requirement and on the basis of availability, and preference by growers of maize (Zea mays). Physico-chemical analysis of the soil was carried out before the experiment. Analysis of sugarcane raw press mud (RPM) and treated press mud (TPM) was carried out to determine the plant nutrients status. Effect of organic raw and treated press mud and inorganic fertilizers on maize (Zea mays) plants were studied on an attribute like plant height and number of leaves per plant.

Result and Discussion

Soil Analysis

Physico-chemical analysis of the soil was carried out before the experiment. The results of determining the potential for soil fertility are shown in Table no.1.

Table 1: Physico-chemical analysis of Soil

Sr. No	Parameter	Unit	Value	Interpretation
1	pH	-	8.09	Alkaline
2	E.C	dSm^{-1}	0.36	Normal
3	Organic Carbon	%	0.78	More
4	Available Nitrogen	Kgha^{-1}	87.81	Very Low
5	Phosphorus	Kgha^{-1}	13.60	Low
6	Potassium	Kgha^{-1}	237	Moderately high
7	Sand	%	19.48	-
8	Clay	%	33.64	-
9	Slit	%	22.13	-
10	Coarse sand	%	24.75	-

From Table 1, the soil of the experiment was analysed, pH 8.09 which was alkaline in nature, EC (0.36 dSm^{-1}) was normal in range and organic carbon (0.78%) was more available in soil. Nutrient status of soil consists of very low in available nitrogen (87.81 $Kgha^{-1}$), low in phosphorous (13.60 $Kgha^{-1}$) and moderately high in potash (237$Kgha^{-1}$). Soil is dominated by fraction of sand (19.48%), clay (33.64%), slit (22.13%) and coarse sand (24.75%).

Analysis of sugarcane raw and treated press mud

The analysis of sugarcane raw and treated press mud was carried to determine the availability nutrients status.

Table 2: Analysis of sugarcane raw and treated press mud

Sr. No	Sugar Factory	Symbol	Unit	Raw press mud (RPM)	Treated press mud (TPM)
1	pH	-	-	7.46	8.04
2	Electrical conductivity	E.C	S/m	1.07	2.59
3	Organic Carbon	OC	%	15.38	6.83
4	Nitrogen as N	N	%	2.62	1.35
6	Silicon	SiO_2	%	5.868	6.385
7	Aluminium	Al_2O_3	%	0.4852	0.429
8	Potassium	K_2O	%	2.548	4.538
9	Calcium	CaO	%	12.58	10.46
10	Magnesium	MgO	%	2.681	2.298
11	Phosphorus	P_2O_5	%	5.856	4.675
12	Manganese	MnO	%	0.05518	0.04754
13	Iron	Fe_2O_3	%	1.014	0.9184
14	Sulphur	S	ppm	15890	36080
15	Chlorine	Cl	ppm	13520	19520
16	Nickel	Ni	ppm	7.9	8.4
17	Copper	Cu	ppm	69.5	75.3
18	Zinc	Zn	ppm	127.7	108
19	Selenium	Se	ppm	16.3	23.9
20	Bromine	Br	ppm	16.7	24
21	Strontium	Sr	ppm	86.3	88
22	Molybdenum	Mo	ppm	2.9	6.1
23	Tin	Sn	ppm	13.7	17.7
24	Antimony	Sb	ppm	0	12.3
25	Barium	Ba	ppm	58.6	90.7

From table 2, Sugarcane press mud is organic material, containing micro -macro plant nutrients. The RPM and TPM contains a varied amount of available nutrients N, P, K, Si, Al, Ca, Mg, Mn, Fe, S, Cl, Ni, Cu, Zn, Se, Br, Sr, Mo. Sugarcane press mud is mixed with other organic fertilizers (P.M. Diaz 2016). Reported that, press mud is a by-product of sugar industries and used as fertilizer in agriculture as a soil reclamation agent as well as a soil conditioner (Bhosale P.R., Chonde S.G. *et al* 2012) [9]. Application of press mud improved soil N, P, K, Fe, Zn, Mn, and Cu, and increases crop yield, quality and to some extent saved chemical fertilizer.

Growth parameters

Growth analysis is an important tool for interaction between plant and environment and understanding the critical phase in the life cycle of any plant. Effect of organic raw and treated press mud and inorganic fertilizers on maize (Zea mays) plant were studied on attributes like plant height, and number of leaves per plant.

Table 3: Effect of treatments on the Plant height and number of leaves of maize (Zea mays)

Sr.No.	Treatment	Plant Height			Number of leaves		
		Days after sowing					
		15DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS
1	T1	19.43	29.47	103.40	3.7	6.00	13.00
2	T2	22.40	33.77	114.03	3.7	6.33	13.33
3	T3	20.57	35.50	162.50	4.0	6.33	13.67
4	T4	22.80	37.90	165.13	4.0	7.00	13.67
5	T5	20.77	36.83	166.60	4.0	6.67	13.67
6	T6	20.30	36.80	167.43	4.0	6.67	14.00
7	T7	22.83	37.57	167.53	4.0	7.00	14.00
S.E.		0.73	0.30	0.30	0.16	0.36	0.58
CD 5%		2.25	0.91	0.93	0.50	1.10	1.77

According to the research report, the application of inorganic fertilizer nitrogen and phosphorous at rate of 120kgN/ha + 40kgP/ha and at rate of 60kgN/ha + 40kgP/ha, both were increasing the maize growth, grain yield and maize production (R.O. Onasanya, O.P. Aiyelari *et al* 2009) [3]. Maize crops grow very well in different rates of nitrogen, phosphorous fertilizer (Singh, V.K. and O.P. Dukey 1991) [5]. Decreasing soil fertility and insufficient use of fertilizer causes a low yield of maize. Nitrogen, and potassium plays important role in stalk of maize, magnesium and copper help in different growth stages of maize. Nitrogen and phosphorous had most required during the grain filling stage

(Csaba Bojtor,Arpad Illes *et al* 2021) [6]. The essential nutrients sulphur, potassium, molybdenum, and nitrogen showed a significant effect on NPK treatments, also molybdenum, potassium, and iron had a positive effect on the leaves of maize. Phosphorous requirement in sowing stage (K. Girma, K. L. Martin, K. W. Freeman *et al* 2007) [7].

Plant height

15DAS

The height of maize at 15 DAS was significantly highest in treatment T4 which was at par with treatment T7, T2, T5. The recorded plant height was in treatment T4 (22.83 cm), T7 (22.80 cm), T2 (22.40 cm) and T5 (20.77cm). The height of T3 (20.57 cm) was followed by T6 (20.30 cm) and T1 (19.43cm). The hierarchical trend of plant height observed amongst was T4> T7> T2> T5> T3> T6> T1.

30DAS

The height of maize at 30 DAS was significantly highest in treatment T4 which was at par with treatment T7. The recorded plant height was in treatment T4 (37.90 cm), T7 (37.57 cm). The plant height was recorded in treatment T5 (36.83 cm), T6 (36.80 cm), T3 (35.50 cm), T2 (33.77 cm) and T1 (29.47 cm). The hierarchical trend of plant height observed amongst was T4> T7> T5>T6> T3> T2> T1. The treatments of inorganic fertilizer (nitrogen, phosphorous and potassium) were applied at 30DAS after planting *viz:* Urea, SSP (single super phosphate), MOP (Muriate of potash).

60 DAS

After using inorganic fertilizer (nitrogen, phosphorous and potassium), plant height was recorded. The height of maize at 60 DAS was significantly highest in treatment T7 which was at par with treatment T6. The recorded plant height was in treatment T7 (167.53cm), T6 (167.43 cm) T5 (166.60 cm) which was closely followed by T4 (165.13cm) was next line to T3 (162.50 cm), T2 (114.03 cm) and T1 (103.40 cm) were found. The hierarchical trend of plant height observed amongst was: T7> T6> T5> T4> T3> T2> T1.

Number of leaves

15DAS

The number of leaves of maize at 15 DAS was significantly highest in treatments T3, T4, T5, T6, and T7 at par with treatments T1, T2. Although the difference amongst the treatments depicted in table no. 3 was not highly significant, the number of leaves was highest and found to be similar in treatment T3, T4, T5, T6, T7 i. e number of leaves 4. Also, the number of leaves was found to be similar in treatment T1, T0 (3.7). The general leaf number in all treatments was as follows: T3=T4= T5=T6= T7> T1=T2.

30DAS

The number of leaves of maize at 30 DAS was significantly highest in treatment T7, T4 at par with treatment T5, T6, T2, T3, T1. The number of leaves was highest found in T7 and T4 (7). The number of leaves was found to be similar in treatment T5 and T6 (6.67). The number of leaves similar in treatment T2 and T3 (6.33). The number of leaves was the lowest found in treatment T1 (6). The general leaf number in all treatments was as follows: T7=T4> T5=T6> T2= T3>T1.

60 DAS

The number of leaves of maize at 60 DAS was significantly highest in treatment T7, T6 at par with treatment T5, T4, T3, T2, T1. The number of leaves was highest found in treatments T7 and T6 (14). The number of leaves was similar in treatments T5, T4, T3, T2, and T1 (13). The general leaf number in all treatments was as follows: T7= T6> T5 =T4= T3= T2= T1.

Discussion

Without using inorganic fertilizer in the first 30DAS shows increased growth of maize plant *viz:* plant height and a number of leaves in treatment T2, T3, T4, T5, T6, T7, due to availability of plant nutrients in RPM and TPM. Plant height varied significantly due to the application of nutrients contained in raw and treated press mud at the stage of plant growth at 30DAS (Table No.3). Raw press mud and treated press mud possess different elemental compositions. The micro/macro nutrients elements contents were higher level in TPM due to spraying of distillery spent wash on it as compared to raw press mud (Nayan Chapane, Shridhar Saptale 2022) [15].

Significantly highest plant height and number of leaves in treatment T7 such as plant height (22.83, 37.57, 167.53 cm at 15, 30 and 60 DAS respectively) and the number of leaves (4,7,13.67 at 15, 30 and 60 DAS respectively). The result obtained from this study; growth was mostly supported by application rates of treated press mud treatment T7. It can be observed that plant height and the number of leaves per plant tended to increase in treatment T7.

Treatment T4 also showed positive results of plant height and number of leaves, plant height (22.80, 37.90,165.13 cm at 15,60, and 60 DAS respectively) and number of leaves (4,7,13.67 at 15, 30, 60 DAS respectively) was recorded.

The treatment T7 significantly recorded the highest plant height as well as the number of leaves. Researchers reported that, sugarcane treated press mud is an organic fertilizer that is a slow-release nutrient, it produces the most potassium availability. The application of organic treated press mud to soil can significantly increase the available potassium and exchangeable -potassium (Hamed *et al*., 2011) [13].

The significantly increased in plant height and number of leaves in responses to the application of organic and inorganic fertilizer is probably due to the enhanced availability of nutrients in maize plant. The higher nutrient supply of inorganic NPK from soil to plant and uptake of nutrients improve plant height and number of leaves of maize (Jemal Abdulai 2010) [14]. Using inorganic fertilizer along with press mud as commercial fertilizer for the crop (M. L. Dotaniya, S. C. Datta, D. R. Biswas *et al* 2016) [10].

Conclusion

The application of raw and treated press mud contains micro -macro nutrients which showed a positive effect on plant growth of maize in the first 30DAS without using inorganic fertilizer in treatment T2, T3, T4, T5, T6, T7. The experimental treatment, sugarcane raw press mud and treated press mud combination with cow dung among with RDF 20:60:40 kg N:P_2O: K_2O ha^{-1} used as manure in maize (Zea mays). Sugar cane raw and treated press mud interact with inorganic fertilizer, responses the growth parameter of maize, and increase the plant height and number of leaves.

This study concluded that, treatment T7 is appropriate for increasing the plant height and number of leaves.

Recommendation

1. The raw press mud and treated press mud combination along with a recommended dose of fertilizer (RDF) within a certain limit will get greatly beneficial to farmers.
2. According to soil status of available NPK, raw press mud, and treated press mud status of NPK, farmers can apply inorganic fertilizer NPK to a certain limit.

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