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Impact of Bagasse Ash Abatement Soil on Growth and Production of Mustard (Brassica juncea)

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Abstract

Sugar cane bagasse ash is an industrial waste which is used worldwide as fuel in the same sugar cane industry. The combustion yield ashes containing high amounts of unburned matter, silicon and aluminium oxide as main components. Sugar cane bagasse is a type fibrous waste-product which obtained from sugar refining industry, along with ethanol vapour. Large quantity of ash which is a usually waste product, available at very insignificant rate. To the current research work achieve the aim, sugar industry bagasse ash was applied to Brassica juncea crop in pots having 2 kg soil @ 20%, 40%, 60%, 80% and 100% respectively, when we compared to the control sample. The physiochemical properties of soil under the investigation was having a pH (8.5), low in organic matter (8200 mg kg^{-1}), and low content of Nitrogen (334 mg kg^{-1}), Phosphorus (4.4 mg kg^{-1}), Zink (6.1 mg kg^{-1}) and Iron (5.5 mg kg^{-1}) . Bagasse ash was rich source of micronutrients like Fe, Mn, Zn and Cu and also contained sufficient amount of K and P. Consequently, total porosity of soil, presence P, K, Fe, Mn, Zn and Cu content in soil, increased with the levels of bagasse ash application. On the other hand, dry bulk density declined which shows a positive effect. EC_e and pH of the soil was minutely increased. Yields and most of the yield components of Brassica juncea crop in pots, also increased due to bagasse ash application. It is recommended that application of bagasse ash 20% to can Prol 40-60% will result in enhanced yield of *Brassica juncea* crop soil.

Keywords: Bagasse Ash, Soil Nutrients, Soil Characteristics, Brassica Juncea Crop.

Introduction

Bagasse ash is type of organic wastes which obtained from sugar industry during the process of sugar production . Basically we use Bagasse in agriculture as organic fertilizers for crop improvement is now a day's becoming an established practice. Researches considers bagasse ash as a good source of micro nutrients like, Fe, Mn, Zn and Cu (Anguissola et al. 1999) It can also be used as soil additive in agriculture farming having its capacity to supply the plants with small amounts of nutrients (Carlson and Adriano 1993). Bagasse ash contain no An, but there are commonly high concentration of K and P (Page et al. 1979), therefore, it us e in agriculture for crop production will be proved more beneficial.

The present study was carried out on sugar cane bagasse ash (SCBA) obtain by controlled combustion of sugar cane bagasse, which was produced from the Tamil Nadu province in Indian. Sugar cane production in India is over 300 million tons per year leaving about 10 million tons of as unutilized and hence, waste material.

Fly ash is waste product of industrial plants that serious part of environmental hazards. Releasing of the large amount of ash produced by burning of Cole for energy purpose in many industry is a significant concern today (Gautam et al. 2012) Fly ash, though finds a use in the manufacturing of cement, bricks and its allied construction materials, but this is not so popular in India on cost consideration. Countries like U.S.A, Germany and The Netherlands utilize 70 % of fly ash as building material and for other constructional purpose, but in India its utilization is less than 5 % (Mandal and Sinha, 1988). It can also be used as a land fill material, or for renovat acidic or sodic soils (Plank and Martens, 1974; Taylor and Schuman, 1988). Because of the banned use of ash in such activities, thermal power stations have to provide adequate storage space and check associated current environmental pollution problems (Pathak et al. 1996).

The waste of sugar cane produces bagasse ash. Currently in sugar factories bagasse is burnt as fuel so as to run their boilers. This bagasse ash is usually scattered over Agriculture farms and dump in ash pond which provide environmental problems also research states that were place exposure to dusts from the processing of bagasse can cause the health problems including chronic lung condition pulmonary fibrosis, more specifically related to as bagassosis. So there is great need for its reuse, also it is found that bagasse ash is high in Silica and is found to have pozollinic property so it can be used as substitute to construction material. Such huge amount of bagasse ash always created disposal problems for the sugar mills owners, municipal administration and environmental organizations.

Keeping in view the nutritive importance of this organic waste and its positive effects on the yield of cereal crops (Sharma *et al*., 2001 and Kumar *et al*., 1999), its proper doses shall be enquired thoroughly.

Therefore, the present research work was planned to investigate about the chemical composition of bagasse ash, to elucidate the effects of different rates of bagasse ash on wheat crop in soil and to recommend its most appropriate dose for higher yield of *Pisum sativum* crop.

Materials and Methods

Material collection and Experimental set-up

This research of pot culture experiment was performed at the research site of the Department of Environmental Science, Bareilly College, Bareilly during winter season 2014-2015. Bulk soil samples from 0-3 inches 0-30 cm depth were collected which was air dried, ground and passed through a 2mm sieve. Bagasse ash was collected from the dumping site of Oswal Sugar Mills Nawabganj; Different concentration of bagasse ash and clay soil were prepared by mixing the two in different ratio @ T_1-20%, T_2-40%, T_3-60%, T4- 80%, T_5-100%. C was kept as control. Ten seeds pot^{-1}of *Brassica juncea* were sown in each separate pot. The experiment was laid out in a randomized complete design and each treatment was replicated four times. The crop was irrigated at appropriate times and conditions and weeds were controlled manually. After germination, thinning was done and only three plants were left in each pot. The Observation and recorded data of plant were including plant height, number of leaves plant^{-1}, number of flowers plants^{-1}, number of pods plants^{-1}, dry weight of root, shoot, leaves and pods plant^{-1}.

Soil and Bagasse ash Sampling and Analysis

We collected Bulk soil samples from 0-3 cm depth before sowing. The collection of samples were air dried, ground and passed through a 2mm sieve. Bagasse ash samples were also air dried and passed through a 4 mm sieve. Also after harvesting of the crop, We collected soil samples from the plots of field experiment, air dried and passed through a 2 mm sieve. All of the collected soil samples before sowing and after harvesting, and the bagasse ash samples, were analyzed and note various physico-chemical properties characteristics. Particle size of sample in soil samples was examined by a hydrometer method as described by Day (1965). Ca^{++} + Mg^{++} were examined and determined by EDTA titration where NH_4Cl-NH_4OH buffer solution and eriochrome black T indicator was used (Richard, 1954). Organic matter content in the soil and bagasse ash samples was examined and determined by dichromate method recommended by MAFF (1986). Total N was examined determined by the Kjeldahl procedure (Jackson 1964). Available K was examined determined by ammonium acetate method (Black, 1965). P was estimated by formation of a phosphomolybdate complex, which is reduced by using ascorbic acid to produce a blue color (Lennox, 1979). Zn, Cu, Fe and Mn determination was made in 0.005 M DTPA extract ant (Lindsay & Norvell, 1978) by atomic absorption spectrophotometer.

Morphological Parameters

We harvested plants and washed carefully to remove the dust particles adhering to the surface. Root hairs of plants were wiped carefully to prevent breakage. They were then blotted with a blotting paper. Then we starts observation Root and shoot length and number of leaves was counted thrice at a month's interval each. Dry matter weight was taken after partitioning the plant into leaf, stem and roots followed by drying at 40^{o}C for two hours and then at 85^{o}C for 24hours.

Bio Chemical Assay

Chlorophyll constituent of plant leaves was examines estimated by Arnon's method using 80% acetone for preparing leaf extract. This was followed by centrifugation and measurement of the optical density of the clear supernatant. Protein content was assayed by Lowery method as modified by Herbert *et al*., 10% Trichloroacetic acid was used to prepare leaf extract followed by centrifugation after which the pellet was mixed with 1NNaOH followed by heating.Thissolution was further centrifuged and 0.5ml of the supernatant was mixed with 5ml of reaction mixture and allowed to stand for 15min. 0.5ml of folin's reagent was added to get a blue coloured solution. The absorbance was read at 650nm. Carbohydrate content in leaves was estimated by Ashwell's method using anthrone and sulphuric acid as the cardinal reagents.

Results and Discussion

Impact of bagasse ash on physico-chemical characteristics of the soil.

Table 1 shows the detailed and broad laboratory analysis of soil sample receiving different doses of bagasse ash during the pot experiment. The observation analysis reveals that like other organic wastes, bagasse ash also affects the physico-chemical characteristics of the soil positively and improve its quality. As a result the dry bulk density of the soil decreased from 1.065 gm cm^{-3} to .413 gm cm^{-3} and the total porosity of the soil increased from 50.0 to 52.840%, while the textural class remained the same. There was also a slight increase in soil pH from 7.6 in control to 9.1 in the treatment receiving bagasse ash @ 100%. An increase in exchangeable calcium and magnesium contents was observed due to bagasse ash. Available micronutrients, EC_e, P and K also increased in comparison to the control sample . The highest amounts of Phosphorus (48 mg kg^{-1})

and Potassium (220 mg kg^{-1}) was found in the treatments amended with 100% bagasse ash. Maximum Zn (41 mg kg^{-1}), copper (14 mg kg^{-1}), iron (38 mg kg^{-1}) and manganese (1599.65 mg kg^{-1}) contents were also recorded in bagasse ash. The values recorded for EC_e (7.2 dsm^{-1}) and Ca^{++} + Mg^{++} (1160+1599 mg kg^{-1}) were also highest in collected bagasse ash.

Table 1
Comparative Analysis of Soil and Bagasse Ash

Parameter	Soil	Bagasse Ash
Dry Bulk Density $gmcm^{-3}$	0.98	0.38
Ph	7.6	9.1
EC dsm - 1	2.2	7.2
Organic Carbon	2.30	7.12
N (mg kg-1)	336	150
C/N	1.5	4.76
P (mg kg-1)	4.2	48
K (mg kg-1)	160	220
Zn (mg kg-1)	5.9	41
Fe (mg kg-1)	5.3	38
Cu (mg kg-1)	7	40
Mn (mg kg-1)	9	110
O.M. (mg kg-1)	8300	Nil

The decrease in dry bulk density and increase and improvement in soil porosity which positively affect the water retention quality and moisture availability in the root zone. This finally ,results in better availability of plant nutrients and enhances plant roots proliferation in the soil. The observation and analysis also reveals that, along with improvement in soil physical properties, bagasse ash also increases and improvement the Ca, Mg, K, P and Micronutrient content of the soil. Deshmukh *et al*. (2000), during their treatments improved the nutrients status and physiological properties of the soil. Although the amendments had some effects on soil bulk density, CEC, available micronutrients and very minute improvement in exchangeable Ca and Mg, they did not have an effect on soil pH, soil EC, organic C content and available N status of the soil. Grewal *et al.* (2001) also found that fly ash application also resulted in greater moisture storage in the plough layer of soil at all the stages of crop growth. Braman *et al.* (1999) observed during a wide range experiments that metal contents (Cd, Cu, Zn, Fe, Ni, Cr and Pb) in the soil samples having fly ash were higher than in the control soil. Kumar (2002) studied the possibility of fly ash application to agricultural soils. The final observation revealed that fly ash application, usually in higher amount (8% w/w) increased the pH and electrical conductivity of the soils, however, the application of low amount (2% and 4% w/w) favored plant growth and improved yield. Although the element concentration was found more in fly ash amended soils than the control. Lee *et al.* (2006) also concluded that fly ash could be mixed as a supplement with other inorganic soil amendments to improve the nutrient balance in paddy soils.

Morphological Characteristics of the Plant

The effect and impact of bagasse ash on the different morphological parameters of *Brassica juncea* was studied Seed germination, growth of plant Root length and shoot length, Number of leaves, flowers and pods.

Effect of bagasse ash amendment (Figures 1) revealed and find out maximum percentage of seed germination in the T_4 (4:1, Bagasse ash and soil) as recorded at the end of second week. The seed germination increased gradually from T_5 to T_4 (90 - 96 %) and then decreased from T_3, T_2, T_1 and C (80%, 76%, 72% and 68%). This work that significant increase the germination of seed, due to improvement in soil physical and chemical properties and abundance of different dose of bagasse ash. Pawar and Dubey (1988) also found an increase in germination of maize, sorghum, wheat and gram treated with up to 10% fly ash and decreased with higher fly ash dose expected in gram, which tolerated a 30% fly ash dose. This result coincides with the finding of Gautam *et al.* in *Brassica juncea*.

Priyatma et al. (2015) was observed the seed germination maximum in T_5 (98.88%) in 60% (bagasse ash + soil) Triticum aestivum.

Figure 1 - Effect Of Bagasse Ash Amended Of Soil On The Percentage Seed Germination Of Brassica Juncea

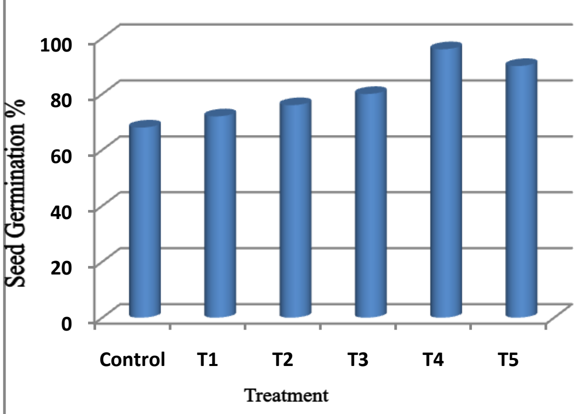
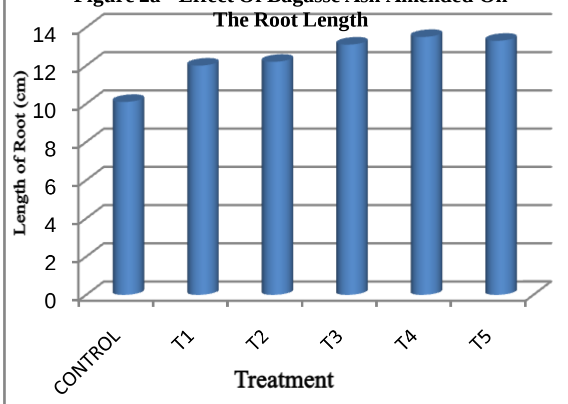
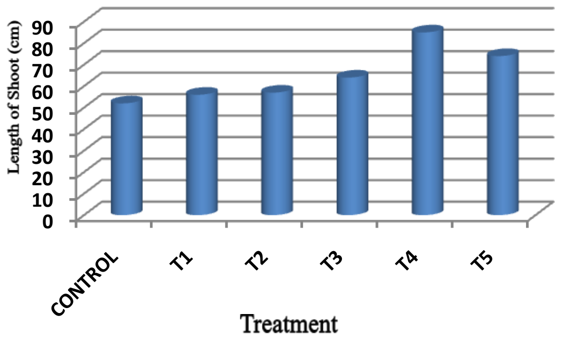


Figure 2a - Effect Of Bagasse Ash Amended On The Root Length



Effect of bagasse ash amendment on root length and shoot length of *Brassica juncea* revealed that both the length of root and shoot were observed maximum in the amendment in T_4 (4 : 1, bagasse ash and soil) as recorded on 90 days of experiment. The length of root maximum in T_4 (80% bagasse ash + soil) 13.5 cm and minimum in C (control soil) 10.1 cm. The length of Shoot maximum in T_4 (80% Bagasse ash and soil) 85cm and minimum shoot length in C (control soil) 52cm.

Figure 2b - Effect of Bagasse Ash Amended on the Shoot Length



Effect of bagasse ash amendment was studied with respect to the number of leaves, flowers and pods per plant. Results in Table -2 revealed that the maximum no. of leaves present in T_4 (4:1 bagasse ash + soil) 20 and the minimum number to leaves in Control (Soil) 10. The maximum no of flower present in T_4 (4:1 bagasse ash + soil) 81 and the minimum no. of flower present in, C (control soil) 38. The maximum no. of pods present in T_4 (4:1Bagasseash+soil) and the minimum number of pods present in C (control soil) 34. The plant height (root and shoot length) in pots experiment might have increased due to abundant K and micronutrients, and improved soil physical condition. Improvement and increment in soil porosity also provides to better crop growth, concerning roots and shoots development in the soil and better availability of essential nutrients. Hernandez (2000) also found the best growth including (height, diameter and biomass production) of Hyeronimaalchorneoides and Terminalia Amazonia due to the application of organic wastes (including bagasse ash). Upadhayay *et al*. (2001) find out an increase in plant height and biomass of three native forest species treated with bagasse ash. Stosio and Tomaszewicz, (1999) also found a significant increase in various yield parameters of four winter crop varieties, including wheat, due to fly ash application.

Table 2
Effect of Bagasse Ash on Number of Leaves, Flower and Pods at 90 Days

	Leaf	Flowers	Pods
Treatment	**30 Days**	**60 Days**	**90 Days**
Control	10	38	34
T1	12	48	44
T2	14	50	46
T3	16	60	57
T4	20	81	78
T5	18	72	70

Dry Weight of Root, Stem, Leaves and Pods

The data collected from the pot experiments given in (Table 3) shows that the application of different doses of bagasse ash, significant changes in the weight of root, stem, leaves and pods over the control sample. The dry weight of root (0.8gm), stem (3.3gm), leaves (.075 gm), and pods (3.2 gm) observed highest in T_4 (4 : 1, Bagasse ash and soil) at the end of experiment of period. However, the lowest dry weight of root, stem, leaves and pods were found only 0.1gm, 1.0 gm, 0.054 gm and 1.5gm respectively in control at the end of ninety days. Although the dry weight of plant parts were found to increase with increasing the ratio of bagasse ash as observed in T_4 (80%) with a further increase in the ratio of bagasse ash at T_3, T_2, T_1 and control a decline in the dry weight of plant parts was observed (Table 3). The morphological characteristics e.g., root length, shoot length, dry weight, number of leaves, flowering and fruiting (number of pods) of Brassica juncea growing in different concentration of bagasse ash reveals an overall increasing pattern from control to T_4 (80% bagasse ash) expect in the case of number of pods which was higher in T_4 (80% bagasse ash). Improvement in soil porosity and abundant supply of micronutrients like Zn, Cu, Fe and Mn, along with Ca, Mg, P and K is recorded in the soil samples having different doses of bagasse ash. Therefore, an increase in the number of pods and dry weight of seeds might be the effect of bagasse ash application. Selva kumari *et al*. (1999) inferred that integration of fly ash alone and with other components of the nutrient supply system, because of synergistic effects, resulted in better nutrient uptake, higher yield and improved maintenance of soil fertility. also that the 1000-grain weight in bagasse ash treatments increased significantly over the control due to the improvement in soil fertility reported by Kalra *et al*. (1998), especially due to the availability of P and micronutrients like Zn and Cu. During their experiments, Kumar *et al*. (1999) reported the grain yield of wheat improved due to the favorable effects of fly ash on the soil components structure, moisture retention and essential nutrients present in the soil. Sharma *et al*. (2001) also reported increased crop yield and improvements in the soil nutrient status due to the application of fly ash to the soil. This results coincides with the finding of Niaz *et al.*, on *Eclipta alba*, Guatum *et al.*, on *Brassica juncea*, Dee *et al.*, on maize crop, Khen and Qusim on wheat crop.

Table 3
Effect of Bagasse Ash on Morphological Parameter on Pods Dry Weight (Mg Gm-) Fresh Weight) at 90 Days

Treatment		90 Days
Control	Root	0.1gm
	Stem	1.0gm
	Leaf	0.054gm
	Pod	1.5gm
T_1	Root	0.2gm
	Stem	1.4gm
	Leaf	0.059gm
	Pod	2.0gm
T_2	Root	0.3gm
	Stem	1.6gm
	Leaf	0.064gm
	Pod	2.1gm
T_3	Root	0.4gm
	Stem	1.9gm
	Leaf	0.066gm
	Pod	2.5gm
T_4	Root	0.8gm
	Stem	3.3gm

	Leaf	0.075gm
	Pod	3.2gm
T_5	Root	0.5gm
	Stem	2.2gm
	Leaf	0.069gm
	Pod	2.9gm

Conclusion

Bagasse ash is generally considered a waste product, however, the present findings show it is rich in micro-nutrients and also constitute sufficient amounts of Ca, Mg and other macro-nutrients like P and K. Different levels of bagasse ash positively affects the physico-chemical properties of soil, and most of the yield parameters of *Brassica juncea* crop improved in response to its favorable effects on the soil characteristics. Use of bagasse ash as organic fertilizer can also save the cost of chemical fertilizer along with reducing environ-mental pollution. By comparing the levels of bagasse ash application, 80% control was found to be the optimal dose regarding important yield parameters, such as, the root and shoot length of plant^{-1}, root and shoot dry weight of plant^{-1}, number of leaves, flowers and pods weight and yield of *Brassica juncea* crop in soil.

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