EFFECT OF SUGARCANE BOILER ASH ON GROWTH, YIELD AND QUALITY OF BRINJAL (*Solanum melongena* L.)

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CERTIFICATE

This is to certify that, the thesis entitled **"EFFECT OF SUGARCANE BOILER ASH ON GROWTH, YIELD AND QUALITY OF BRINJAL (*Solanum melongena* L.)"** submitted by **Mr. PRAJWAL R** bearing **ID NO. UHS20PGM1345** in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY** of the University of Horticultural Sciences, Bagalkot, is a record of research work carried out by him during the period of his study in this University, under my guidance, supervision and the thesis has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

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BAGALKOT

OCTOBER, 2022 **(PRAJWAL R)**

Affectionately

dedicated to my

beloved parents

Mrs Nagarathna M. N.

and

Mr Ramesh K.S

and my

brother Rahul R.

CONTENTS

LIST OF ABBREVIATIONS

%	Per cent
@	At the rate of
^0C	Degree Celsius
cm	Centimeter
et al.	Et alia (and others)
etc.	Etcetera
g	Gram
ha^{-1}	Per hectare
kg ha^{-1}	Kilogram per hectare
kg	Kilogram
m ha	Million hectare
mg kg^{-1}	Milligram per kilogram
c mol (p^+) kg^{-1}	Centi mole (proton) per kilo gram
NPK	Nitrogen, Phosphorus and Potassium
NS	Non-significant
pH	Puissance de hydrogen
ppm	Parts per million
t ha^{-1}	Tons per hectare
RDF	Recommended dose of fertilizers
S.Em±	Standard error of mean
CD	Critical difference
m mol (p^+) 100 g^{-1}	Milli mole (proton) per 100 grams
DTPA	Diethylene triamine penta acetic acid
EC	Electrical conductivity
RH	Relative humidity
P_2O_5	Available phosphorous
K_2O	Available potassium

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1. INTRODUCTION

Potassium (K) is a vital nutrient for both living plants and animals. It is the seventh abundant element occurring in the earth crust. It is monovalent cation found in higher concentration (100-200 m mol $100g^{-1}$) in the plant cell sap therefore it is called 'master cation'. It is ionic (K^+) and mobile in plants. Essentiality of potassium was given by Carl Sprengel (1839). Among the nutrients potassium is the second important essential plant nutrient for plant growth. K is often described as the "Quality Element" for plant growth (*Kaliha et al.,*1995). The importance of potassium in quality assurance stems from it's role in promoting synthesis of photosynthates and their transport to fruits, grains, tubers and storage organs and to their conversion into starch, protein, vitamins oil etc.

Potassium known to activate over sixty different types of enzymes which are involved in energy relations, translocations of assimilates, photosynthesis, protein and starch synthesis in crop plants (Oosterhuis *et al.*, 2014). Potassium is vital in all processes needed for the plant growth, development and reproduction. Potassium deficiency in plants shows spots on older leaves, marginal burning, susceptibility to diseases, cold and drought injury (*Hwang et al.,* 2002). Potassium increases the plant's resistant to drought and other stresses and reduces the severity of plant diseases. It also plays role in quality factors like colour, shape and vigour of the grain and seed.

Potassium plays many functional roles in plants like increasing yield, promoting root growth, strengthening plant tissues, increase resistance to pests, regulating water used by the plant and preventing lodging. It is one among the main pillars of balanced fertilizer use along with N and P. While India is the third largest user of NPK fertilizers in the world, with recent annual consumption at about 18 million tons (Mt) of $N+P_2O_5+K_2O$, K constitutes only one seventh of the total. In the present agriculture scenario, the net negative NPKbalance is split into 19% N, 12% P and 69% K. The large proportion for K is partly because crops remove an average 1.5 times more K than N, and K application through fertilizer is much lower than that of N or P. Most of Indian soils are rated as medium to high in available K status (Gurav *et al*., 2018).

Consequently, soils of some regions of the southern hemisphere are also being depleted of potassium due to the expansion and intensification of agriculture coupled with the lack of affordable potash. Modern high-yield agriculture depends upon fertilizers to replace the potassium lost at harvest. Intensification of agriculture has significantly declined the K status in soil due to crop removal without making the compensatory efforts to reclaim the soil through the K fertilizers (*Ciceri et al.,* 2015). As of now, potassium is mined predominantly in the northern hemisphere (Germany, Russia, Canada, Belarus), where large deposits occur. India, wholly dependent on those northern hemisphere countries since its whole consumption of K fertilizer is imported. So, self-sufficiency in manufacturing and producing K fertilizer is a major obstacle in developing countries like India. Therefore, alternative sources of K have a promising future for importing commercial K fertilizers for crop production. There are some of the low grade indigenous K- bearing mineral resources which are a best alternative to the high cost importing commercial K fertilizers. Indigenous sources of K are from manures, seaweed, crop residues, fly ash etc.

To study the impact of different sources of potassium on potassium reserve in soil, it is necessary to understand potassium nutrition, uptake and its management for a sustained crop production. Huge quantities of industrial by-products like spent wash, distillery sludge, sugarcane boiler ash etc., are rich in nutrients. Among these sugarcane boiler ash has shown the high (12.60%) amount of potassium in it. So, by using this sugarcane boiler ash for agriculture provides a feasible alternative for importing K fertilizers and safe disposal of agricultural wastes besides improvement in the soil environment. Thus, the industrial by- products may serve as an alternative source of potassium which eventually saves the foreign exchange on K fertilizers in the near future.

To check the efficiency of sugarcane boiler ash on crop performance Brinjal was selected as a test crop. Brinjal (*Solanum melongena* L.) or 'Eggplant' belongs to the nightshade family Solanaceae and genus Solanum popularly known as guinea squash or aubergine and it is one of the important vegetable crop in India. It is a warm climate, perennial crop but grown as annually all over the country except on higher altitudes in all seasons. High nutritive values of brinjal and high content of Vit-A and Vit-B have made brinjal a staple vegetable in our diet and cultivated since ancient times. It is also called Poor man's crop due to its availability throughout the year and affordable price. Due to its versatility in use in Indian food, brinjal is often described as the 'King of vegetables'. Brinjal has a low calorific value and it is a healthy vegetable. It is found to have very high water content and supply adequate amount of phosphorus, potassium, calcium, fiber, folic acid, sodium, vitamin B and vitamin C given by Chaudhary and Gaur (2009).

Brinjal possesses some medicinal properties that enhances the hemoglobin in the human body. In ayurvedic medicines it is used for healing hypertension, diabetes and obesity. Patients with liver complaints are advised brinjal in their diet (*Chadha and Kalloo.,* 1993). In the global scenario, India ranks second in the production of brinjal next to China with an area of 0.736 million hectares and production of 12.777 million tons (NHB, 2019-2020). The major brinjal producing states are West Bengal, Gujarat, Orissa, Bihar, Chhattisgarh, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Maharashtra and Assam. Among them, West Bengal is the largest [3,029.02 ('000' MT)] producer of brinjal. The major brinjal growing districts of Karnataka are Belgaum, Dharwad, Bijapur, Hassan, Mysore and Bagalkot. By considering all the above points, the present study on "Effect of sugarcane boiler ash on growth, yield and quality of Brinjal (*Solanum melongena*)" was planned with the following objectives.

Objectives:

1. To study the effect of sugarcane boiler ash on growth, yield and quality of Brinjal
2. To study the effect of sugarcane boiler ash on soil properties
3. To study the economics of sugarcane boiler ash on Brinjal

2. REVIEW OF LITERATURE

Published literature pertaining to the investigation entitled “Effect of sugarcane boiler ash on growth, yield and quality parameters of brinjal (*Solanum melongena* L.)” is briefly reviewed in the review of literature chapter under the following headings and subheadings.

2.1 Effect of sugarcane boiler ash on soil properties

2.1.1 Soil reaction

pH is an important quality that reflects the chemical conditions of a solution. The pH can control the availability of nutrients, biological functions, microbial activity and the behaviour of chemicals.

Hue (1988) proclaimed that the pH of the soil increased progressively with increasing sludge rate. The pH was increased significantly from 5.3 to 5.8, 6.0 and 6.1in 45, 90 and 180 Mg ha^{-1} sludge treatments respectively.

Sharma and Kalra (2006) reviewed the effect of fly ash on soil pH. They promulgated that the application of fly ash to soil increases the pH from 5.4 to 9.9.

Kanojia and Singh (2008) disclosed that the soil reaction was slightly varied in the plots incorporated with sludge and fly ash only or in blend with chemical fertilizers.

Torkashvand (2010) found impact of incorporated paper mill sludge on soil pH. Paper mill sludge considerably improved soil reaction, which was relative to the incorporation dose of paper mill sludge.

Tripathi and Tripathi (2011) disclosed that the application of distillery sludge at the rate of 0, 10, 25, 50, 100 and 150 t ha^{-1} showed the pH of 6.8, 7.3, 7.8, 8.47, 8.2 and 8.2 respectively.

Bajirao *et al.* (2021) deliberated the effect of bagasse ash on soil pH. They divulged that the reaction of soil in 0-15 cm, 15-30 cm and 30-45 cm depth ranged from 8.08 to 8.28, 8.09 to 8.30 and 8.10 to 8.32 respectively. The results disclosed that the reaction of soil improved significantly with increasing the rate of bagasse ash because of presence of alkaline earth metal cations like calcium, magnesium, sodium, and potassium.

2.1.2 Electrical conductivity (EC)

Sims *et al.* (1995) disclosed that the EC values for soils applied with fly ash at the rate of 20% and 40% increased from 0.2 to 1.1 - 1.5 dS m^{-1} and to 1.7 to 2.1 dS m^{-1} respectively.

Surekha (2005) investigated the effect of graded levels of fly ash on maize. The results revealed that different levels of fly ash considerably increased the soil reaction and EC.

Doddamani *et al.* (2010) disclosed that the electrical conductivity of soil increasedslightly with the increasing dose of the distillery spent wash.

Kumar and Chopra (2011) conducted a pot culture experiment on distillery effluent at the dose of 0 (control), 5, 10, 25, 50, 75 and 100 ml kg^{-1} which shows EC values of 2.08, 2.42, 2.52, 2.8, 3.13, 3.40 and 3.83 dSm^{-1} respectively. The results disclosed thatEC of soil higher with increasing doses of distillery effluent.

Solanki *et al.* (2016) carried out an experiment on alfisols in green house, Rajendranagar, Hyderabad. They applied sewage sludge at the level of 20, 40, 60, 80 and 100 per cent but the highest EC was recorded at 100 per cent sewage sludge. They also disclosed that there was an increase in EC with increase in dose of sewage sludge application.

Kumar and Chopra (2016) carried out a field trial on the effect of sugarcane press mud on eggplant. They incorporated sugarcane press mud of 0, 20, 40, 60, 80 and 100 per cent but the highest EC was obtained at 100 per cent treatment of sugarcane press mud.

2.1.3 Organic carbon

Kalra *et al.* (1997) deliberated the effect of fly ash levels at the levels of 0 to 40 per cent which shows the organic carbon content of 0.28 to 0.313 per cent respectively.

They also disclosed that organic carbon increases with increasing the levels of fly ash levels.

Sharma *et al.* (2002) conducted a field trial with wheat crop grown under different grades of fly ash added in soil at the rate of 0, 10 and 20 t ha^{-1}. They divulged that the organic carbon increases with the implication of fly ash in soil.

Tripathi *et al.* (2008) disseminated the impact of distillery effluent under pre and post sown irrigation on rice and wheat. They disclosed an increasing organic carbon from 0.25 to 0.32 per cent and 0.28 to 0.35 per cent in wheat and rice respectively under pre sown distillery effluent application whereas 0.28 to 0.35 per cent and 0.25 to 0.41 per cent in wheat crop and rice crop under post sown distillery effluent application respectively.

Lal *et al*. (2015) disclosed that the incorporation of 75 per cent General Recommended Dose (GRD) + fly ash at 60 t ha^{-1} + FYM at 5 t ha^{-1} on degraded land considerably enhanced the organic carbon content compared to sole GRD and control.

Ramteke (2016) disclosed that the implication of fly ash only or in combination with manure and fertilizers in *Alfisol* and *Vertisol* improved the organic carbon in soil in college of agriculture, IGKV, Raipur.

2.1.4 Available nitrogen

Deshmukh *et al.* (2000) promulgated that the implication of fly ash at 10 t ha^{-1} only and in blended application with NPK (100:50:50 kg ha^{-1}) enhanced the available nitrogen status of soil.

Surekha (2005) conducted an experiment to study the impact of various grades of fly ash on maize in acid soils. They disclosed that relatively higher available nitrogen in soil was noticed with increased levels of fly ash.

Kanojia and Singh (2008) deliberated the impact of sludge and fly ash in different combinations. They divulged that the available nitrogen content increased slightly throughout the course of study in sludge and fly ash incorporated plots.

Jena *et al*. (2013) carried out a trial on the impact of paper mill fly ash on the soil characters and corn yield. They started with five treatment combination of control plot, 50 per cent soil + 50 per cent fly ash, 70 per cent soil + 30 per cent fly ash, 70 per cent soil + 20 per cent fly ash + 10 per cent compost and soil + chemical fertilizer. They concluded that the combined implication of fly ash and compost increased the available nitrogen than the chemical fertilizer alone.

Lal *et al.* (2015) disclosed that the available nitrogen in soil recorded the highest with incorporation of 75 per cent GRD + fly ash at 40 t ha^{-1} + FYM at 5 t ha^{-1}**.** Ramteke (2016) revealed that the available nitrogen considerably improved due to the implication of fly ash only or in blended application with 100 per cent NPK kg ha^{-1} + 5 t FYM + 20 t FA ha^{-1} in rice crop and wheat crop under *Alfisol* and *Vertisol***.**

2.1.5 Available Phosphorus

Khan and Quasim (2008) opined that the boiler ash incorporated @ 3, 12, 25, 50, 125 and 250 t ha^{-1} in pots having 20 kg soil and field with a basal dose of NPK for the wheat crop. They recorded that the available phosphorus in soil increased with the improved levelsof boiler ash incorporation.

Honnalli (2008) disclosed that the incorporation of rice hull ash at the dose of 2 t ha^{-1} and FYM at 10 t ha^{-1} along with blended application with recommended dose of fertilizers showed the maximum (55.18 kg ha^{-1}) available phosphorus after the harvest of rice.

Reddy *et al*. (2010) carried out a study on the impact of fly ash (FA) and FYM on physicochemical characters and available nutrient under paddy crop. Among the different combinations, application of fly ash @ 15 t ha^{-1} + FYM @ 10 t ha^{-1} (FA_{15} FYM_{10}) showed the maximum (24.6 kg $ha^{-1)}$ available phosphorus after harvest of rice crop.

Lal *et al.* (2015) disclosed that the incorporation of 75 per cent General Recommended Dose (GRD) + fly ash at 60 t ha^{-1} + FYM at 5 t ha^{-1} showed maximum available phosphorus in soil over control.

Sabanoor *et al.* (2016) disclosed that the phosphorus in soil increased with increased levels of incorporation of bagasse ash.

2.1.6 Available Potassium

Benipal *et al.* (2006) carried out a study on the impact of implication of different graded levels of fly ash. They disclosed that the potassium content in soil improved with implication of categorized levels of fly ash.

Mandre (2006) studied the impact of application of wood ash on young scots pine. They observed that the incorporation of wood ash reported an increase in the available potassium content of soil.

Kanojia and Singh (2008) disclosed that available potassium content increased slightly throughout the course of study in sludge and fly ash incorporated plots as compared with the control.

Honnalli (2008) divulged that the incorporation of rice hull ash at the dose of 2 t ha^{-1} and FYM at 10 t ha^{-1} along with blended application recommended fertilizers showed the maximum (103.81 kg ha^{-1}) soil potassium content after the harvest of rice.

Reddy *et al.* (2010) carried out a study on the effect of fly ash (FA) and FYM on physicochemical characters and available nutrient under paddy system. Among the different combinations, incorporation of fly ash @ 15 t ha^{-1} + FYM @ 10 t ha^{-1} (FA_{15} FYM_{10}) showed the maximum (366.7 kg ha^{-1}) available potassium content after harvest of rice crop.

Jena *et al.* (2013) conducted research on the impact of paper mill ash on the soil parameters and corn yield. They tried with five treatment combinations *i.e.*, control plot, 50 percent soil + 50 per cent fly ash, 70 per cent soil + 30 per cent fly ash, 70 per cent soil + 20 per cent fly ash + 10 per cent compost and soil + chemical fertilizer. The study disclosed that the blended application of fly ash, compost increased the availability of potassium than the chemical fertilizer alone.

Lal *et al.* (2015) disclosed that the incorporation of 75 per cent General Recommended Dose (GRD) + fly ash at 60 t ha^{-1} + FYM at 5 t ha^{-1} showed the highest soil available potassium compared to other treatments.

Sabanoor *et al.* (2016) carried out a trial on the impact of incorporation of different level of bagasse ash on mustard. They revealed that the potassium content in soil increased with increased levels of bagasse ash incorporation.

Veena (2018) conducted a field trial on the impact of sugarcane industry incinerated ash on rice. They revealed that the available potassium content in soil considerably increased with higher incinerated ash incorporation.

2.1.7 Exchangeable calcium

Deshmukh *et al.* (2000) reported that implication of fly ash at 10 t ha^{-1} only and in blended application with NPK (100:50:50 kg ha^{-1}) showed slight improvement in exchangeable calcium in the soil.

Surekha (2005) studied with various grades of fly ash application on maize. They disclosed that the relatively higher available calcium in soil was reported with increased levels of fly ash.

Benipal *et al.* (2006) disclosed that the calcium in soil improved with incorporation of categorized levels of fly ash.

Mandre (2006) disclosed that the incorporation of wood ash resulted in a higher calcium content in soil.

Gourab and Joy (2011) disclosed that the calcium in soil improved with higher application of fly ash.

2.1.8 Exchangeable magnesium

Deshmukh *et al.*, (2000) found that the implication of fly ash at 10 t ha^{-1} only and in blended application with NPK (100:50:50 kg ha^{-1}) showed slight improvement in exchangeable magnesium content in soil.

Surekha (2005) conducted a trial on the impact of different levels of fly ash on maize in acid soils. They recorded relatively higher magnesium in soil with increased levels of fly ash.

Benipal *et al.* (2006) concluded that the magnesium in soil improved with incorporation of graded levels of applied fly ash.

Mandre (2006) conducted an experiment on influence of wood ash on young scots pine. They disclosed that the incorporation of wood ash shown increase in the magnesium of the soil.

2.1.9 Available sulphur

Sikka and Kansal (1995) carried out a greenhouse trial to investigate the impact of fly ash incorporation at the levels of 0, 2, 4 and 8% (w/w) levels. The concentration of sulphur in rice plants increased up to the 8% considerably with the incorporation of fly ash.

Surekha (2005) conducted an experiment to study the effect of graded levels of fly ash on maize. They opined that the sulphur considerably improved with higher levels of fly ash.

Kanojia and Singh (2008) disclosed that the available sulphur content increased slightly throughout the course of study in sludge and fly ash incorporated plots over the control.

Khan and Quasim (2008) studied the application of boiler ash @ 3, 12, 25, 50, 125 and 250 t ha^{-1} in pots having 20 kg soil and field with a basal dose of NPK for the wheat crop. They revealed that the available sulphur in soil increased with the increased levels of boiler ash incorporation.

The past research on aspects related to blended application of different types of indigenous sources along with fertilizers was found improve the available nutrient in soil and thus helped in enhancing the soil fertility as well as soil quality.

2.1.10 Effect of sugarcane boiler ash on micronutrients

Pawar *et al.* (1992) found that incorporation of spent wash increased the available DTPA extractable soil Fe, Mn and Zn at the harvest of sorghum.

Zalawadia *et al.* (1997) studied the effect of irrigation with tube well water (S_0) as well as with spent wash diluted 25 (S_{25}), 50 (S_{50}) and 100 (S_{100}) times on yield and nutrient uptake by sugarcane grown on typic chromustert. The post-harvest nutrient status of soil revealed that there was significant increase in available DTPA extractable Fe, Mn, Cu and Ni over control.

A field trial was carried out by Sukanya and Meli (2003) during 2000 in red soil where the wheat was taken as a test crop, employing various effluent dilution levels (1:5, 1:10, 1:25 and 1:50) in comparing with undiluted effluent and fresh water. Results indicated that available DTPA extractable Zn, Cu and Mn contents in soil were lowered with increased dilution levels.

Suma (2006) carried out a field trial to study the impact of fertigation of spent wash on sugarcane and on soil attributes. The chemical properties of soil did not vary considerably due to fertigation of spent wash excluding organic carbon, available potassium and iron. Fertigation of spent wash at 150 per cent dose of RDN reported higher OC, available K and Fe after harvest of crop.

A field trial was carried out to study the effect of spent wash on yield and quality of mulberry crop. Results noticed that micronutrients DTPA-Fe, Mn and Cu content was considerably increased due to the implication of 150 per cent N through spent wash except DTPA- Zn content of soil.

2.2 Effect of sugarcane boiler ash on nutrient uptake of crop

Kochari (1991) conducted a pot culture study on groundnut by implication of varied levels of fly ash (0, 1.25, 2.5, 5.0, 7.5 and 10%). They disclosed that the incorporation of fly ash at the rate of 7.5 per cent recorded significant effect on uptake of nutrients like N, K, Ca and Mg by groundnut.

Vageesh (2000) carried out an experiment on incorporation of fly ash and its influence on soil. They recorded that the calcium and sulphur uptake by plants increased with higher fly ash incorporation.

Mozaffari *et al.* (2002) observed that there was significant increase in the uptake of nutrients like phosphorus and potassium with the incorporation of alfafa ash.

Mitra *et al.* (2003) disclosed that the nutrients like Ca, Mg, Mn, Zn, Cu, Co increased with the blended application of fly ash and FYM as compared to chemical fertilizers only or in combination with the organic source.

Rautaray *et al*. (2003) revealed that the integrated implication of fly ash at the level of 10 t ha^{-1}, organic waste and fertilizer was found to enhance the uptake of nutrients like N, P, K, Ca, Mg, Fe, Mn, Zn, and Cu compared with only chemical fertilizers.

Patil *et al*. (2005) opined that with the higher level of fly ash and FYM increases the nutrients like nitrogen phosphorus, potassium and also increases the yield of onion with pronounced influence on produce of onion bulbs. Thus, fly ash can be used at 30 tons ha^{-1} wasrecommended for good health of the crop yield.

Lee *et al.* (2006) conducted a study on implication of fly ash on rice. They revealed that the implication of fly ash also enhanced the nutrients like silicon, phosphorusand potassium by the rice plants.

Lopez *et al*. (2009) disclosed that incorporation of sugarcane meal ash and rape meal ashes had positive effects on phosphorus, K uptake and also improved the readily available phosphorus content in soil.

Schiemenz and Eichler Lobermann (2011) disclosed that the incorporation of ash showed an increased the phosphorus in crops besides increased the soil P pools (total P, water- soluble P, double-lactate-soluble P, and oxalate-soluble P) and P saturation.

Bhople *et al*. (2016) conducted a trial on incorporation of fly ash at the rate of 0, 20, 40, 60, 80, 100 and 120 t ha^{-1} on sunflower. Implication of fly ash at the rate of 20, 40 and 60 t ha^{-1} reported considerable higher uptake of nitrogen and potassium compared with control.

Durgude (2018) conducted a trial on impact of fly ash and sugarcane bagasse ash on soil parameters, yield and quality of wheat in an inceptisol. They showed that the maximum uptake of nutrients like nitrogen, phosphorus and potassium in wheat in treatment which constitutes 50 kg ha^{-1} K_2O through bagasse ash along with RDN and P_2O_5 through fertilizer and 10 t ha^{-1} of FYM.

Veena (2018) disclosed that the nutrients like N, P, K, Ca, Mg and S significantly higher with incinerated ash incorporation.

The literature related to earlier studies disclosed that the application of indigenous sources in combination with fertilizers enhanced the nutrients in plants.

2.3 Effect of sugarcane boiler ash on growth, yield and quality of crop

Khan and Wajid (1996) conducted a trial on the impact of fly ash on plant growth and yield of tomato. They applied fly ash at the levels of 0 to 100 per cent. They disclosed that 40-80 per cent of fly ash reported highest plant growth, yield (flowering, fruiting, fruit weight/plant, and mean fruit weight), carotenoids and chlorophylls.

Rajakumar (2000) disclosed that the implication of fly ash or pond ash separately or blended with FYM considerably increased the germination of sunflower seeds. Seed yield of sunflower was higher with increasing levels of ash incorporation up to 33.16 per cent over the control. It also showed that the implication of different levels of fly ash increased the residual effect on succeeding maize crop, yield increased to 22.4 q ha^{-1} on incorporation of 30 t ha^{-1} pond ash with 20 t ha^{-1} FYM over the control (17.7q ha^{-1}).

Selvakumari *et al*. (2000) disclosed that the application of fly ash to *Alfisols* at 20 and 40 t ha^{-1} increased yield of rice by 10.3 and 16 per cent, respectively compared with the control treatment.

Upadhayay *et al*. (2001) carried out an investigation on impact of addition of sugarcane factory waste on crops productivity and soil fertility. They recorded that the incorporation of sugarcane factory waste at the rate of 0, 10, 20, 30 and 40 t ha^{-1} produced 25, 28, 35, 35 and 25 t ha^{-1}, respectively biomass of dhaincha. The similar result was also observed in subsequent crop with aggregate and large sized (>75g) tuber yield of subsequent potato crop.

Jamil *et al.* (2004) disclosed that the implication of different grades of bagasse ash considerably increased the yield and yield attributes of wheat over control. However, the incorporation of bagasse ash at 2.00 per cent recorded maximum plant height (102.8 cm), spike length (11.0 cm), number of productive tillers m^{-2} (333.5), number of grains spike^{-1} (49.5) and grain yield (5.2 t ha^{-1}). Then application of bagasse ash at 1.00 per cent enhanced number of tillers m^{-2} (409.0) and straw yield (8.0 t ha^{-1}) was with 10.0 per cent bagasse ash and 1000 grain weight (41.20 g). The overall response of wheat crop was considerably higher by the incorporation of bagasse ash at 2.0 per cent in the calcareous soil.

Pradhan and Sahu (2004) revealed that the maximum (3.8 t ha^{-1}) yield of rice followed by groundnut (1.4 t ha^{-1}) with high shelling per cent (75 %) and oil content in groundnut were obtained with incorporation of 40 t ha^{-1} fly ash + 5 t ha^{-1} FYM + 50 per cent recommended dose of NPK.

Mishra *et al*. (2007) disclosed that there was considerable improvement in soil health and germination percentage of rice seeds with the incorporation of fly ash. They disclosed that the implication of fly ash was also reported to improve the growth parameters like shoot length, leaf area and pigment composition and yield parameters like panicle length, seeds per panicle, seed weight and yield per plant.

Khan and Quasim (2008) carried out an experiment to find out the use of boiler ash as organic manures on yield of wheat crop in calcareous soils. The boiler ash was incorporated at the levels of 3, 12, 25, 50, 125 and 250 t ha^{-1} in pots with 20 kg soil and field with a basal dose of NPK 120, 90, and 60 kg ha^{-1} respectively for the wheat crop. The yield and yield attributes of wheat crop increased due to boiler ash incorporation in the field and also in the pots @ 50 t ha^{-1} in calcareous soil.

Jayasinghe *et al.* (2009) disclosed that the implication of fly ash based Granular Synthetic Aggregates (GSA) as amendment to soil in the ratios of 1:5 and 1:10 recorded an increase in plant height and plant fresh weight by three and 12 times, respectively and there was increase in N, K, Mg, Ca, Cu, and Zn contents of the shoots.

Karmakar *et al.* (2009) investigated that implication of three industrial by product's solid waste *viz.* fly ash (FA), rice husk ash (RHA) and paper factory sludge (PFS) along with lime, FYM and chemical fertilizer (CF). The rice growth, yield parameters and yield were maximum in integrated use of FYM+RHA+CF tailed by PFS+FA+CF.

Saini *et al.* (2010) opined that the macro and micro nutrients concentration in rice seen dominant increase when grown in fly ash applied soil with and excluding FYM application. The macro and micro nutrients in rice grain also enhanced with increasing dose of fly ash implication.

Katiyar *et al.* (2012) disclosed that the incorporation of fly ash showed higher number of leaves, plant height, biomass and yield of three crop plants (palak, mung bean and chilly) and was found maximum with 25 per cent fly ash amended soil. Application of more than 25 per cent fly ash found to result in decline in growth and yield of plants.

Singh *et al.* (2012) disclosed that the incorporation of fly ash at 10 per cent reported considerably maximum growth, grain quality and yield of three rice cultivars. The variety Sugandha-3 recorded maximum grain produce as compared to Sambha and Saryu-52 with incorporation of fly ash at 10 per cent level.

Das *et al*. (2013) disclosed that the treatments which constitute fly ash at 5 and 15t ha^{-1} recorded maximum yield of 23.3 per cent and 32.4 per cent respectively than the check. The maximum rice yield (34.1 t ha^{-1}) was seen in the treatment which constitutes 50 per cent RDF + FYM 5 t ha^{-1} + FA 15 t ha^{-1}. On the other hand, incorporation of fly ash at 5 t ha^{-1} in blended application with RDF 50 per cent + FYM 5 t ha^{-1} recorded 40.1 per cent more yield than the absolute control.

Jena *et al*. (2013) carried out an experiment on implication of paper industries fly ash on corn growth (*Zea mays* L.). They disclosed that the treatment which constitutes 70 per cent soil + 20 per cent fly ash + 10 per cent compost was seen to be very good for production over the control. It also decreased the cost of production over the fertilizer treatment plot.

Prakash *et al*. (2014) observed that the fly ash implication at 200 g kg^{-1} recorded considerably maximum plant height at 50 per cent blooming, number of branches per plant, number of fruits per plant, length of the fruit, girth of the fruit, fruit weight, number of seeds per fruit, seed weight per fruit and seed yield per plant in brinjal.

Sireesha and Prasuna Rani (2014) observed that the combined incorporation of fly ash at 10 t ha^{-1} and 80 per cent recommended dose of fertilizer on groundnut gave significantly maximum pod and haulm yield and nutrient uptake and also recorded 20 per cent savings on fertilizers.

Panda *et al.* (2015) carried out a trial on impact of various concentration of fly ash at the levels of 20, 40, 60, 80 and 100 per cent on the growth and photosynthetic activity of rice and maize. Plant growth was mostly enhanced in the treatments with 20-40 per cent ash, being optimal at 60 per cent. From 80 per cent onwards, the measured parameters tended to reduce. The most economic dose of fly ash incorporation was 60 per cent, which improved the growth of maize and rice.

Pani *et al*. (2015) carried out an experiment on impact of fly ash on growth and yield of sunflower. They used fly ash at the levels of 0, 25, 50, 75 and 100 percent. They disclosed that the plant, seed yield and oil content of seed increased with 25 per cent fly ash.

Patel (2015) revealed that 75 per cent GRD (General Recommended Dose) in blended application 60 t fly ash ha^{-1} along with 5 t FYM ha^{-1} showed the maximum rice yield (37.27 q ha^{-1}). The minimum grain yield was noticed under control (26.07 q ha^{-1}). However, the treatment combination, 75 per cent GRD + 20 t fly ash ha^{-1} along with 5 t FYM ha^{-1} showed to be economical with respect to increase the availability, uptake of nutrients and there by an increase in grain yield of rice (35.80 q ha^{-1}).

Dhindsa *et al.* (2016) disclosed that the incorporation of 20 per cent fly ash in clay soils and up to 30 per cent in sandy soils showed higher germination, tillering, height of the plant, biological yield and grain yield in wheat.

Panda and Biswal (2018) opined that the implication of 20 per cent fly ash in decade soils and up to 30 per cent in sandy soil was found to improve the germination, height of the plant, biological yield and grain yield in wheat.

The results of the recent past research investigated that the incorporation of indigenous sources along with chemical fertilizers was none the less beneficiary for crop production and also it was found to help in enhancing the plant growth, yield and quality of crops.

2.4 Effect of sugarcane boiler ash on economic analysis

Jawahar and Vaiyapuri (2010) studied on impact of fly ash at the levels of 5, 10, 15, 20 and 25 t ha^{-1} on rice. They revealed that the plots applied with fly ash at 25 t ha^{-1} recorded higher net income (Rs 43553 ha^{-1}) and benefit cost ratio (3.89) for rice.

Durgude (2018) observed that the maximum net monetary returns (Rs. 41406 and Rs. 39028) were reported in treatments of implication of bagasse ash at the levels of 13.02 and 10.41 q ha^{-1} respectively in soil for the supplementation of K_2O at the rate of 50 and 40 kg ha^{-1} respectively. The same trend was seen in benefit cost ratio in treatments T_7 (1.86) followed by T_8 (1.81).

Veena (2018) disclosed that the treatment which constitutes 10 t ha^{-1} of incinerated ash blended application of recommended dose of fertilizer and 10 t of FYM showed maximum gross and net return of Rs. 159578 and Rs. 109625 respectively. The benefit cost ratio was seen maximum (3.38) in treatment which received 10 t ha^{-1} of incinerated ash blended application with recommended dose of fertilizer and 5 t of FYM.

The literature associated to earlier research enquired that the application of indigenous sources reduces the cost of production compared with chemical fertilizers.

3. MATERIAL AND METHODS

This section describes the information regarding the material used in the experiment and the methods followed in the current investigation entitled "Effect of sugarcane boiler ash on growth, yield and quality of Brinjal (*Solanum melongena*)" which was accomplished in the year 2021-22.

3.1 Experimental site

The experiment was conducted in the Medicinal and Aromatic Block Sector no. 41, college of horticulture, Navanagar, Bagalkot in the year 2021-22. The topography of the experimental plot was uniform with suitable surface drainage.

3.1.1 Soil properties

The soil of the experimental site is red sandy loam. Before the experiment the chemical parameters of soil of experimental plot were analyzed by gathering the composite soil sample from a depth of 0 -15 cm and is presented in Table1.

Table 1: Initial soil chemical properties of experimental field

Soil properties	Value
pH	8.19
EC (dSm^{-1})	0.26
Organic carbon ($g\ kg^{-1}$)	6
Available N ($kg\ ha^{-1}$)	188.16
Available P_2O_5 ($kg\ ha^{-1}$)	28.21
Available K_2O ($kg\ ha^{-1}$)	121.2
Exchangeable Ca [c mol (p^+) kg^{-1} soil]	7.88
Exchangeable Mg [c mol (p^+) kg^{-1} soil]	7.18
Available S [ppm]	11
DTPA – Fe ($mg\ kg^{-1}$)	3.17
DTPA – Cu ($mg\ kg^{-1}$)	0.68
DTPA – Mn ($mg\ kg^{-1}$)	6.39
DTPA – Zn ($mg\ kg^{-1}$)	1.09

3.2 Location and climate

The experimental plot was located at the latitude of 16.15° North and Longitude of 75.65° East with an elevation of 533 meters above the mean sea level. The experimental plot comes under the northern dry zone (Zone III) of Karnataka. Climate is warm and dry throughout the year with mean annual rainfall of 542.8 mm. The average maximum temperature is 35.66 °C and minimum temperature 20.4 °C.

The meteorological parameters throughout the crop season were documented at Meteorological observatory of UHS, Bagalkot and are given in Appendix-I.

3.2.1 Cropping history of experimental field

The experiment plot has been grown with different crops during past two years. A brief crop history of crop sequence followed in the past three years is exhibited in the Table 2.

Table 2: Cropping history of the experimental field

Year	*Kharif*	*Rabi*	Summer
2018-2019	Fallow	Fallow	Fallow
2019-2020	Fallow	Fallow	Snap melon
2021	Tomato	Present experiment	-

3.3 Experimental details

The experiment was carried out in statistical Randomized Complete Block Design (RCBD) with a set of three replications. All the treatments were randomized discretely in every replication. The layout of the experimental plot is given in Fig.1 and other experiment details are given in Table 3.

Table 3: Experimental design

Design	:	Randomized Complete Block Design
Replication	:	Three
Treatment	:	Nine
Crop	:	Brinjal
Variety	:	Mahyco Super 10
Total number of plots	:	27
Spacing	:	120 X 60 cm
Plot size	:	6m X 4m
Experiment area	:	648 m^2
Number of plants per plot	:	58
No. of plants for observation perplot	:	5
Season	:	*Rabi* season
Date of transplanting	:	24-01-2022
End of the crop season	:	25-05-2022
RDF for brinjal	:	125:100:50 (kg ha^{-1}) of $N:P_2O_5:K_2O$

N

R-I	R-II	R-III
T_2	T_5	T_1
T_4	T_9	T_2
T_6	T_1	T_3
T_9	T_7	T_4
T_8	T_2	T_5
T_1	T_8	T_6
T_5	T_3	T_7
T_7	T_4	T_8
T_3	T_6	T_9

Fig.1: Plan of the layout of experiment plot

3.4 Experimental material

The experimental material for this experiment consists of ten treatments is exhibited in Table 4. Various dosages of K manures and fertilizers were applied to soil are as under

Table 4: Treatment details

T_1	**RDF**	84 kg ha^{-1}MOP
T_2	**RDF + S_1**	84 kg ha^{-1}MOP and 10 kg ha^{-1} Sulphur
T_3	**RDF + S_2**	84 kg ha^{-1} MOP and 20 kg ha^{-1} Sulphur
T_4	**100% K SBA + S_1**	336 kg ha^{-1} SBA and 10 kg ha^{-1} Sulphur
T_5	**100% K SBA + S_2**	336 kg ha^{-1} SBA and 20 kg ha^{-1} Sulphur
T_6	**75% K SBA +25% MOP + S_1**	252 kg ha^{-1} SBA, 21 kg ha^{-1} MOP and 10 kg ha^{-1} Sulphur
T_7	**75% K SBA +25% MOP + S_2**	252 kg ha^{-1} SBA, 21 kg ha^{-1} MOP and 20 kg ha^{-1} Sulphur
T_8	**50% K SBA + 50% MOP+ S_1**	168 kg ha^{-1} SBA, 42 kg ha^{-1} MOP and 10 kg ha^{-1} Sulphur
T_9	**50% K SBA + 50% MOP + S_2**	168 kg ha^{-1} SBA, 42 kg ha^{-1} MOP and 20 kg ha^{-1} Sulphur

MOP- Muriate of Potash

SBA- Sugarcane boiler ash

S_1-Elemental Sulphur (10 kg ha^{-1})

S_2-Elemental Sulphur (20 kg ha^{-1})

N & P as per RDF of UHS, Bagalkot

Table 5: Nutrient composition of sugarcane boiler ash

Nutrient	Sugarcane boiler ash
pH	9.58
EC (dSm^{-1})	7.30
P_2O_5 (%)	1.20
K_2O (%)	12.60
S (%)	0.398
CaO (%)	1.93
MgO (%)	3.16
DTPA – Fe (mg kg^{-1})	31.30
DTPA – Cu (mg kg^{-1})	28.10
DTPA – Mn (mg kg^{-1})	233.4
DTPA – Zn (mg kg^{-1})	5.10

The raw material like sugarcane boiler ash is provided by Sameer wadi sugar factory, Bagalkot and their composition is exhibited in Table 5.

3.5 Agronomical practices

3.5.1 Land preparation

The experimental plot was thoroughly prepared by four to five times ploughing to make fine tilth and harrowing in order to make the soil well-pulverized condition. Then the experimental area was divided into randomized plots according to the layout plan. Well decomposed 2.5 kg FYM per square meter is thoroughly incorporated during land preparation.

3.5.2 Transplanting

Healthy brinjal seedlings (30 days old) were transplanted in the main experimental plot with spacing of 120 cm X 60 cm according to the package of practice UHS, Bagalkot. The 58 seedlings were transplanted in 6m X 4m of plot size. The gap filling operation was carried out immediately after 4-5 days for better establishment of the seedlings in the experimental plot.

3.5.3 Irrigation

The initial irrigation was applied immediately after transplanting to assure proper establishment and germination of seedlings. To maintain the soil moisture frequent water was given at 3 days interval throughout cropping period by surface irrigation.

3.5.4 Intercultural operations

To keep the experimental plots weed free hand weeding at one month after transplanting was done. Followed by top dressing and earthing up around the plants was done.

3.5.5 Fertilizer application

The fertilizer required for brinjal as per University of Horticultural Sciences, Bagalkot's package of practice (POP) is 125:100:50 N: P_2O_5:K_2O kg ha^{-1} was applied as required by the treatments, through urea, di-ammonium phosphate (DAP), muriate of potash or KCl (MOP) and sugarcane boiler ash was applied as a source of potassium according to the treatments mentioned in table 4. Half of Nitrogen, full amount of phosphorous and potassium were given at the time of transplanting and remaining 50% of nitrogen was top dressed after one month of first dose application.

3.5.6 Plant protection measures

Some of the major sucking insects like aphids, jassids and thrips were controlled by spraying plantomax pro and actara @ 0.5 ml per litre at 15 days interval. No diseases were documented during experiment.

3.6 Growth parameters

3.6.1 Plant height

Height of the plant observations were documented at 45 and 90 days after transplanting. Five plants among the superior quality were randomly selected and tagged. Tagged plant's plant height was measured by using meter scale from bottom level to the tip of main stem. The mean plant height of five plants was figured and expressed in centimeters.

3.6.2 Number of leaves

The number of leaves present in each of randomly selected five tagged plants was counted at 45 and 90 days after transplanting and the mean value of number of leaves was taken and expressed as leaves per plant.

3.6.3 Number of branches

The number of branches present individually of the five randomly selected and tagged plants was observed at 45 and 90 days after transplanting and their mean value of number of branches was taken and computed as branches per plant.

3.6.4 Days to 50% flowering

The days required for 50 per cent plants to produce first flower in each treatment was documented by counting the days from the date of transplanting.

3.7 Yield parameters

3.7.1 Number of fruits per plant

The total number of fruits harvested from randomly selected five tagged plants was collected and average was expressed as number of fruits per plant.

3.7.2 Fruit yield per plant (kg plant^{-1})

The weight of all the fruits taken from the plant during the fruiting season, stated in kilos, was added to determine the fruit production per plant.

3.7.3 Fruit yield per plot (kg plot^{-1})

At each plucking, the fruits from all of a net plot's plants were weighed and expressed in kilo grams per plot.

3.7.4 Fruit Yield per ha (t ha^{-1})

Each net plot and each replication's weight of the fruits that were harvested according to treatment received were recorded. Based on the fruit production per net plot from each harvest, the total yield per hectare was determined and reported in tons per hectare (t ha-1).

$$\text{Fruit yield}(t/ha) = \frac{\text{Fruit yield (kg per plant)} \times \text{plant per hectare}}{1000}$$

3.8 Quality parameters

3.8.1 Ascorbic acid content

The ascorbic acid content was estimated titrimetrically using 2,6-Dichlorophenol indo phenol dye as per modified procedure of A.O.A.C. (1997).

$$\text{Vitamin C content}(mg/kg) = \frac{\text{Ascorbic (mg)in sample}}{\text{ml of aliquot}} \times \frac{V2}{V1} \times \frac{\text{Total sample (ml)}}{\text{Wt. of sample}} \times 100$$

A known volume of one gram of freshly squeezed fruit juice was diluted with 4% oxalic acid. To obtain a clear juice, this was filtered through muslin fabric. An aliquot of five ml was titrated against the dye 2, 6-dichlorophenol indo phenol. Ascorbic acid was computed as mg per 100 ml of fruit juice (Sadasivam and Thyemoli, 1987).

3.8.2 Texture by texture analyzer

The viscosity of concentrated sample was examined by TXT Plus Texture Analyzer (Make: Stable Micro system; Texture Exporter Version 1.22). The force with which the black extrusion rig was taken out of the fruit sample was recorded in the software graph and the peak force value in the graph was depicted as the firmness (N), consistency (Kg.S) cohesiveness (N) and the index of viscosity (Kg.S) value.

Type of probe used: Piercing needle

Test mode: Measure force in compression

Probe diameter: 8 mm

3.8.3 Colour by colorimetry

The color of the brinjal fruit samples was measured in the Colour Flex EZ colorimeter fitted with a 45 mm diameter aperture. The instrument was standardized using two different colour tiles *i.e.,* black and white tiles provided. Colour was expressed in terms of L* (lightness/ darkness), a* (redness/ greenness), b* (yellowness/ blueness).

3.8.4 Sensory evaluation (9-point hedonic scale)

Sensory evaluation of brinjal fruits was conducted by a semi trained panel of Teachers and Post- Graduate students with the help of a nine- point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor a dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely). Sensory parameters considered in the evaluation included colour, appearance and texture.

3.8.5 Physiological loss of weight

For studying the physiological loss of weight of brinjal fruits, the weight of the brinjal was documented and the total loss of physiological weight was calculated by deducting the final weight of the brinjal fruits from the initial weight of brinjal fruits. The results were then expressed in percentage using following equation:

$$\%\ \text{PLW} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Table 6. Methods employed for the analyses of soil samples

Parameters	Methods	References
pH	Potentiometric method	Jackson,1973
EC (dSm^{-1})	Conductivity method	Jackson,1973
Organic carbon (%)	Walkley and black's wet oxidationmethod	Walkley and black (1934)
Avail. N ($kg\ ha^{-1}$)	Alkaline $KMnO_4$ distillation method	Subbiah and Asija,1956
Avail. P_2O_5 ($kg\ ha^{-1}$)	Olsen's method, Colorimetry	Jackson,1973
Exch. Ca [c mol (p+) kg^{-1}]	Versanate titration method	Jackson,1973
Exch. Mg [c mol (p+) kg^{-1}]		
Avail. K_2O ($kg\ ha^{-1}$)	Neutral normal NH_4OAC method,Flame photometry	Jackson,1973
Avail. S ($kg\ ha^{-1}$)	$CaCl_2$ method, Turbidometry	Black, 1965
DTPA extractable Fe, Mn, Zn and Cu ($mg\ kg^{-1}$)	Micro plasma atomic emissionspectrophotometer	Lindsay and Norvell (1978)

3.9 Collection and preparation of soil samples

Soil samples from 0-15 cm were drawn prior to the initiation of experiment using auger and composite sample was prepared by adopting quartering technique. The similar procedure was adopted for soil sample collection after the harvest of the crop. The collected soil samples were shade dried, ground in wooden pestle and mortar and sieved (2 mm). These samples were analyzed for different parameters by adopting appropriate protocols as mentioned in Table 6.

3.10 Collection and preparation of plant samples

Plant samples from each treatment were collected at final harvest of fruits by uprooting the entire brinjal plant. The samples collected from the field were brought to laboratory and washed with dilute detergent (0.2%) and hydrochloric acid (0.1%) to remove dust and contaminants, finally washed with distilled water, air dried and oven dried at 65 to 70 °C for 48 hours. Further, powdered separately into leaves, stem, fruit and root using mixer and stored in air tight plastic cover for further analysis.

3.11 Acid digestion of plant samples

For estimation of total nitrogen content, plant sample of 1 g was digested with conc. sulphuric acid (10ml) and digestion mixture (CuSO4: K2SO4: Se-100:40:1) in digestion unit. The digested sample was distilled by kjeldhal distillation unit. For phosphorus, potassium, calcium, magnesium, sulphur and micronutrients determination, plant sample was digested with diacid mixture (HNO3: HClO4-9:4 ratio) till white precipitation is obtained and digested sample was kept for cooling for 10 minutes. Filtration of extract was done using whatsman No. 40 filter paper and filtered extractant's volume was made up to 100 ml using distilled water. These samples were further analyzed by adopting appropriate protocols as mentioned in table 7.

Table 7: Methods employed for the analysis of plant samples

Parameters	Methods	References
Nitrogen (%)	Micro Kjeldahl method	Piper (1966)
Phosphorus (%)	Microwave Plasma Atomic Emission Spectrophotometer	
Potassium (%)	Flame photometer method	
Calcium and Magnesium (%)	Versanate titration method	
Sulphur (%)	$Cacl_2$ method, Turbidometry	
Fe, Mn, Zn and Cu (mg kg^{-1})	Diacid digestion and Micro plasma atomic emission Spectrophotometer method	Lindsay and Norvel (1978)

3.12 Nutrient uptake

Total nutrient uptake was calculated by multiplying per cent nutrient in different plant parts (leaves, stem, root and fruit) with the dry biomass of respective plant parts and then calculated totally and expressed in kg ha^{-1}.

$$\text{Nutrient uptake} = \frac{\text{Nutrient concentration in plant}}{100} \times \text{Total biomass of plant}$$

3.13 Economics

Cost of cultivation was calculated according on the prices of inputs that were in the market during the period of their use. The selling price for the produce was obtained from market. The net return per hectare was calculated by subtracting the cost of cultivation from gross return and expressed in rupees per hectare (ha^{-1}) and calculated as B:C ratio.

$$\text{Benefit cost ratio} = \frac{\text{Net return (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

3.14 Statistical analysis

The data collected from experimental study was examined statistically by using the randomized block design procedure as described by Panse and Sukhatme (1967). The level of significance used in 'F' test was P=0.05. Critical difference was calculated whenever F test was significant.

Plate 1. General view of experimental field

4. EXPERIMENTAL RESULTS

About 57% of India's occupation is dependent on agriculture, intensive agriculture practice has lead to substantial decline in soil potassium owing to crop removal besides inadequate compensation through K fertilizers. India is completely dependent on imports and seldom has K reserves for the manufacture of fertilizers. Owing to these factors self- sufficiency in commercial K fertilizer is a major issue in developing countries in general and India in particular. In this context, some low-grade indigenous resources of K- bearing minerals can be explored as an alternative to the expensive imported K fertilizers. Some of the indigenous sources of K are from crop residues, sugarcane waste products, manures, fly ash, seaweed etc. With this backdrop a trial was conducted during 2021-22 to know the effect of sugarcane boiler ash on growth, yield and quality of brinjal in the sector no. 41, University of Horticultural Sciences, Bagalkot.

Among the treatments, the potash was replenished by sole indigenous potassium source i.e., sugarcane boiler ash. Further in another set of treatments, three fourth of the MOP was replaced by indigenous potassium source sugarcane boiler ash (75%). Additionally, in another set of treatments, half the dosage of MOP was used in conjuction indigenous potassium source sugarcane boiler ash (50%). As a standard check the treatment with cent per cent of MOP. And all the nine treatments were treated with two different grades of sulphur i.e., Elemental Sulphur I (10 Kg/ha) and Elemental Sulphur II (20 Kg/ha). The results concerning to various soil fertility attributes, growth, yield and quality of brinjal as impacted by the implication of sugarcane boiler ash are defined in this chapter.

4.1 Growth parameter

The results obtained on growth parameters like height of the plant, number of leaves, number of branches and days to 50 per cent flowering of brinjal were compiled and handed out in different tables.

4.1.1 Plant height (cm) at 45 and 90 DAT

The data concerning to plant height as impacted by implication of sugarcane boiler ash on brinjal is handed out in table 8.

The analysis of results revealed substantial differences amongst the different treatments for plant height. At 45 DAT showed substantial difference due to implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (41.47cm) plant height at 45 DAT. This was preceded by the treatment T_8 (50% K SBA + S_1 + 50% MOP) with plant height 38.40 cm, which was equipollent with T_9. Later, minimum (35.00 cm) plant height was observed in treatment T_4 with sole implication of sugarcane boiler ash.

The plant height at 90 DAT showed substantial difference as impacted by sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (77.80cm) plant height at 90 DAT, which was equipollent with the treatment T_8 (50% K SBA + S_1 + 50% MOP) with plant height 72.33 cm. This was preceded by treatment T_7 (75% K SBA + S_2 + 25% MOP) with plant height 68.57 cm. Minimum (62.43 cm) plant height was observed in treatment T_4 (100% K SBA + S_1).

4.1.2 Number of branches at 45 and 90 DAT

The data concerning to number of branches as impacted by implication of sugarcane boiler ash is handed out in table 8.

The number of branches at 45 DAT showed substantial difference due to implication of sugarcane boiler ash. Among the various treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded significantly higher (8.67) number of branches at 45 DAT. This was preceded by the treatment T_8 (50% K SBA + S_1 + 50% MOP) with 7.27 branches which was equipollent with the further treatments. On the contrary, less (5.93) number of branches were recorded in treatment T_4 (100% K SBA + S_1).

The number of branches at 90 DAT showed considerable effect due to implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP), T_8 (50% K SBA + S_1 + 50% MOP), T_7 (75% K SBA + S_2 + 25% MOP) and T_6 (75% K SBA + S_1 + 25% MOP) recorded higher (13.53, 13.00, 12.87 and 12.73 respectively) number of branches at 90 DAT which were equipollent with each other. This was preceded by the treatment T_3 (RDF + S_2) with 12.53 branches which was equipollent with the treatments T_2 (RDF + S_1) and T_1 (RDF) of 12.33 and 12.00 branches respectively. However, less (9.13) numbers of branches were recorded in treatment T_4 (100% K SBA + S_1).

4.1.3 Number of leaves at 45 and 90 DAT

The data concerning to number of leaves as impacted by implication of sugarcane boiler ash is handed out in table 9.

The number of leaves at 45 DAT showed substantial difference due to implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP), T_8 (50% K SBA + S_1 + 50% MOP) and T_7 (75% K SBA + S_2 + 25% MOP) recorded significantly higher (39.73, 38.60 and 38.33 respectively) number of leaves at 45 DAT which was equipollent with each other. This was preceded by the treatment T_6 (75% K SBA + S_1 + 25% MOP) of 34.67 leaves. Minimum (30.47) number of leaves was observed in treatment T_4 (100% K SBA + S_1).

The number of leaves at 90 DAT showed substantial difference due to implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (79.07) number of leaves at 90 DAT which was equipollent with the treatments T_8 (50% K SBA + S_1 + 50% MOP) of 74.53 leaves and T_7 (75% K SBA + S_2 + 25% MOP) of 74.43 leaves. In contrast to the above, minimum (56.00) number of leaves was observed in treatment T_4 (100% K SBA + S_1).

4.1.4 Days to 50 per cent flowering

The data concerning to days required to 50 per cent flowering as impacted by implication of sugarcane boiler ash is handed out in table 9.

Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) took least (47.67) number of days to 50 per cent flowering, while the treatment T_4 (100% K SBA + S_1) took maximum (56.00) number of days to 50 per cent flowering, on an average all the other treated brinjal plants took 53.19 days to 50 per cent flowering.

Table 8: Effect of sugarcane boiler ash on plant height and number of branches

Treatment	Plant height (cm)		No. of branches	
	45 DAT	90DAT	45 DAT	90DAT
T_1: RDF	35.53^{bc}	65.87^{cd}	6.60^{bc}	12.00^{ab}
T_2: RDF + S1	35.87^{bc}	66.40^{cd}	6.67^{bc}	12.33^{ab}
T_3: RDF + S2	36.33^{bc}	66.73^{bcd}	6.93^{bc}	12.53^{ab}
T_4: 100% K SBA + S1	35.00^{c}	62.43^{d}	5.93^{c}	9.13^{c}
T_5: 100% K SBA + S2	35.33^{bc}	64.67^{cd}	6.27^{bc}	11.07^{b}
T_6: 75% K SBA + S1 +25% MOP	36.47^{bc}	67.53^{bcd}	7.20^{b}	12.73^{a}
T_7: 75% K SBA + S2 +25% MOP	36.93^{bc}	68.87^{bc}	7.23^{b}	12.87^{a}
T_8: 50% K SBA + S1+ 50% MOP	38.40^{ab}	72.33^{ab}	7.27^{b}	13.00^{a}
T_9: 50% K SBA+ S2+ 50% MOP	41.47^{a}	77.80^{a}	8.67^{a}	13.53^{a}
S.Em±	1.07	1.97	0.35	0.52
CD (5%)	3.21	5.92	1.05	1.57

SBA- Sugarcane boiler ash DAT- Days After Transplanting N & P as per RDF
S1- Elemental Sulphur I-10 kg/haS2- Elemental Sulphur II-20 kg/ha

Table 9: Effect of sugarcane boiler ash on number of leaves and days to 50 per cent flowering.

Treatment	No. of leaves		Days to 50% flowering
	45 DAT	90 DAT	
T_1: RDF	33.07[bcd]	63.40[de]	55.67[ab]
T_2: RDF + S_1	34.07[bc]	65.10[de]	55.00[ab]
T_3: RDF + S_2	34.40[bc]	65.87[cd]	54.00[abc]
T_4: 100% K SBA + S_1	30.47[d]	56.00[ef]	56.67[a]
T_5: 100% K SBA + S_2	31.33[cd]	59.30[ef]	56.33[ab]
T_6: 75% K SBA + S_1 +25% MOP	34.67[b]	71.13[bc]	52.67[abcd]
T_7: 75% K SBA + S_2 +25% MOP	38.33[a]	74.43[ab]	51.33[bcd]
T_8: 50% K SBA + S_1+ 50% MOP	38.60[a]	74.53[ab]	49.33[cd]
T_9: 50% K SBA+ S_2+ 50% MOP	39.73[a]	79.07[a]	47.67[d]
S.Em±	1.06	1.99	1.67
CD (5%)	3.19	5.97	5.00

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/ha S_2- Elemental Sulphur II-20 kg/ha

4.2 Yield parameter

4.2.1 Number of fruits per plant

The interpretation of data concerning to number of fruits harvested per plant as impacted by implication of sugarcane boiler ash is handed out in table 10.

Substantial difference was observed among the treatments for number of fruits harvested per plant. Maximum (84.33) number of fruits harvested per plant was recorded in treatment T_9 (50% K SBA + S_2 + 50% MOP), which was equipollent with the treatment T_8 (50% K SBA + S_1 + 50% MOP) and T_7 (75% K SBA + S_2 + 25% MOP). Minimum (70.00) number of fruits was observed with the treatment T_4 (100% K SBA + S_1).

4.2.2 Fruit yield per plant (Kg)

The data concerning to fruit yield per plant as impacted by implication of sugarcane boiler ash is handed out in table 10.

The substantial difference was observed in fruit yield per plant among the different treatments. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (3.68 Kg) yield per plant which was equipollent with the treatment T_8 (50% K SBA + S_1 + 50% MOP). Lesser (2.93 Kg) yield was recorded in the treatment T_4 (100% K SBA + S_1).

4.2.3 Fruit yield per plot (Kg)

The data concerning to fruit yield per plot as impacted by implication of sugarcane boiler ash is handed out in table 11.

The perusal of the data revealed significantly higher yield amongst the treatments. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded the higher (206.27 Kg) yield per plot which was on par with T_8 (50% K SBA + S_1 + 50% MOP). Preceded by T_7 (75% K SBA + S_2 + 25% MOP) with 182.75 Kg which was equipollent with the further treatments. Later, lower (164.08 Kg) yield was observed in T_4 (100% K SBA + S_1).

Table 10: Effect of sugarcane boiler ash on number of fruits per plant and fruit yield per plant.

Treatment	No. of fruits per plant	Fruit yield per plant (kg)
T_1: RDF	72.00^{cd}	3.09^{c}
T_2: RDF + S1	72.33^{cd}	3.14^{bc}
T_3: RDF + S2	75.33^{bcd}	3.16^{bc}
T_4: 100% K SBA + S1	70.00^{d}	2.93^{c}
T_5: 100% K SBA + S2	70.67^{d}	3.03^{c}
T_6: 75% K SBA + S1 +25% MOP	76.33^{bcd}	3.21^{bc}
T_7: 75% K SBA + S2 +25% MOP	78.33^{abc}	3.26^{bc}
T_8: 50% K SBA + S1+ 50% MOP	81.00^{ab}	3.47^{ab}
T_9: 50% K SBA+ S2+ 50% MOP	84.33^{a}	3.68^{a}
S.Em±	2.48	0.12
CD (5%)	7.44	0.35

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20 kg/ha

Table 11: Effect of sugarcane boiler ash on fruit yield per plot and fruit yield per hectare.

Treatment	Fruit yield per plot (kg)	Fruits yield per hectare (t)
T_1: RDF	172.85[c]	42.87[c]
T_2: RDF + S1	175.65[bc]	43.57[bc]
T_3: RDF + S2	176.96[bc]	43.89[bc]
T_4: 100% K SBA + S1	164.08[c]	40.69[c]
T_5: 100% K SBA + S2	169.49[c]	42.04[c]
T_6: 75% K SBA + S1 +25% MOP	179.95[bc]	44.63[bc]
T_7: 75% K SBA + S2 +25% MOP	182.75[bc]	45.32[bc]
T_8: 50% K SBA + S1+ 50% MOP	194.13[ab]	48.15[ab]
T_9: 50% K SBA+ S2+ 50% MOP	206.27[a]	51.16[a]
S.Em±	6.55	1.62
CD (5%)	19.63	4.87

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S1- Elemental Sulphur I-10 kg/haS2- Elemental Sulphur II-20 kg/ha

4.2.4 Fruit yield per hectare (t)

The data concerning to fruit yield per hectare as impacted by implication of sugarcane boiler ash is handed out in table 11.

The examination of the data revealed that higher (51.16 t) yield was recorded in treatment T_9 (50% K SBA + S_2 + 50% MOP) which was equipollent with treatment T_8 (50% K SBA+ S_1 + 50% MOP) of 48.15 t. Minimum (40.69) yield was recorded in T_4 (100% K SBA + S_1).

4.3 Quality parameters

4.3.1 Texture by texture analyzer (N)

The data concerning to texture as impacted by implication of sugarcane boiler ash is handed out in table 12.

Implication of sugarcane boiler ash had significantly increased the firmness of brinjal fruits amongst the different treatments. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) was recorded higher (17.76 N) firmness preceded by the treatment T_8 (17.32 N) which was equipollent with treatments T_7 (16.86 N) and T_6 (16.79 N). However, less (14.96 N) firmness was found in T_4 (100% K SBA + S_1) fruits.

4.3.2 Physiological loss of weight (%)

The data concerning to physiological loss of weight as impacted by implication of sugarcane boiler ash is handed out in table 12.

The interpretation of data on physiological loss of weight as impacted by implication of sugarcane boiler ash showed substantial difference. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded minimum (8.66 %) loss of weight which was equipollent with the treatment T_8 (9.40 %). However, maximum (13.29 %) loss of weight was found in T_4 (100% K SBA + S_1) fruits.

4.3.3 Ascorbic acid (mg/100g)

The data concerning to ascorbic acid as impacted by implication of sugarcane boiler ash is handed out in table 12.

The perusal of data on ascorbic acid as impacted by implication of sugarcane boiler ash showed substantial difference. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (16.96 mg/100g) ascorbic acid content preceded by the treatment T_8 (16.68 mg/100g) which was equipollent with treatment T_7 (15.75 mg/100g). However, lower (12.55 mg/100g) ascorbic acid content was found in T_4 (100% K SBA + S_1) fruits.

4.3.4 Sensory evaluation (9-point hedonic scale)

The sensory evaluation was done by the panel of judges by giving marks on the basis of 9-point hedonic scale.

4.3.4.1 Color

The data concerning to color as impacted by implication of sugarcane boiler ash is handed out in table 13.

Significantly higher (8.78 and 8.30) scores for color were recorded in the treatment T_9 (50% K SBA + S_2 + 50% MOP) and T_8 (50% K SBA + S_1 + 50% MOP) respectively. Preceded by the treatment T_7 (7.49) which was equipollent with the treatment T_6 (7.16). However, lower (6.00) score was recorded in the T_4 (100% K SBA + S_1) fruits.

4.3.4.2 Texture

The data concerning to texture as impacted by implication of sugarcane boiler ash is made available in table 13.

Significantly higher (8.66) score for texture was recorded in the treatment T_9 (50% K SBA + S_2 + 50% MOP) preceded by the treatment T_8 (8.30) which was equipollent with the treatment T_7 (7.57). Lower (6.42) score was recorded in the T_4

Table 12: Effect of sugarcane boiler ash on brinjal quality parameters.

Treatment	Texture analyzer values (N)	Physiological loss of weight (%)	Ascorbic acid (mg/100g)
T_1: RDF	15.58[cd]	12.44[bc]	13.26[de]
T_2: RDF + S1	16.06[bcd]	11.86[c]	13.74[cde]
T_3: RDF + S2	16.13[bcd]	11.71[c]	14.01[cde]
T_4: 100% K SBA + S1	14.96[d]	13.29[a]	12.55[e]
T_5: 100% K SBA + S2	15.00[d]	13.20[ab]	13.09[de]
T_6: 75% K SBA + S1 +25% MOP	16.79[abc]	11.67[c]	14.85[bcd]
T_7: 75% K SBA + S2 +25% MOP	16.86[abc]	10.84[d]	15.75[abc]
T_8: 50% K SBA + S1+ 50% MOP	17.32[ab]	9.40[e]	16.68[ab]
T_9: 50% K SBA+ S2+ 50% MOP	17.76[a]	8.66[e]	16.96[a]
S.Em±	0.50	0.26	0.70
CD (5%)	1.49	0.79	2.10

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S1- Elemental Sulphur I-10 kg/haS2- Elemental Sulphur II-20 kg/ha

Table 13: Effect of sugarcane boiler ash on sensory evaluation by 9-point hedonic scale.

Treatment	Color	Texture	Appearance
T_1: RDF	6.34[de]	6.84[c]	6.33[c]
T_2: RDF + S1	6.77[cd]	6.87[c]	6.50[bc]
T_3: RDF + S2	7.04[bc]	7.04[bc]	6.88[bc]
T_4: 100% K SBA + S1	6.00[e]	6.42[c]	6.09[c]
T_5: 100% K SBA + S2	6.16[de]	6.60[c]	6.22[c]
T_6: 75% K SBA + S1 +25% MOP	7.16[bc]	7.31[bc]	6.90[bc]
T_7: 75% K SBA + S2 +25% MOP	7.49[b]	7.57abc	7.50[abc]
T_8: 50% K SBA + S1+ 50% MOP	8.30[a]	8.30[ab]	7.94[ab]
T_9: 50% K SBA+ S2+ 50% MOP	8.78[a]	8.66[a]	8.50[a]
S.Em±	0.23	0.45	0.51
CD (5%)	0.69	1.35	1.51

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20 kg/ha
(100% K SBA + S_1) fruits.

4.3.4.3 Appearance

The data concerning to appearance as impacted by implication of sugarcane boiler ash is handed out in table 13.

Significantly higher (8.50) score for appearance was recorded in the treatment T_9 (50% K SBA + S_2 + 50% MOP) preceded by T_8 (7.94) which was equipollent with the treatment T_9. Lower (6.09) score was recorded in the T_4 (100% K SBA + S_1) fruits.

4.3.5 Color by colorimetry

The data concerning to color as impacted by implication of sugarcane boiler ash is handed out in table 14.

Implication of sugarcane boiler ash did not show any substantial difference over the treatments. Numerically L* (lightness to darkness) was higher (40.29) in T_5 (100% K SBA + S_2), lower (31.78) in the T_1 (RDF) fruits. Similarly numerical value a* (reddish to green) was higher (9.99) in T_7 (75% K SBA + S_2 + 25% MOP) fruits, lower (8.46) in the T_6 (75% K SBA + S_1 + 25% MOP) fruits. And b* (yellowish to blue) was higher (1.45) in T_5 (100% K SBA + S_2) fruits, lower (-1.31) in the T_3 (RDF + S_2) fruits.

4.4 Soil chemical parameters

4.4.1 pH

The data concerning to pH of the soil as impacted by implication of sugarcane boiler ash is handed out in table 15.

The pH of soil increased with an incremental dose of sugarcane boiler ash. The higher (8.75) pH was recorded with the treatment T_4 (100% K SBA + S_1) preceded by the T_5 (8.67) which was equipollent with T_4. However, lower (7.76) pH was observed in the treatment where the plants were treated with only RDF.

4.4.2 Electrical conductivity (EC)

The data concerning to electrical conductivity of the soil as impacted by implication of sugarcane boiler ash is handed out in table 15.

The EC of soil increases with increasing sugarcane boiler ash volume. The higher (0.16dS/m) EC was observed in the T_4 (100% K SBA + S_1) preceded by T_5. The lower (0.12) EC was observed in the treatment T_1 where the plants were treated with only RDF.

4.4.3 Organic carbon (OC)

The data concerning to organic carbon per cent of the soil as impacted by implicationof sugarcane boiler ash is handed out in table 15.

Substantial difference was observed with respect to the organic carbon of soil as impacted by implication of sugarcane boiler ash among the treatments. Among the treatments,T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.69%) organic carbon which was equipollent with the treatment T_8 (0.66%). Lower (0.29%) organic carbon per cent was recorded in the treatment T_4 (100% K SBA + S_1).

4.4.4 Available nitrogen

The data concerning to available nitrogen as impacted by implication of sugarcane boiler ash is handed out in table 16.

Interpretation of the data showed substantial difference in available nitrogen as impacted by implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (238.45 Kg/ha) available nitrogen which was equipollent with the treatment T_8 (226.88 kg/ha). Lower (197.14 Kg/ha) available nitrogen was observed in T_4 (100% K SBA + S_1).

4.4.5 Available phosphorus

The data concerning to available phosphorus as impacted by implication of sugarcane boiler ash is handed out in table 16.

Table 14: Effect of sugarcane boiler ash on colour by colorimetry.

Treatment	L*	a*	b*
T_1: RDF	31.78	9.36	-1.30
T_2: RDF + S1	36.09	8.98	0.65
T_3: RDF + S2	34.20	9.84	-1.31
T_4: 100% K SBA + S1	35.36	9.43	-0.94
T_5: 100% K SBA + S2	40.29	8.48	1.47
T_6: 75% K SBA + S1 +25% MOP	36.69	8.46	-0.18
T_7: 75% K SBA + S2 +25% MOP	32.53	9.99	-1.16
T_8: 50% K SBA + S1+ 50% MOP	35.87	9.00	-0.96
T_9: 50% K SBA+ S2+ 50% MOP	35.14	8.90	0.26
S.Em±	-	-	-
CD (5%)	NS	NS	NS

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/ha, S_2- Elemental Sulphur II-20 kg/ha

Table 15: Effect of sugarcane boiler ash on chemical properties of soil.

Treatment	pH	EC (dS/m)	Organic carbon(%)
T_1: RDF	7.76^{c}	0.12^{d}	0.39^{d}
T_2: RDF + S1	8.17^{bc}	0.13^{cd}	0.39^{d}
T_3: RDF + S2	8.16^{bc}	0.13^{cd}	0.48^{c}
T_4: 100% K SBA + S1	8.75^{a}	0.16^{a}	0.29^{e}
T_5: 100% K SBA + S2	8.67^{ab}	0.16^{ab}	0.33^{de}
T_6: 75% K SBA + S1 +25% MOP	8.45^{ab}	0.15^{abc}	0.51^{c}
T_7: 75% K SBA + S2 +25% MOP	8.30^{abc}	0.14^{bcd}	0.59^{b}
T_8: 50% K SBA + S1+ 50% MOP	8.23^{abc}	0.14^{abcd}	0.66^{ab}
T_9: 50% K SBA+ S2+ 50% MOP	8.21^{abc}	0.13^{cd}	0.69^{a}
S.Em±	0.18	0.01	0.03
CD (5%)	0.55	0.02	0.08

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S1- Elemental Sulphur I-10 kg/haS2- Elemental Sulphur II-20 kg/ha

Substantial difference was observed in available phosphorus as impacted by implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (61.14 Kg/ha) available phosphorus which was equipollent with the treatment T_8 (50% K SBA + S_1 + 50% MOP) and T_7 (75% K SBA + S_2 + 25% MOP). Lower (53.43 Kg/ha) available phosphorus was observed in T_4 (100% K SBA + S_1).

Substantial difference was observed in available phosphorus as impacted by implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (61.14 Kg/ha) available phosphorus which was equipollent with the treatment T_8 (50% K SBA + S_1 + 50% MOP) and T_7 (75% K SBA + S_2 + 25% MOP). Lower (53.43 Kg/ha) available phosphorus was observed in T_4 (100% K SBA + S_1).

4.4.6 Available potassium

The data concerning to available potassium as impacted by implication of sugarcane boiler ash is handed out in table 16.

Substantial difference was observed in available potassium as impacted by implicationof sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (228.51 Kg/ha) available potassium, preceded by T_8 (224.64kg/ha) which was equipollent with T_9. Lower (175.57 Kg/ha) available potassium was observed in T_4 (100% K SBA + S_1).

4.4.7 Exchangeable calcium

The data concerning to exchangeable calcium as impacted by implication of sugarcane boiler ash is handed out in table 17.

Substantial difference was observed in exchangeable calcium as impacted by implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher [13.39 c mol (p^+) Kg^{-1} soil] exchangeable calcium, preceded by T_8 [12.60 c mol (p^+) Kg^{-1} soil] which was equipollent with the T_9. Lower [8.95 c mol (p^+) Kg^{-1} soil] exchangeable calcium was observed in T_4 (100% K SBA + S_1).

Table 16: Effect of sugarcane boiler ash on primary nutrients in soil.

Treatment	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium(kg/ha)
T_1: RDF	201.29^{c}	54.60^{bcd}	180.71^{b}
T_2: RDF + S1	203.42^{c}	54.64^{bcd}	180.97^{b}
T_3: RDF + S2	207.19^{bc}	54.71^{bcd}	182.26^{b}
T_4: 100% K SBA + S1	197.14^{c}	53.43^{d}	175.57^{b}
T_5: 100% K SBA + S2	200.72^{c}	53.86^{cd}	177.00^{b}
T_6: 75% K SBA + S1 +25% MOP	213.02^{bc}	55.28^{bcd}	210.73^{a}
T_7: 75% K SBA + S2 +25% MOP	216.05^{bc}	58.65^{abc}	220.43^{a}
T_8: 50% K SBA + S1+ 50% MOP	226.88^{ab}	59.62^{ab}	224.64^{a}
T_9: 50% K SBA+ S2+ 50% MOP	238.45^{a}	61.14^{a}	228.51^{a}
S.Em±	6.79	1.69	7.33
CD (5%)	20.35	5.06	21.97

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S1- Elemental Sulphur I-10 kg/haS2- Elemental Sulphur II-20 kg/ha

Table 17: Effect of sugarcane boiler ash on secondary nutrients in soil

Treatment	Calcium [c mol (p^+)/kg]	Magnesium [c mol (p^+)/kg]	Sulphur (ppm)
T_1: RDF	10.94^{ef}	5.74^{de}	24.80^{cd}
T_2: RDF + S1	11.15^{def}	6.06^{cde}	25.36^{bcd}
T_3: RDF + S2	11.49^{cde}	6.32^{cd}	25.55^{abcd}
T_4: 100% K SBA + S1	8.95^{g}	5.45^{e}	22.87^{d}
T_5: 100% K SBA + S2	10.29^{f}	5.69^{de}	24.02^{cd}
T_6: 75% K SBA + S1 +25% MOP	12.12^{bcd}	6.64^{c}	26.11^{abc}
T_7: 75% K SBA + S2 +25% MOP	12.36^{bc}	7.42^{b}	26.11^{abc}
T_8: 50% K SBA + S1+ 50% MOP	12.60^{ab}	8.55^{a}	27.93^{ab}
T_9: 50% K SBA+ S2+ 50% MOP	13.39^{a}	8.68^{a}	28.28^{a}
S.Em±	0.34	0.23	0.94
CD (5%)	1.02	0.68	2.82

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20kg/ha

4.4.8 Exchangeable magnesium

The data concerning to exchangeable magnesium as impacted by implication of sugarcane boiler ash is handed out in table 17.

Substantial difference was observed in exchangeable magnesium as impacted by implication of sugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher [8.68 c mol (p^+) Kg^{-1} soil] exchangeable magnesium, preceded by T_8 which was equipollent with T_9. Lower [5.45 c mol (p^+) Kg^{-1} soil] exchangeable magnesium was observed in T_4 (100% K SBA + S_1).

4.4.9 Available sulphur

The data concerning to available sulphur as impacted by implication of sugarcane boiler ash is handed out in table 17.

Substantial difference was observed in available sulphur as impacted by implication ofsugarcane boiler ash. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher [28.28 ppm] available sulphur, preceded by T_8 (27.93 ppm) which was equipollent with T_9. Lower [22.87 ppm] available sulphur was observed in T_4 (100% K SBA + S_1).

4.4.10 DTPA extractable iron

The data concerning to DTPA extractable Fe as impacted by implication of sugarcane boiler ash is handed out in table 18.

Implication of sugarcane boiler ash had significantly increased the DTPA extractable iron content in soil. Among the different treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (7.83 mg/Kg) DTPA extractable iron, preceded by the treatment T_8 (7.38 mg/kg) which was equipollent with T_9. However lower (6.67 mg/Kg) DTPA extractable iron was found with the treatment T_4 (100% K SBA + S_1).

Table 18: Effect of sugarcane boiler ash on micronutrients in soil

Treatment	Iron (mg/kg)	Copper(mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
T_1: RDF	6.84^{bc}	0.72^{de}	3.95^{d}	1.31^{bcd}
T_2: RDF + S1	6.85^{bc}	0.74^{de}	4.04^{d}	1.35^{bcd}
T_3: RDF + S2	7.23^{abc}	0.81^{cde}	5.14^{c}	1.36^{bcd}
T_4: 100% K SBA + S1	6.67^{c}	0.65^{e}	3.88^{d}	1.19^{d}
T_5: 100% K SBA + S2	6.78^{bc}	0.69^{e}	3.91^{d}	1.26^{cd}
T_6: 75% K SBA + S1 +25% MOP	7.23^{abc}	0.86^{cd}	5.75^{b}	1.44^{bc}
T_7: 75% K SBA + S2 +25% MOP	7.27^{abc}	0.96^{bc}	6.11^{b}	1.47^{bc}
T_8: 50% K SBA + S1+ 50% MOP	7.38^{ab}	1.11^{ab}	6.15^{b}	1.49^{ab}
T_9: 50% K SBA+ S2+ 50% MOP	7.83^{a}	1.15^{a}	7.14^{a}	1.69^{a}
S.Em±	0.23	0.05	0.20	0.07
CD (5%)	0.68	0.16	0.60	0.21

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF

S1- Elemental Sulphur I-10 kg/haS2- Elemental Sulphur II-20 kg/ha

4.4.11 DTPA extractable copper

The data concerning to DTPA extractable copper as impacted by implication of sugarcane boiler ash is handed out in table 18.

Implication of sugarcane boiler ash had significantly increased the DTPA extractable copper in soil. Among the different treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (1.15 mg/Kg) DTPA extractable copper, preceded by the treatment T_8 (1.11 mg/Kg). However, lower (0.65 mg/Kg) DTPA extractable copper was observed in the treatment T_4 (100% K SBA + S_1).

4.4.12 DTPA extractable manganese

The data concerning to DTPA extractable manganese as impacted by implication of sugarcane boiler ash is handed out in table 18.

Implication of sugarcane boiler ash had significantly increased the DTPA extractable manganese in soil. Among the different treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded significantly higher (7.14 mg/Kg) DTPA extractable manganese, preceded by the treatment T_8 (6.15 mg/Kg) which was equipollent with the treatments T_9. However, lower (3.88 mg/Kg) DTPA extractable manganese was observed in the treatment T_4 (100% K SBA + S_1).

4.4.13 DTPA extractable zinc

The data concerning to DTPA extractable Zn as impacted by implication of sugarcane boiler ash is handed out in table 18.

Implication of sugarcane boiler ash had significantly increased the DTPA extractable manganese in soil. Among the different treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (1.69 mg/kg) DTPA extractable zinc, preceded by the treatment T_8 (1.69) which was equipollent with T_9. However, lower (1.19 mg/Kg) DTPA extractable zinc was observed in the treatment T_4 (100% K SBA + S_1).

4.5 Plant nutrient content

4.6 Leaf nitrogen content

The data concerning to leaf nitrogen content impacted by implication of sugarcane boiler ash is handed out in table 19.

Leaf nitrogen content showed substantial difference among treatments which ranged between 2.26 to 1.73 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (2.26%) leaf nitrogen content. Preceded by T_8 (2.23%) which was equipollent with T_9. However, lower (1.73%) leaf nitrogen content was found in T_4 (100% K SBA + S_1).

4.6.1 Stem nitrogen content

The data concerning to stem nitrogen content impacted by implication of sugarcane boiler ash is handed out in table 19.

Stem nitrogen content showed substantial difference among the treatments which ranged between 1.83 to 1.46 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) and T_8 (50% K SBA + S_1 + 50% MOP) recorded higher (1.83% & 1.78%) stem nitrogen content. Preceded by T_7 (1.74 %) which was equipollent with T_8 and T_9. However, lower (1.46 %) stem nitrogen content was found in T_4 (100% K SBA + S_1).

4.6.2 Fruit nitrogen content

The data concerning to fruit nitrogen content impacted by implication of sugarcane boiler ash is handed out in table 19.

Fruit nitrogen content showed substantial difference among the treatments which ranged between 2.26 to 1.73 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP)recorded higher (2.26%) fruit nitrogen content. Preceded by T_8 (2.18%) which was equipollent with T_9. However, lower (1.73%) fruit nitrogen content was found in T_4 (100% K SBA + S_1).

4.6.3 Fruit nitrogen content

The data concerning to fruit nitrogen content impacted by implication of sugarcane boiler ash is handed out in table 19.

Fruit nitrogen content showed substantial difference among the treatments which ranged between 2.26 to 1.73 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (2.26%) fruit nitrogen content. Preceded by T_8 (2.18%) which was equipollent with T_9. However, lower (1.73%) fruit nitrogen content was found in T_4 (100% K SBA + S_1).

4.6.4 Root nitrogen content

The data concerning to root nitrogen content impacted by implication of sugarcane boiler ash is handed out in table 19.

Root nitrogen content showed substantial difference among the treatments which ranged between 1.36 to 1.12 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (1.36 %) root nitrogen content. Preceded by T_8 (1.31 %) which was equipollent with T_9. However, lower (1.12 %) root nitrogen content was found in T_4 (100% K SBA + S_1).

4.6.5 Leaf phosphorus content

The data concerning to leaf phosphorus content impacted by implication of sugarcane boiler ash is handed out in table 19.

Leaf phosphorus content showed substantial difference among the treatments which ranged between 0.66 to 0.33 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded significantly higher (0.66%) leaf phosphorus content. Preceded by T_8 (0.57%) which was equipollent with T_9. However, lower (0.33%) leaf phosphorus content was found in T_4 (100%K SBA + S_1).

4.6.6 Stem phosphorus content

The data concerning to stem phosphorus content impacted by implication of sugarcane boiler ash is handed out in table 19.

Stem phosphorus content showed substantial difference among the treatments which ranged between 0.48 to 0.24 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.48 %) stem phosphorus content. Preceded by T_8 (0.44%) which was equipollent with T_9. However, lower (0.24 %) stem phosphorus content was found in T_4 (100% K SBA + S_1).

4.6.7 Fruit phosphorus content

The data concerning to fruit phosphorus content impacted by implication of sugarcane boiler ash is handed out in table 19.

Fruit phosphorus content showed substantial difference among the treatments which ranged between 0.66 to 0.40 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.66%) fruit phosphorus content. Preceded by T_8 (0.63%) which was equipollent with T_9. However, lower (0.40%) fruit phosphorus content was found in T_4 (100% K SBA + S_1).

4.6.8 Root phosphorus content

The data concerning to root phosphorus content impacted by implication of sugarcane boiler ash is handed out in table 19.

Root phosphorus content showed substantial difference among the treatments which ranged between 0.36 to 0.24 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.36%) root phosphorus content. Preceded by T_8 (0.63%) which was equipollent with T_9. However, lower (0.24%) fruit phosphorus content was found in T_4 (100% K SBA + S_1).

4.6.9 Leaf potassium content

The data concerning to leaf potassium content impacted by implication of sugarcane boiler ash is handed out in table 19.

Leaf potassium content showed substantial difference among the treatments which ranged between 2.23 to 1.63 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP), T_8 (50% K SBA + S_1 + 50% MOP) and T_7 (75% K SBA + S_2 + 25%

MOP) reported higher (2.23, 2.20 & 2.18 % respectively) leaf potassium content. However, lower (1.63%) leaf nitrogen content was found in T_4 (100% K SBA + S_1).

4.6.10 Stem potassium content

The data concerning to stem potassium content impacted by implication of sugarcane boiler ash is handed out in table 19.

Stem potassium content showed substantial difference among the treatments which ranged between 1.89 to 1.43 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (1.89%) stem potassium content. Preceded by T_8 (1.81%) which was equipollent with T_9. However, lower (1.43%) stem potassium content was found in T_4 (100% K SBA + S_1).

4.6.11 Fruit potassium content

The data concerning to fruit potassium content impacted by implication of sugarcane boiler ash is handed out in table 19.

Fruit potassium content showed substantial difference among the treatments which ranged between 2.30 to 1.60 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (2.30%) fruit potassium content. Preceded by T_8 (2.26%) which was equipollent with T_9. However, lower (1.60%) fruit potassium content was found in T_4 (100% K SBA + S_1).

4.6.12 Root potassium content

The data concerning to root potassium content impacted by implication of sugarcane boiler ash is handed out in table 19.

Root potassium content showed substantial difference among the treatments which ranged between 1.65 to 1.26 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (1.65%) root potassium content. Preceded by T_8 (1.60 %) which was equipollent with T_9. However, lower (1.26%) root potassium content was found in T_4 (100% K SBA + S_1).

Table 19: Effect of sugarcane boiler ash on nitrogen, phosphorus and potassium content in leaf, stem, fruit, root ofbrinjal.

Treatment	Nitrogen (%)				Phosphorus (%)				Potassium (%)			
	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root
T_1: RDF	1.93[cd]	1.59[cde]	1.77[ef]	1.25[ab]	0.4[4cd]	0.31[def]	0.51c	0.27[bcd]	1.84[c]	1.63[cd]	1.76[cd]	1.44[c]
T_2: RDF + S1	2.04[bc]	1.61[bcd]	1.87[def]	1.26[ab]	0.44[c]	0.35[cde]	0.53c	0.28[bcd]	1.85[c]	1.64[cd]	1.99[bc]	1.44[c]
T_3: RDF + S2	2.11[abc]	1.62[bcd]	1.97[cde]	1.26[ab]	0.47[c]	0.36[cde]	0.53c	0.29[bcd]	1.90[bc]	1.66[bcd]	2.05[ab]	1.46[c]
T_4: 100% K SBA + S1	1.73[e]	1.46[e]	1.73[f]	1.12[c]	0.33[e]	0.24[f]	0.40d	0.24[d]	1.63[d]	1.43[e]	1.60[d]	1.26[d]
T_5: 100% K SBA + S2	1.74[de]	1.48[de]	1.75[f]	1.18[bc]	0.37[de]	0.29[ef]	0.41d	0.25[cd]	1.72[cd]	1.54[de]	1.75[cd]	1.39[cd]
T_6: 75% K SBA + S1 +25% MOP	2.15[ab]	1.73[abc]	2.04[bcd]	1.27[ab]	0.48[c]	0.38[bcd]	0.57bc	0.30[bc]	2.08[ab]	1.70[bcd]	2.12[ab]	1.50[bc]
T_7: 75% K SBA + S2 +25% MOP	2.18[ab]	1.74[ab]	2.16[abc]	1.30[a]	0.55[b]	0.40[bc]	0.60ab	0.32[ab]	2.18[a]	1.72[bc]	2.12[ab]	1.51[bc]
T_8: 50% K SBA + S1+ 50% MOP	2.23[ab]	1.78[a]	2.18[ab]	1.31[a]	0.57[b]	0.44[ab]	0.63ab	0.32[ab]	2.20[a]	1.81[ab]	2.26[ab]	1.60[ab]
T_9: 50% K SBA+ S2+ 50% MOP	2.26[a]	1.83[a]	2.26[a]	1.36[a]	0.66[a]	0.48[a]	0.66a	0.36[a]	2.23[a]	1.89[a]	2.30[a]	1.65[a]
S.Em±	0.06	0.05	0.07	0.04	0.02	0.03	0.02	0.02	0.07	0.06	0.09	0.04
CD (5%)	0.19	0.15	0.21	0.12	0.07	0.08	0.07	0.05	0.20	0.17	0.28	0.13

SBA- Sugarcane boiler ash
DAT- Days After Transplanting
N & P as per RDF
S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20 kg/ha

4.6.13 Leaf calcium content

The data concerning to leaf calcium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Leaf calcium content showed substantial difference among the treatments which ranged between 0.91 to 0.77 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded significantly highest (0.91%) leaf calcium content. Preceded by T_8 (0.86 %) which was equipollent with T_9. However, minimum (0.77%) leaf calcium content was found in T_4 (100% K SBA + S_1).

4.6.14 Stem calcium content

The data concerning to stem calcium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Stem calcium content showed substantial difference among the treatments which ranged between 0.85 to 0.73 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP)recorded higher (0.85%) stem calcium content. Preceded by T_8 (0.85%) which was equipollent with T_9. However, minimum (0.73%) stem calcium content was found in T_4 (100% K SBA + S_1).

4.6.15 Fruit calcium content

The data concerning to fruit calcium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Fruit calcium content showed substantial difference among the treatments which ranged between 0.94 to 0.79 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP)recorded higher (0.94%) fruit calcium content. Preceded by T_8 (0.91%) which was equipollent with T_9. However, minimum (0.79%) fruit calcium content was found in T_4 (100% K SBA + S_1).

4.6.16 Root calcium content

The data concerning to root calcium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Root calcium content shown substantial difference among the treatments which ranged between 0.87 to 0.78 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.87%) root calcium content. Preceded by T_8 (0.84%) which was equipollent with T_9. However, minimum (0.79%) root calcium content was found in T_4 (100% K SBA + S_1).

4.6.17 Leaf magnesium content

The data concerning to leaf magnesium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Leaf magnesium content showed substantial difference among the treatments which ranged between 0.271 to 0.249 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.271%) leaf magnesium content. Preceded by T_8 (0.270%) which was equipollent with T_9. However, minimum (0.249%) leaf magnesium content was found in T_4 (100% K SBA + S_1).

4.6.18 Stem magnesium content

The data concerning to stem magnesium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Stem magnesium content showed substantial difference among the treatments which ranged between 0.281 to 0.256 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.281%) stem magnesium content. Preceded by T_8 (0.280%) which was equipollent with T_9. However, minimum (0.256%) stem magnesium content was found in T_4 (100%K SBA + S_1).

4.6.19 Fruit magnesium content

The data concerning to fruit magnesium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Fruit magnesium content showed substantial difference among the treatments which ranged between 0.241 to 0.219 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.241%) fruit magnesium content. Preceded by T_8

(0.240%) which was equipollent with T_9. However, minimum (0.219 %) fruit magnesium content was found in T_4 (100%K SBA + S_1).

4.6.20 Root magnesium content

The data concerning to root magnesium content impacted by implication of sugarcane boiler ash is handed out in table 20.

Root magnesium content showed substantial difference among the treatments which ranged between 0.236 to 0.219 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.236%) root magnesium content. Preceded by T_8 (0.135%) which was equipollent with T_9. However, minimum (0.219 %) root magnesium content was found in T_4 (100%K SBA + S_1).

4.6.21 Leaf sulphur content

The data concerning to leaf sulphur content impacted by implication of sugarcane boiler ash is handed out in table 20.

Leaf sulphur content showed substantial difference among the treatments which ranged between 0.35 to 0.25 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.35%) leaf sulphur content. Preceded by T_8 (0.33%) which was equipollent with T_9. However, minimum (0.25%) leaf sulphur content was found in T_4 (100% K SBA + S_1).

4.6.22 Stem sulphur content

The data concerning to stem sulphur content impacted by implication of sugarcane boiler ash is handed out in table 20.

Stem sulphur content showed substantial difference among the treatments which ranged between 0.31 to 0.22 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.31%) stem sulphur content. Preceded by T_8 (0.29%) which was equipollent with T_9. However, minimum (0.22%) stem sulphur content was found in T_4 (100% K SBA + S_1).

Table 20: Effect of sugarcane boiler ash on calcium, magnesium and sulphur content in leaf, stem, fruit, root ofbrinjal.

Treatment	Calcium (%)				Magnesium (%)				Sulphur (%)			
	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root
T_1: RDF	0.80^{c}	0.78^{cd}	0.86^{cd}	0.80^{c}	0.256^{bc}	0.264^{bcd}	0.226^{bc}	0.223^{bcd}	0.26^{def}	0.23^{c}	0.30^{bcd}	0.22^{cd}
T_2: RDF + S1	0.81^{c}	0.80^{cd}	0.88^{bc}	0.81^{c}	0.258^{abc}	0.268^{abcd}	0.228^{abc}	0.226^{abcd}	0.28^{cde}	0.25^{bc}	0.31^{bcd}	0.23^{cd}
T_3: RDF + S2	0.82^{bc}	$0.80b^{cd}$	0.89^{ab}	0.81^{c}	0.265^{abc}	0.272^{abc}	0.232^{abc}	0.227^{abcd}	0.29^{cd}	0.25^{bc}	0.33^{abc}	0.24^{bc}
T_4: 100% K SBA + S1	0.77^{d}	0.73^{e}	0.79^{d}	0.78^{d}	0.249^{bc}	0.256^{d}	0.219^{c}	0.219^{d}	0.25^{f}	0.22^{c}	0.28^{d}	0.19^{d}
T_5: 100% K SBA + S2	0.79^{cd}	$0.76d^{e}$	0.83^{cd}	0.79^{cd}	0.254^{bc}	0.259^{cd}	0.224^{bc}	0.222^{cd}	0.25^{ef}	0.23^{c}	0.29^{cd}	0.21^{cd}
T_6: 75% K SBA + S1 +25% MOP	0.83^{ab}	0.81^{bcd}	0.90^{ab}	0.82^{bc}	0.264^{ab}	0.274^{abc}	0.234^{ab}	0.231^{abc}	0.31^{bc}	0.28^{ab}	0.33^{abc}	0.25^{bc}
T_7: 75% K SBA + S2 +25% MOP	0.86^{a}	0.83^{bc}	0.91^{ab}	0.83^{bc}	0.266^{ab}	0.276^{ab}	0.236^{ab}	0.233^{ab}	0.31^{bc}	0.28^{ab}	0.33^{ab}	0.26^{bc}
T_8: 50% K SBA + S1+ 50% MOP	0.86^{a}	0.85^{ab}	0.91^{ab}	0.84^{ab}	0.270^{a}	0.280^{a}	0.240^{a}	0.235^{a}	0.33^{ab}	0.29^{ab}	0.36^{a}	0.28^{ab}
T_9: 50% K SBA+ S2+ 50% MOP	0.91^{a}	0.85^{a}	0.94^{a}	0.87^{a}	0.271^{a}	0.281^{a}	0.241^{a}	0.236^{a}	0.35^{a}	0.31^{a}	0.37^{a}	0.30^{a}
S.Em±	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01
CD (5%)	0.03	0.04	0.05	0.05	0.04	0.02	0.05	0.04	0.03	0.05	0.04	0.04

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_{1}- Elemental Sulphur I - 10 kg/ha
S_{2}- Elemental Sulphur II - 20 kg/ha

4.6.23 Fruit sulphur content

The data concerning to fruit sulphur content impacted by implication of sugarcane boiler ash is handed out in table 20.

Fruit sulphur content showed substantial difference among the treatments which ranged between 0.37 to 0.28 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.37%) fruit sulphur content. Preceded by T_8 (0.36%) which was equipollent with T_9. However, minimum (0.28%) fruit sulphur content was found in T_4 (100% K SBA + S_1).

4.6.24 Root sulphur content

The data concerning to root sulphur content impacted by implication of sugarcane boiler ash is handed out in table 20.

Root sulphur content showed substantial difference among the treatments which ranged between 0.30 to 0.19 per cent. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (0.30%) root sulphur content. Preceded by T_8 (0.28%) which was equipollent with T_9. However, minimum (0.19%) root sulphur content was found in T_4 (100% K SBA + S_1).

4.6.25 Leaf iron content

The data concerning to leaf iron content impacted by implication of sugarcane boiler ash is handed out in table 21.

Leaf iron content showed substantial difference among the treatments which ranged between 159.96 to 151.19 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (159.96 mg/kg) leaf iron content. Preceded by T_8 (158.19 mg/kg) which was equipollent with the T_9. However, minimum (151.19 mg/kg) leaf iron content was found in T_4 (100% K SBA + S_1).

4.6.26 Stem iron content

The data concerning to stem iron content impacted by implication of sugarcane boiler ash is handed out in table 21.

Stem iron content showed substantial difference among the treatments which ranged between 158.96 to 150.16 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (158.96 mg/kg) stem iron content. Preceded by T_8 (157.20 mg/kg) which was equipollent with the T_9. However, minimum (150.16 mg/kg) stem iron content was found in T_4 (100% K SBA + S_1).

4.6.27 Fruit iron content

The data concerning to fruit iron content impacted by implication of sugarcane boiler ash is handed out in table 21.

Fruit iron content showed substantial difference among the treatments which ranged between 162.14 to 153.39 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (162.14 mg/kg) fruit iron content. Preceded by T_8 (160.46 mg/kg) which was equipollent with the T_9. However, minimum (162.14 mg/kg) fruit iron content was found in T_4 (100% K SBA + S_1).

4.6.28 Root iron content

The data concerning to root iron content impacted by implication of sugarcane boiler ashis handed out in table 21.

Root iron content showed substantial difference among the treatments which ranged between 146.53 to 138.84 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (146.53 mg/kg) root iron content. Preceded by T_8 (144.83 mg/kg) which was equipollent with the T_9. However, minimum (138.84 mg/kg) root iron content was found in T_4 (100% K SBA + S_1).

4.6.29 Leaf copper content

The data concerning to leaf copper content impacted by implication of sugarcane boilerash is handed out in table 21.

Leaf copper content showed substantial difference among the treatments which ranged between 19.86 to 17.02 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (19.86 mg/kg) leaf copper content. Preceded by T_8 (19.50

mg/kg) which was equipollent with the T_9. However, minimum (17.02 mg/kg) leaf copper content was found in T_4 (100% K SBA + S_1).

4.6.30 Stem copper content

The data concerning to stem copper content impacted by implication of sugarcane boiler ash is handed out in table 21.

Stem copper content showed substantial difference among the treatments which ranged between 17.86 to 14.68 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (17.86 mg/kg) stem copper content. Preceded by T_8 (19.50 mg/kg) which was equipollent with the T_9. However, minimum (14.68 mg/kg) stem copper content was found in T_4 (100% K SBA + S_1).

4.6.31 Fruit copper content

The data concerning to fruit copper content impacted by implication of sugarcane boiler ash is handed out in table 21.

Fruit copper content showed substantial difference among the treatments which ranged between 18.76 to 16.32 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (18.76 mg/kg) fruit copper content. Preceded by T_8 (18.36 mg/kg) which was equipollent with the T_9. However, minimum (16.32 mg/kg) fruit copper content was found in T_4 (100% K SBA + S_1).

4.6.32 Root copper content

The data concerning to root copper content impacted by implication of sugarcane boiler ash is handed out in table 21.

Root copper content showed substantial difference among the treatments which ranged between 8.27 to 6.90 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (8.27 mg/kg) root copper content. Preceded by T_8 (8.20 mg/kg) which was equipollent with the T_9. However, minimum (6.90 mg/kg) root copper content was found in T_4 (100% K SBA + S_1).

4.6.33 Leaf manganese content

The data concerning to leaf manganese content impacted by implication of sugarcane boiler ash is handed out in table 21.

Leaf manganese content showed substantial difference among the treatments which ranged between 59.68 to 49.77 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (59.68 mg/kg) leaf manganese content. Preceded by T_8 (59.66 mg/kg) which was equipollent with the T_9. However, minimum (49.77 mg/kg) leaf manganese content was found in T_4 (100% K SBA + S_1).

4.6.34 Stem manganese content

The data concerning to stem manganese content impacted by implication of sugarcane boiler ash is handed out in table 21.

Stem manganese content showed substantial difference among the treatments which ranged between 56.59 to 46.83 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (56.59 mg/kg) stem manganese content. Preceded by T_8 (56.02 mg/kg) which was equipollent with the T_9. However, minimum (46.83 mg/kg) stem manganese content wasfound in T_4 (100% K SBA + S_1).

4.6.35 Fruit manganese content

The data concerning to fruit manganese content impacted by implication of sugarcane boiler ash is handed out in table 21.

Fruit manganese content showed substantial difference among the treatments which ranged between 57.01 to 47.24 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (57.01 mg/kg) fruit manganese content. Preceded by T_8 (56.29 mg/kg) which was equipollent with the T_9. However, minimum (47.24 mg/kg) fruit manganese content was found in T_4 (100% K SBA + S_1).

4.6.36 Root manganese content

The data concerning to root manganese content impacted by implication of sugarcane boiler ash is handed out in table 21.

Root manganese content showed substantial difference among the treatments which ranged between 44.01 to 34.24 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (44.01 mg/kg) root manganese content. Preceded by T_8 (34.24 mg/kg) which was equipollent with the T_9. However, minimum (34.24 mg/kg) root manganese content was found in T_4 (100% K SBA + S_1).

4.6.37 Leaf zinc content

The data concerning to leaf zinc content impacted by implication of sugarcane boiler ash is handed out in table 21.

Leaf zinc content showed substantial difference among the treatments which ranged between 29.57 to 22.87 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (29.57 mg/kg) leaf zinc content. Preceded by T_8 (28.91 mg/kg) which was equipollent with the T_9. However, minimum (22.87 mg/kg) leaf zinc content was found in T_4 (100% K SBA + S_1).

4.6.38 Stem zinc content

The data concerning to stem zinc content impacted by implication of sugarcane boiler ash is handed out in table 21.

Stem zinc content showed substantial difference among the treatments which ranged between 30.07 to 23.70 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) was recorded higher (30.07 mg/kg) stem zinc content. Preceded by T_8 (29.31 mg/kg) which was equipollent with the T_9. However, minimum (23.70 mg/kg) stem zinc content was found in T_4 (100% K SBA + S_1).

4.6.39 Fruit zinc content

The data concerning to fruit zinc content impacted by implication of sugarcane boiler ash is handed out in table 21.

Table 21: Effect of sugarcane boiler ash on iron, copper, manganese and zinc content in leaf, stem, fruit, root of brinjal.

Treatment	Iron (mg/kg)				Copper(mg/kg)				Manganese (mg/kg)				Zinc (mg/kg)			
	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root	Leaf	Stem	Fruit	Root
T_1	152.77^{bc}	151.77^{bc}	155.00^{bc}	142.49^{bc}	18.06^{bcd}	15.65^{bc}	16.91^{bcd}	7.47^{bc}	54.76^{abc}	52.09^{abc}	52.51^{abc}	39.51^{abc}	26.48^{ab}	26.77^{abc}	29.60^{c}	15.53^{bc}
T_2	154.40^{abc}	153.41^{abc}	156.64^{abc}	142.74^{abc}	18.18^{bcd}	16.08^{abc}	17.19^{bcd}	7.62^{ab}	56.97^{ab}	53.97^{ab}	54.38^{ab}	41.38^{ab}	26.61^{ab}	26.94^{abc}	29.91^{bc}	15.63^{bc}
T_3	155.20^{abc}	154.17^{abc}	157.37^{abc}	143.60^{ab}	18.19^{abcd}	16.13^{abc}	17.32^{abcd}	7.64^{ab}	57.49^{ab}	54.49^{ab}	54.91^{ab}	41.91^{ab}	26.93^{ab}	27.42^{ab}	30.10^{bc}	16.30^{abc}
T_4	151.19^{c}	150.16^{c}	153.39^{c}	138.84^{c}	17.02^{d}	14.68^{c}	16.32^{d}	6.90^{c}	49.77^{c}	46.83^{c}	47.24^{c}	34.24^{c}	22.87^{c}	23.70^{c}	28.87^{c}	15.12^{c}
T_5	151.39^{c}	150.40^{c}	153.57^{c}	142.10^{bc}	17.75^{cd}	15.39^{bc}	16.72^{cd}	7.30^{bc}	51.55^{bc}	48.55^{bc}	48.97^{bc}	35.97^{bc}	25.87^{bc}	26.36^{bc}	29.27^{c}	15.47^{bc}
T_7	156.59^{abc}	155.49^{abc}	158.72^{abc}	143.62^{ab}	18.59^{abcd}	16.25^{abc}	17.90^{abc}	7.65^{ab}	58.61^{a}	55.61^{a}	55.68^{a}	42.68^{a}	28.40^{ab}	28.89^{ab}	30.49^{bc}	16.53^{abc}
T_8	157.38^{ab}	156.38^{ab}	159.62^{ab}	144.35^{ab}	19.17^{abc}	17.14^{ab}	18.30^{ab}	7.68^{ab}	59.11^{a}	55.78^{a}	56.20^{a}	43.20^{a}	28.86^{ab}	29.02^{ab}	33.00^{ab}	16.96^{ab}
T_9	158.19^{ab}	157.20^{ab}	160.46^{ab}	144.83^{ab}	19.50^{ab}	17.50^{a}	18.36^{ab}	8.20^{a}	59.66^{a}	56.02^{a}	56.29^{a}	43.29^{a}	28.91^{ab}	29.31^{ab}	33.03^{ab}	16.98^{ab}
T_6	159.96^{a}	158.96^{a}	162.14^{a}	146.53^{a}	19.86^{a}	17.86^{a}	18.76^{a}	8.27^{a}	59.68^{a}	56.59^{a}	57.01^{a}	44.01^{a}	29.57^{a}	30.07^{a}	35.22^{a}	17.52^{a}
S.Em±	1.90	1.91	1.89	1.32	0.56	0.62	0.52	0.23	2.21	2.11	2.13	2.13	1.14	1.12	1.07	0.52
CD (5%)	5.68	5.72	5.66	3.97	1.67	1.84	1.55	0.69	6.63	6.33	6.40	6.40	3.41	3.36	3.20	1.55

T_1: RDF T_2: RDF + S1 T_3: RDF + S2 T_4: 100% K SBA + S1 T_5: 100% K SBA + S2 T_6: 75% K SBA + S1 +25% MOP T_7: 75% K SBA + S2 +25% MOP

Fruit zinc content showed substantial difference among the treatments which ranged between 35.22 to 28.87 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (35.22 mg/kg) fruit zinc content. Preceded by T_8 (33.03 mg/kg) which was equipollent with the T_9. However, minimum (28.87 mg/kg) fruit zinc content was found in T_4 (100% KSBA + S_1).

4.6.40 Root zinc content

The data concerning to root zinc content impacted by implication of sugarcane boiler ashis handed out in table 21.

Root zinc content showed substantial difference among the treatments which ranged between 17.52 to 15.12 mg/kg. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (17.52 mg/kg) root zinc content. Preceded by T_8 (16.98 mg/kg) which was equipollent with the T_9. However, minimum (15.12 mg/kg) root zinc content was found in T_4 (100% K SBA + S_1).

4.7 Total nutrient uptake

4.7.1 Total nitrogen uptake

The data concerning to total nitrogen uptake as impacted by implication of sugarcane boiler ash is handed out in table 22.

The total nitrogen uptake showed substantial difference amongst the different treatments which ranged between 141.95 to 117.75 kg/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) showed higher (141.95 kg/ha) total nitrogen uptake. Then, it was preceded by T_8 (137.45 kg/ha) which was equipollent with the treatment T_7 (135.20 kg/ha). Later, lower (117.75 kg/ha) total nitrogen uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.2 Total phosphorus uptake

The data concerning to total phosphorus uptake as impacted by implication of sugarcane boiler ash is handed out in table 22.

The total phosphorus uptake showed substantial difference amongst the different treatments which ranged between 37.71 to 23.14 kg/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded significantly higher (37.71 kg/ha) total phosphorus uptake.

Then, it was preceded by T_8 (35.02 kg/ha) which was equipollent with the treatments T_7 (32.83 kg/ha) and T_6 (32.64 kg/ha). Later, lower (23.14 kg/ha) total phosphorus uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.3 Total potassium uptake

The data concerning to total potassium uptake as impacted by implication of sugarcaneboiler ash is handed out in table 22.

The total potassium uptake showed substantial difference amongst the different treatments which ranged between 150.89 to 113.62 kg/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (150.89 kg/ha) total potassium uptake. Then, it was preceded by T_8 (145.52 kg/ha) which was equipollent with the treatment T_7 (138.64 kg/ha). However, minimum (113.62 kg/ha) total potassium uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.4 Total calcium uptake

The data concerning to total calcium uptake as impacted by implication of sugarcane boiler ash is handed out in table 23.

The total calcium uptake showed substantial difference amongst the different treatments which ranged between 35.20 to 29.07 kg/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (35.20 kg/ha) total calcium uptake. Then, it was preceded by T_8 (34.89 kg/ha) which was equipollent with the treatment T_9. However, lower (29.07 kg/ha) total calcium uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.5 Total magnesium uptake

The data concerning to total magnesium uptake as impacted by implication of sugarcane boiler ash is handed out in table 23.

Table 22: Effect of sugarcane boiler ash on total primary nutrients uptake by brinjal

Treatment	Nitrogen(kg/ha)	Phosphorus (kg/ha)	Potassium(kg/ha)
T_1: RDF	126.07[cd]	30.64[c]	129.51[d]
T_2: RDF + S1	126.76[cd]	31.20[c]	129.69[d]
T_3: RDF + S2	127.51[cd]	32.08[c]	134.88[cd]
T_4: 100% K SBA + S1	117.75[e]	23.14[e]	113.62[e]
T_5: 100% K SBA + S2	122.75[de]	26.70[d]	120.25[e]
T_6: 75% K SBA + S1 +25% MOP	132.88[bc]	32.64[bc]	135.01[cd]
T_7: 75% K SBA + S2 +25% MOP	135.20[ab]	32.83[bc]	138.64[bc]
T_8: 50% K SBA + S1+ 50% MOP	137.45[ab]	35.02[b]	145.52[ab]
T_9: 50% K SBA+ S2+ 50% MOP	141.95[a]	37.71[a]	150.89[a]
S.Em±	2.28	0.89	2.64
CD (5%)	6.84	2.68	7.92

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF

S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20 kg/ha

Table 23: Effect of sugarcane boiler ash on secondary nutrients uptake by brinjal

Treatment	Calcium (kg/ha)	Magnesium (kg/ha)	Sulphur (kg/ha)
T_1: RDF	31.26[de]	10.60[bc]	11.99[de]
T_2: RDF + S1	32.07[cde]	10.96[abc]	12.63[cd]
T_3: RDF + S2	32.26[cd]	11.09[abc]	13.01[bc]
T_4: 100% K SBA + S1	29.07[f]	10.48[c]	9.63[e]
T_5: 100% K SBA + S2	30.45[ef]	10.52[bc]	10.97[e]
T_6: 75% K SBA + S1 +25% MOP	32.76[cd]	11.35[ab]	13.74[abc]
T_7: 75% K SBA + S2 +25% MOP	33.26[bc]	11.36[ab]	13.84[ab]
T_8: 50% K SBA + S1+ 50% MOP	34.89[ab]	11.63[a]	15.95[a]
T_9: 50% K SBA+ S2+ 50% MOP	35.20[a]	11.71[a]	16.12[a]
S.Em±	0.56	0.28	0.49
CD (5%)	1.67	0.85	1.46

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20 kg/ha

The total magnesium uptake showed substantial difference amongst the different treatments which ranged between 11.71 to 10.48 kg/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) and T_8 (50% K SBA + S_1 + 50% MOP) recorded higher (11.71 kg/ha & 11.63 kg/ha respectively) total magnesium uptake. Then, it was preceded by T_7 (11.36 kg/ha) which was equipollent with the treatment T_6 (11.35 kg/ha). However, minimum (10.48 kg/ha) total magnesium uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.6 Total sulphur uptake

The data concerning to total sulphur uptake as impacted by implication of sugarcane boilerash is handed out in table 23.

The total sulphur uptake showed substantial difference amongst the different treatments which ranged between 16.12 to 9.63 kg/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) and T_8 (50% K SBA + S_1 + 50% MOP + N + P) recorded higher (16.12 kg/ha & 15.95 kg/ha respectively) total sulphur uptake. Then, it is preceded by T_7 (13.84 kg/ha) which was equipollent with the treatment T_6 (13.74 kg/ha). However, minimum (9.63 Kg/ha) total sulphur uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.7 Total iron uptake

The data concerning to total iron uptake as impacted by implication of sugarcane boiler ash is handed out in table 24.

The total iron uptake showed substantial difference amongst the different treatments which ranged between 1174.16 to 1114.71 g/ ha. Among the treatments, T_9 (50% K SBA + S_2

+ 50% MOP) recorded higher (1174.16 g/ha) total iron uptake. Then, it is preceded by T_8 (1163.48 g/ha) which was equipollent with the treatment T_7 (1158.11 g/ha). However, lower (1114.71 g/ha) total iron uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.8 Total copper uptake

The data concerning to total copper uptake as impacted by implication of sugarcane boiler ash is handed out in table 24.

The total copper uptake showed substantial difference amongst the different treatments which ranged between 120.48 to 103.04 g/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP) recorded higher (120.48 g/ha) total copper uptake. Then, it is preceded by T_8 (118.51 g/ha) which was equipollent with the treatment T_7 (113.79 g/ha) and T_6 (113.49 g/ha). However, lower (103.04 g/ha) total copper uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7.9 Total manganese uptake

The data concerning to total manganese uptake as impacted by implication of sugarcane boiler ash is handed out in table 24.

The total manganese uptake showed substantial difference amongst the different treatments which ranged between 407.59 to 334.08 g/ ha. Among the treatments, T_9 (50% K SBA + S_2 + 50% MOP), T_8 (50% K SBA + S_1 + 50% MOP), T_7 (75% K SBA + S_2 + 25% MOP) and T_6 (75% K SBA + S_1 + 25% MOP) recorded higher (407.59, 403.87, 401.99 & 398.80 g/ha respectively) total manganese uptake. Then, it is preceded by T_3 (391.68 g/ha) which was on par with the treatment T_2 (387.77 g/ha). However, minimum (334.08 g/ha) total manganese uptake was recorded in the treatment T_4 (100% K SBA + S_1).

4.7 Economic analysis

The result concerning to the economic analysis of implication of sugarcane boiler ash as a source of potassium varied amongst the treatments (Table 25). Among the treatments, the cost of cultivation was higher (Rs 91360/ha) for the treatment T_3 (100% K through MOP and elemental sulphur S_2). Further, it was preceded by the treatments T_2 (100% K through MOP and elemental sulphur S_1). Later, the treatments

Table 24: Effect of sugarcane boiler ash on total micronutrients uptake by brinjal

Treatment	Iron (g/ha)	Copper(g/ha)	Manganese (g/ha)	Zinc (g/ha)
T_1: RDF	1129.89[bcd]	110.33[c]	373.10[abc]	184.09[cde]
T_2: RDF + S1	1137.88[bcd]	111.42[c]	387.77[ab]	187.35[bcde]
T_3: RDF + S2	1142.93[abcd]	111.46[bc]	391.68[ab]	188.08[bcde]
T_4: 100% K SBA + S1	1114.71[d]	103.04[d]	334.08[c]	181.46[e]
T_5: 100% K SBA + S2	1122.49[cd]	109.64[cd]	347.11[bc]	182.58[de]
T_6: 75% K SBA + S1 +25% MOP	1157.49[abc]	113.49[abc]	398.80[a]	196.85[abcd]
T_7: 75% K SBA + S2 +25% MOP	1158.11[ab]	113.79[abc]	401.99[a]	197.81[abc]
T_8: 50% K SBA + S1+ 50% MOP	1163.48[ab]	118.51[ab]	403.87[a]	200.93[ab]
T_9: 50% K SBA+ S2+ 50% MOP	1174.16[a]	120.48[a]	407.59[a]	204.01[a]
S.Em±	11.68	2.35	16.09	4.84
CD (5%)	35.01	7.05	48.23	14.50

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_1- Elemental Sulphur I-10 kg/haS_2- Elemental Sulphur II-20 kg/ha

T_4 (100% K through sugarcane boiler ash and elemental Sulphur S_1) and T_5 (100 % K through sugarcane boiler ash and elemental Sulphur S_1) which recorded the lower cost of cultivation of Rs 85680/ha and RS 86610/ha respectively.

The higher (Rs 511600/ha, Rs 422615/ha and 1: 4.74) gross return, net return and B:C ratio was obtained in the treatment T_9 where 50 percent of MOP was replaced by sugarcane boiler ash and elemetal sulphur S_2. This was preceded by the treatment T_8 where 50 percent of MOP was replaced by sugarcane boiler ash and elemetal sulphur S_1 of gross income (Rs 481500/ha), net income (Rs 393445/ha) and B: C ratio (1: 4.46). The lower (Rs 406900/ha, Rs 321220/ha and 1: 3.74) gross return, net return and B: C ratio was obtained in the treatment T_4 which constituted only sugarcane boiler ash and elemental sulphur S_1.

Table 25: Benefit cost ratio of brinjal with the sugarcane boiler ash

Treatment	Cost of K sources (Rs/ha)	Total marketable yield (t/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C Ratio
T_1: RDF	5250	42.87	89500	428400	338900	1:3.78
T_2: RDF + S_1	6180	43.57	90430	435700	345270	1:3.81
T_3: RDF + S_2	7100	43.89	91360	438900	347540	1:3.80
T_4: 100% K SBA + S_1	1430	40.69	85680	406900	321220	1:3.74
T_5: 100% K SBA + S_2	2360	42.04	86610	420400	333790	1:3.85
T_6: 75% K SBA + S_1 +25% MOP	4992	44.63	89242	446300	357058	1:4.00
T_7: 75% K SBA + S_2 +25% MOP	5922	45.32	90172	453200	363028	1:4.02
T_8: 50% K SBA + S_1+ 50% MOP	3805	48.15	88055	481500	393445	1:4.46
T_9: 50% K SBA+ S_2+ 50% MOP	4735	51.16	88955	511600	422615	1:4.74

SBA- Sugarcane boiler ash DAT- Days After TransplantingN & P as per RDF
S_{1-} Elemental Sulphur I-10 kg/haS_{2-} Elemental Sulphur II-20 kg/ha

Plate 2. Brinjal fruits of different treatments

5. DISCUSSION

Potassium is the third key nutrient required for crop production. It plays a key role in increasing crop yields and overall quality. As India is not having any commercially viable source of potash, entire requirement of potassic fertilizers need to be imported from abroad countries which led to higher production cost. In consideration with this point, we used indigenous sources available from sugar industry like sugarcane boiler ash was used as a source of potassium. The results concerning to numerous soil fertility attributes, plant nutrients, growth, yield and quality parameters of brinjal as impacted by implication of sugarcane boiler ash as a potassium source made available in the previous chapter are discussed in this section.

5.1 Effect of sugarcane boiler ash on growth attributes of brinjal

The growth characters like plant height, number of branches, number of leaves, days to 50 % flowering readings at 45 and 90 DAT were significant among the treatments due to implication of sugarcane boiler ash as a potassium source (Fig. 2). Amongst the treatments, T_9 showed plant height, number of branches and number of leaves of 41.47 cm, 8.67 branches and 39.73 leaves respectively and days to 50 % flowering parameter T_9 took less number of days i.e., 47.67 days at 45 DAT of brinjal where 50 per cent of MOP was supplemented by sugarcane boiler ash. At 90 DAT, again the treatment T_9 showed plant height, number of branches and number of leaves of 77.80 cm, 13.53 branches and 79.07 leaves respectively, where 50 per cent of MOP was supplemented by sugarcane boiler ash respectively. This might be due to the fact that the material used to supplement part of the potassium requirement was also found to supply additional nutrients like P, Mg, and Ca. Further, conductive physical environment leading to better aeration, root activity and nutrient absorption and the consequent complementary effect of ash and chemical fertilizer as reported by Yadav (2006). The same findings were reported by Lal *et al*. (1996), Arvind Kumar *et al*. (1999), Deshmukh *et al*. (2000), Kavyashree (2021) and Sooryalekshmi (2021).

5.2 Effect of sugarcane boiler ash on yield and yield attributes of brinjal

The data concerning to yield and yield attributes of brinjal showed that there was substantial difference among the treatments (Fig. 3). Amongst the treatments, T_9 showed higher number of fruits per plant, fruit yield per plant, fruit yield per plot and yield per hectare of 84.33 fruits, 3.68 kg/plant, 206.27 kg/plot and 51.16 t/ha, respectively where 50 per cent of MOP was replaced by sugarcane boiler ash. This might be due to increased plant nutrients availability and balanced supply of all essential nutrients through organic and inorganic sources. This resulted in increased cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and increased nutrient absorption by increased root activity, all these factors lead to better growth and development of the crop as reported by Veena (2018). The similar results were reported by Hamsa (2015), Ramteke (2016), Kavyashree (2021) and Sooryalekshmi (2021).

5.3 Effect of sugarcane boiler ash on quality attributes of brinjal

The data on quality attributes of brinjal like texture-by-texture analyzer, physiological loss of weight, vitamin C and sensory evaluation content were significant among the treatments due to implication of sugarcane boiler ash as a potassium source. Amongst the treatments, T_9 (50% K through sugarcane boiler ash + 50% MOP + S_2) showed higher firmness in texture, vitamin C content and score for sensory evaluation (color, texture & appearance) and lesser physiological loss of weight of 17.76 N, 16.96 mg/100g, 8.78, 8.66, 8.50 and 8.66 per cent respectively. This might be due to the complementary effect of organic and inorganic sources and balanced supply of nutrients that might have lead to the supply required amount of nutrient to plants. The same was reported by Lal *et al*. (1996), Mulla *et al*. (2000) and Pradhan *et al*. (2004).

5.4 Soil fertility attributes

5.4.1 Soil pH

The results concerning to implication of sugarcane boiler ash as a potassium source on pH of soil showed substantial difference amongst the treatments was handed out in fig. 4. The pH of soil was found to increase with higher doses of implication of

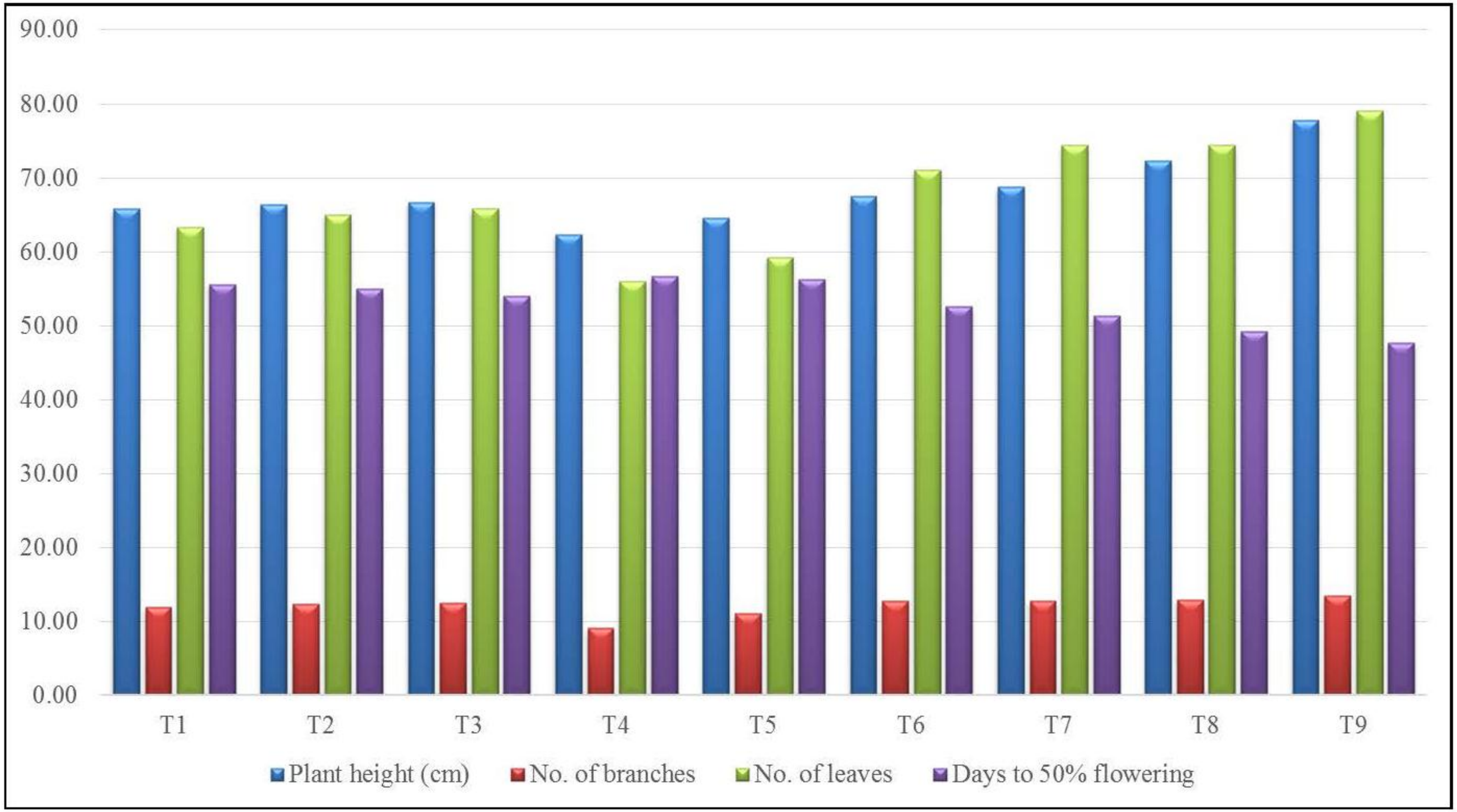

Fig 2. Effect of sugarcane boiler ash on growth parameters

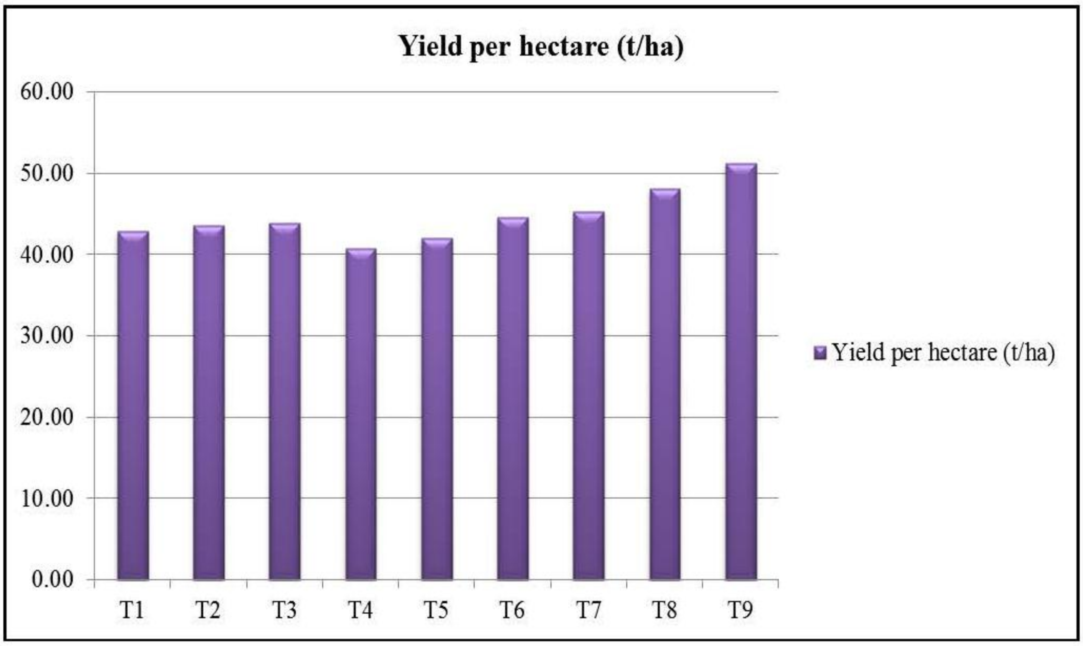

Fig 3. Effect of sugarcane boiler ash on yield

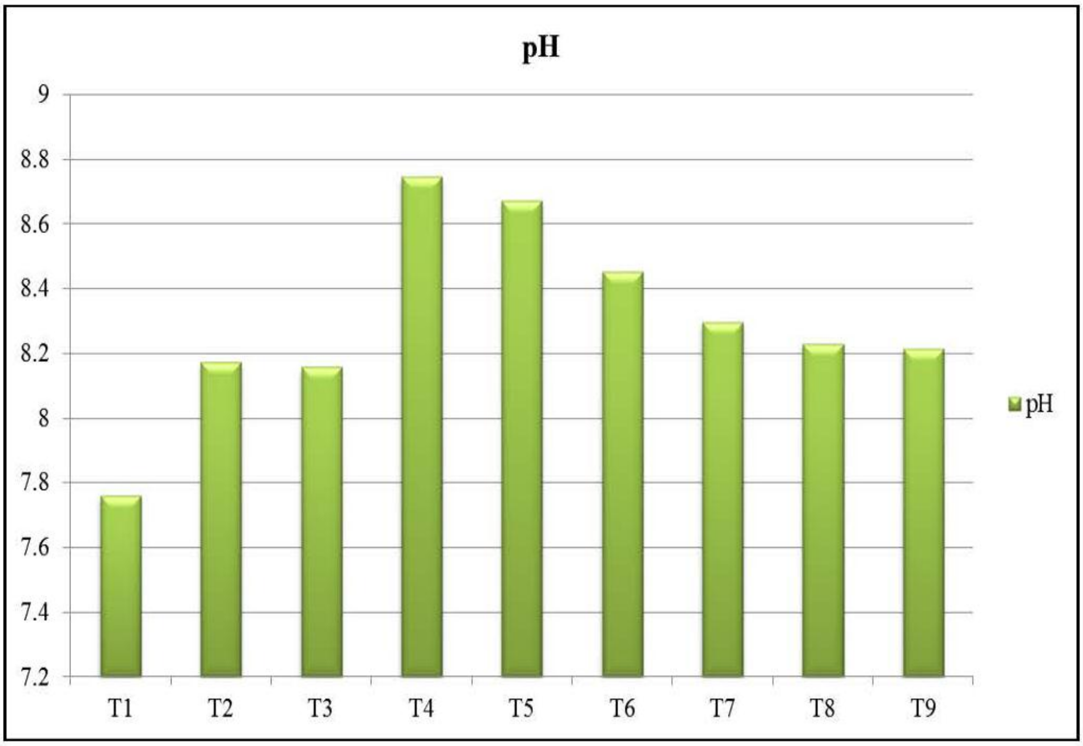

Fig 4. Effect of sugarcane boiler ash on soil pH

sugarcane boiler ash as a source of potassium. The results also revealed that the soil pH was found intermediate with implication of sugarcane boiler ash along with chemical fertilizers. Further, it was found lower in soil pH with incorporation of only chemical fertilizers. Later, the higher (8.75) soil pH was observed in treatment T_4 which constituted only sugarcane boiler ash compared with control (7.76) which constitutes RDF only. It might be due to alkaline nature of ash as reported by Sharma and Kalra (2006). The results were in concordance with the findings of Sikka and Kansal (1995), Deshmukh *et al*. (2000), Kavyashree (2021) and Sooryalekshmi (2021).

5.4.2 Electrical conductivity (EC)

The data concerning to incorporation of sugarcane boiler ash as source of potassium on soil EC showed substantial difference amongst the treatments was handed out in fig. 5. The EC of soil was found to increase with increasing the implication of sugarcane boiler ash as a source of potassium. The maximum (0.16 dsm^{-1}) soil EC was found in treatment T_4 and T_5 which constituted only sugarcane boiler ash. It might be due to the occurrence of cations and anions in soil suspension. However, the salinity created by the indigenous sources remained for low to cause any harm to the crop. The same results were reported by Kumar and Chopra (2016), Paul *et al.* (2005), Kavyashree (2021) and Sooryalekshmi (2021).

5.4.3 Organic carbon (OC)

Implication of sugarcane boiler ash as a source of potassium showed substantial variations amongst the treatments. It was handed out in fig. 5. The organic carbon content remained higher (6.9 g/kg) in treatment T_9 where 50 per cent of MOP was supplemented by sugarcane boiler ash compared with control (3.9 g/kg) i.e., only RDF. This might be due to the improved physical conditions there by higher root growth which might have added organic carbon as reported by Yadav (2006). The lower (2.9 g/kg) organic carbon was observed in only ash applied soil which might be due to lower organic carbon of ash leads to faster decomposition of added organic carbon. The similar findings were reported earlier by Warambhe *et al*. (1993), Kene *et al*. (1991), Kavyashree (2021) and Sooryalekshmi (2021).

5.4.4 Available nitrogen

The data concerning to available nitrogen showed substantial variations amongst the treatments. It was handed out in fig. 6. Amongst the treatments, T_9 showed higher nitrogen content of 238.45 kg/ha where 50 per cent of MOP was supplemented by sugarcane boiler ash. This might be due to addition of chemical fertilizers along with ash as reported by Das *et al*. (2013) and Lal *et al*. (2015). The lower (197.14) nitrogen content in only ash applied soil was due to low nitrogen content of ash as nitrogen is lost during combustion of spent wash as reported by Veena (2018). The similar findings were reported by Deshmukh *et al*. (2000), Yadav (2006), Kavyashree (2021) and Sooryalekshmi (2021).

5.4.5 Available phosphorus

Available phosphorus content in soil was substantial among treatments due to the implication of sugarcane boiler ash as a source of potassium. It was handed out in fig. 6. Amongst the treatments, T_9 (50% K through sugarcane boiler ash + 50% MOP) showed higher (61.14 kg ha^{-1}) available phosphorus content among the treatments. This might be due to combined inherent P and chemical fertilizers as reported by Das *et al*. (2013), Lal *et al*. (2015), Kavyashree (2021) and Sooryalekshmi (2021).

5.4.6 Available potassium

Incorporation of sugarcane boiler ash as source of potassium showed that there was substantial difference amongst the treatments. It was handed out in fig. 6. The available potassium content in soil was higher (228.51 kg ha^{-1}) in treatment T_9 where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. This might be due to combined effect of ash and chemical fertilizer and also higher potassium content in both incinerated ash and chemical fertilizers to augment available potassium in soil. The same results were reported by Yadav (2006), Veena (2018) Kavyashree (2021) and Sooryalekshmi (2021).

5.4.7 Exchangeable calcium and magnesium

The results concerning to exchangeable calcium and magnesium indicated that there was substantial difference among the treatments. It was handed out in fig. 7.

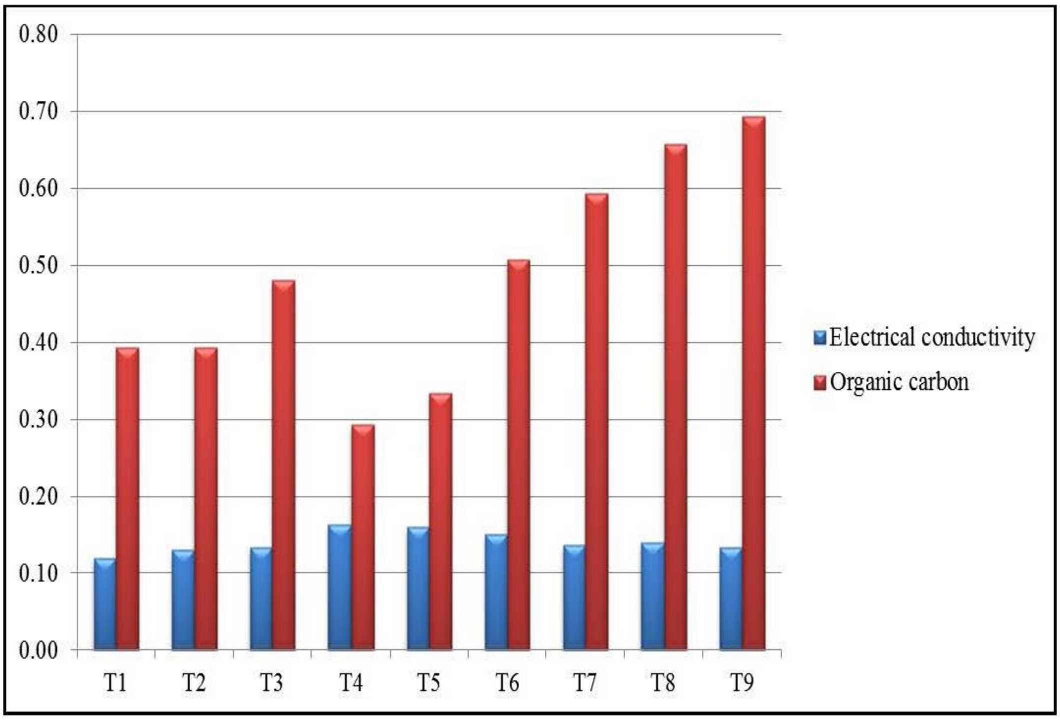

Fig 5. Effect of sugarcane boiler ash on electrical conductivity and organic carbon of soil

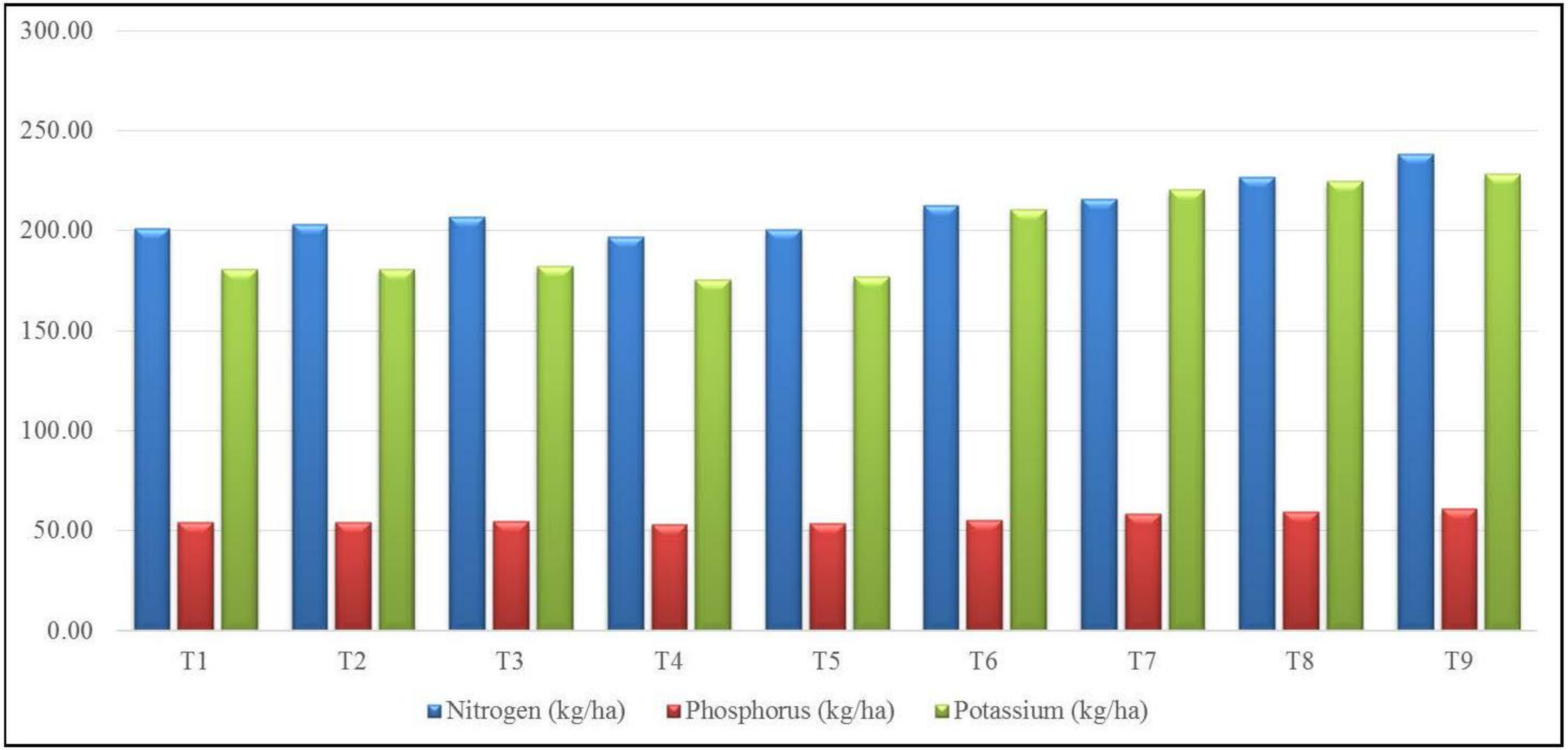

Fig 6. Effect of sugarcane boiler ash on available nitrogen, phosphorus, potassium in soil

Amongst the treatments, T_9 (50% sugarcane boiler ash + 50% MOP) represents higher (13.39 c mol (p^+) kg^{-1} soil) exchangeable calcium. The exchangeable magnesium content was also higher (8.68 c mol (p^+) kg^{-1} soil) in treatment T_9 where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. This might be due to presence of calcium and magnesium content in ash which rapidly released into the soil solution. The similar findings were reported by Deshmukh *et al.* (2000), Bhavya (2020) Kavyashree (2021) and Sooryalekshmi (2021).

5.4.8 Available sulphur

The data concerning to available sulphur showed that there was substantial difference among the treatments. It was handed out in fig. 7. Amongst the treatments, T_9 showed higher (28.28 ppm) available sulphur content where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. This might be due to the higher available sulphur in soil was due to the combined effect of incineration ash and inorganic sources and also they helped in mobilizing the sulphur from the soil as reported by Surekha (2005), Kanojia and Singh (2008), Buddhe *etal.* (2014), Kavyashree (2021) and Sooryalekshmi (2021).

5.4.9 DTPA extractable Iron

The data concerning to DTPA extractable iron showed that there was substantial difference among the treatments. It was handed out in fig. 8. Amongst the treatments, T_9 showed higher (7.83 mg kg^{-1}) DTPA extractable iron content where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. Available iron content in soil increased with increase in levels of sugarcane boiler ash implication in combination with fertilizers and FYM which might be due to a higher concentration of iron in both incineration ash and FYM. Rajakumar (2000) and Benipal*et al.* (2006) also noticed the same results.

5.4.10 DTPA Extractable Copper

The data concerning to DTPA extractable copper showed that there was substantial difference among the treatments. It was handed out in fig. 8. Amongst the treatments, T_9 showed higher (1.15 mg kg^{-1}) DTPA extractable copper content where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. The increase in copper content in soil might be due to the combined implication of incineration ash, fertilizers and FYM. Similar findings were also opined by Das *et al.* (2013) and Sabanoor*et al.* (2016).

5.4.11 DTPA extractable Manganese

The data concerning to DTPA extractable manganese showed that there was substantial difference among the treatments. It was handed out in fig. 8. Amongst the treatments, T_9 showed higher (7.14 mg kg^{-1}) DTPA extractable manganese content where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. Available Manganese content in post harvest soil increased due to higher amount of manganese in both sugarcane boiler ash and FYM was exposed by Das *et al.* (2013). Similar results were revealed by Mitra *et al.* (2003) and Reddy *et al.* (2010). DTPA extractable Zinc

5.4.12 DTPA extractable Zinc

The data concerning to DTPA extractable zinc showed that there was substantial difference among the treatments. It was handed out in fig. 8. Amongst the treatments, T_9 showed higher (1.69 mg kg^{-1}) DTPA extractable zinc content where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. The DTPA extractable zinc content in postharvest soil increased with increased levels of sugarcane boiler ash implication in combination with FYM which might be due to higher amounts of zinc in them which was released upon decomposition. The increase in zinc content of soil due to combined implication of ash and FYM. Similar findings were reported by Mitra *et al.* (2003), Kishor *et al.* (2010), Jena *et al.* (2013), Buddhe *et al.* (2014).

5.5 Total nutrient uptake by plant

5.5.1 Total nitrogen uptake

The total nitrogen uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 9. Amongst the treatments, T_9 showed higher (141.95 kg ha^{-1}) total nitrogen uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. It also showed higher

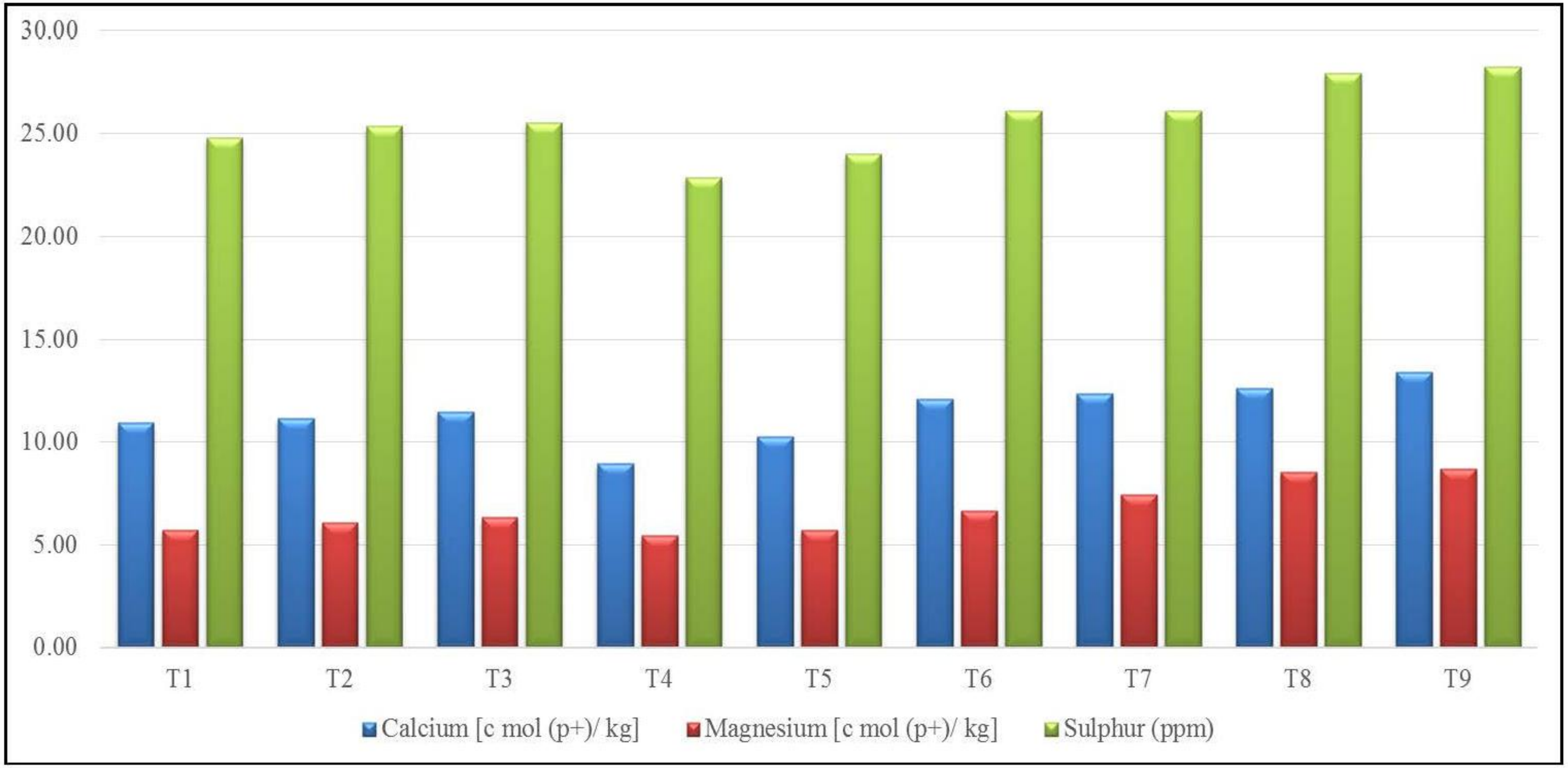

Fig 7. Effect of sugarcane boiler ash on exchangeable calcium magnesium and available sulphur in soil

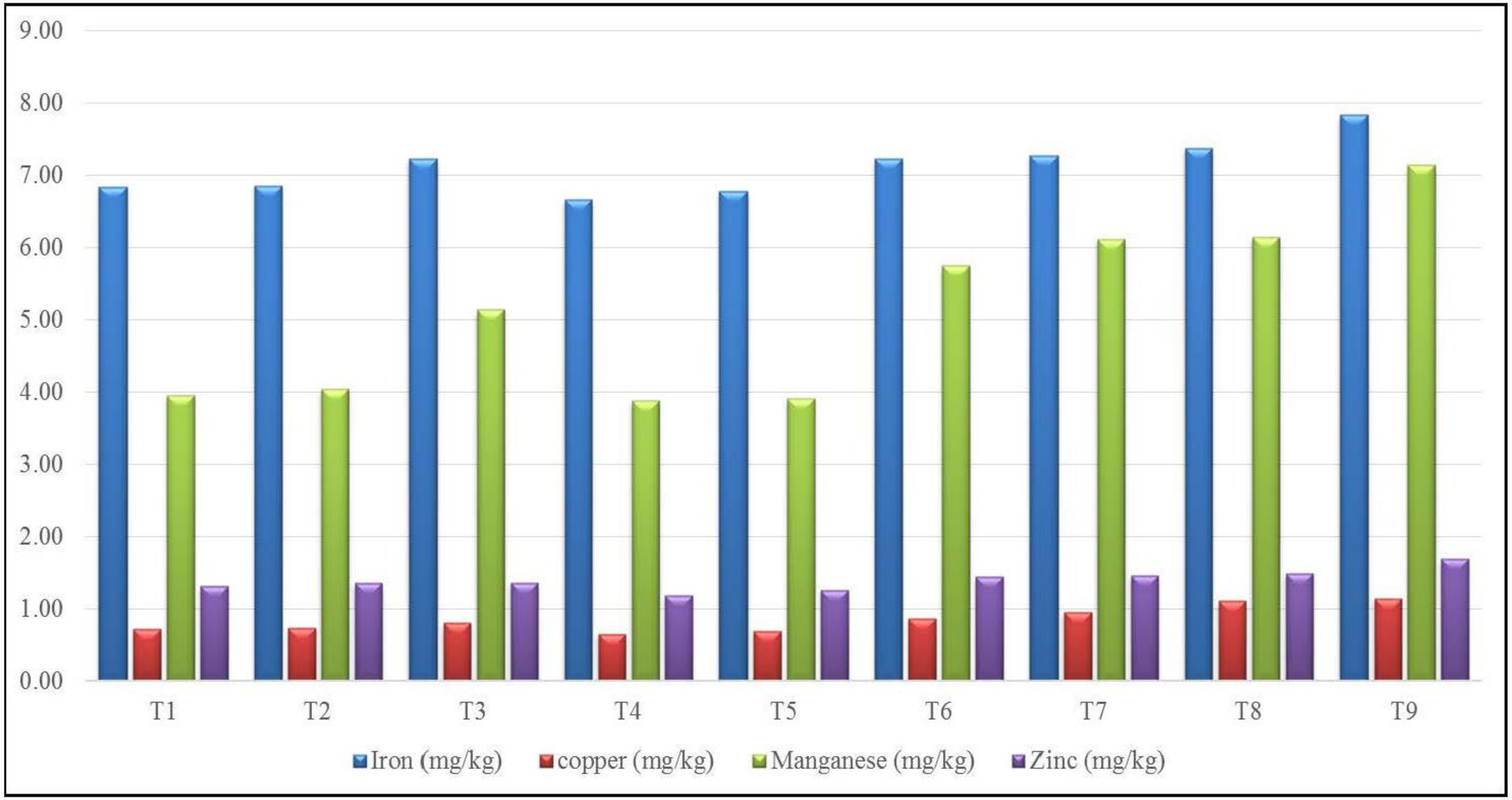

Fig 8. Effect of sugarcane boiler ash on DTPA extractable micronutrients (Fe, Cu, Mn & Zn) in soil

nitrogen content (leaf, stem, fruit and root) of 2.26, 1.83, 2.26 and 1.36 per cent respectively. This might be due to the complementary effect of organic and inorganic sources helped in increased absorption of nitrogen by the crop. Similar results were obtained by Rautaray *et al.* (2003), Lee *et al.* (2006), Ramteke (2016), Kavyashree (2021) and Sooryalekshmi (2021).

5.5.2 Total phosphorus uptake

The data concerning to the total phosphorus uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 9. The treatment T_9 showed higher (37.71 kg ha^{-1}) total phosphorus uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. The treatment T_9 also showed higher phosphorus content (leaf, stem, fruit and root) of 0.66, 0.48, 0.66 and 0.36 per cent respectively. This might be due to the supply of these nutrients by indigenous source and P fertilizer**.** Similar findings were also reported by Ramteke (2016). These results were also in line with Selvakumari *et al.* (2000), Warambhe *et al.* (1993), Rautaray *et al.* (2003), Lee *et al.* (2006), Kavyashree (2021) and Sooryalekshmi (2021).

5.5.3 Total potassium uptake

The results concerning to the total potassium uptake by plant showed that there was substantial difference among the treatments. It was handed out in fig. 9. Amongst the treatments, T_9 showed higher (150.89 kg ha^{-1}) total potassium uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as source of potassium. It also showed higher potassium content (leaf, stem, fruit and root) of 2.23, 1.89, 2.30 and 1.65 per cent. This might be due to a higher concentration of total potassium in the incineration ash and also due to the implication of chemical fertilizers**.** The complementary effect of ash and chemical fertilizers resulted in better soil physical environment, better root activity and also as potassium was present in ionic form in soil solution which led to better absorption by crop**.** Steady and constant supply of K was ensured**.** Similar findings were concluded by Rautaray *et al.* (2003), Ramteke (2016), Veena (2018), Kavyashree (2021) and Sooryalekshmi (2021).

5.5.4 Total calcium uptake

The data on total calcium uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 10. The treatment T_9 showed higher (35.20 kg ha^{-1}) calcium uptake by plant compared with other treatments where 50 per cent of MOP was replaced by sugarcane boiler ash as a source of potassium. It also showed higher calcium content (leaf, stem, fruit and root) of 0.91, 0.85, 0.94 and 0.87 per cent, respectively. This might be due to presence of calcium content in ash which increases the availability of nutrients in the soil and thereby it helps in better absorption and uptake of nutrients. The similar findings were reported by Deshmukh *et al.* (2000), Bhavya (2020), Kavyashree (2021) and Sooryalekshmi (2021).

5.5.5 Total magnesium uptake

The results concerning to total magnesium uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 10. Amongst the treatments, T_9 showed higher (11.71 kg ha^{-1}) total magnesium uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as source of potassium. It also showed higher magnesium content (leaf, stem, fruit and root) of 0.271, 0.281, 0.241 and 0.236 per cent respectively. This might be due to the antagonistic interaction between potassium and magnesium**.** Similar findings were reported by Pathak and Kalra (1971) Veena (2018), Kavyashree (2021) and Sooryalekshmi (2021).

5.5.6 Total sulphur uptake

The total sulphur uptake by plant showed that there was substantial difference amongstthe treatments. It was handed out in fig. 10. Amongst the treatments, T_9 showed higher (16.12 kg ha^{-1}) total sulphur uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as source of potassium. It also showed higher sulphur content (leaf, stem, fruit and root) of 0.35, 0.31, 0.37 and 0.30 per cent respectively. This might be due to the higher available sulphur in soil was due to the combined effect of incinerated ash and inorganic sources and also, they helped in mobilizing the sulphur from the soil as reported by Surekha (2005), Kanojia and Singh (2008), Buddhe *et al.* (2014) Kavyashree (2021) and Sooryalekshmi (2021).

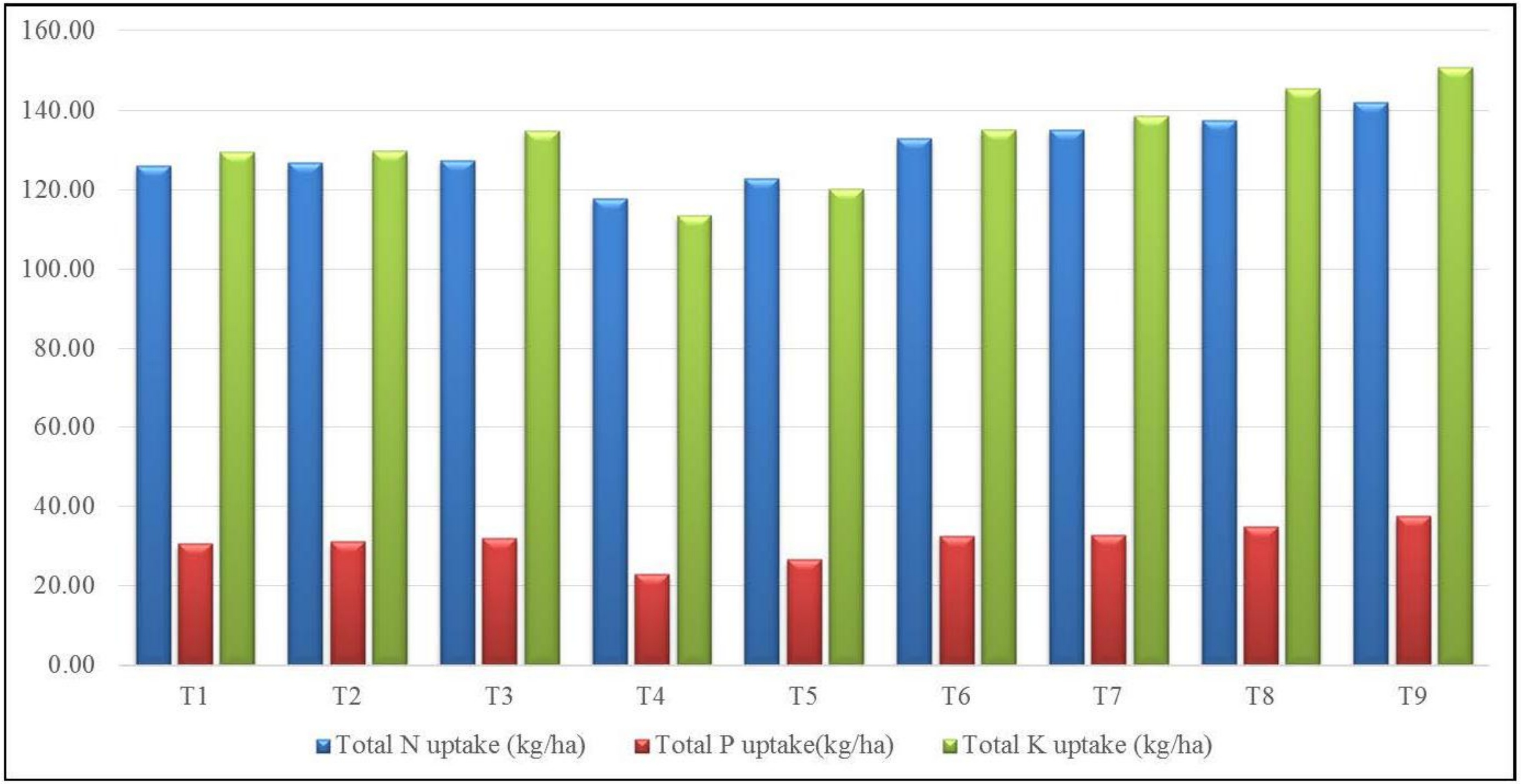

Fig 9. Effect of sugarcane boiler ash on total primary nutrients uptake by plant

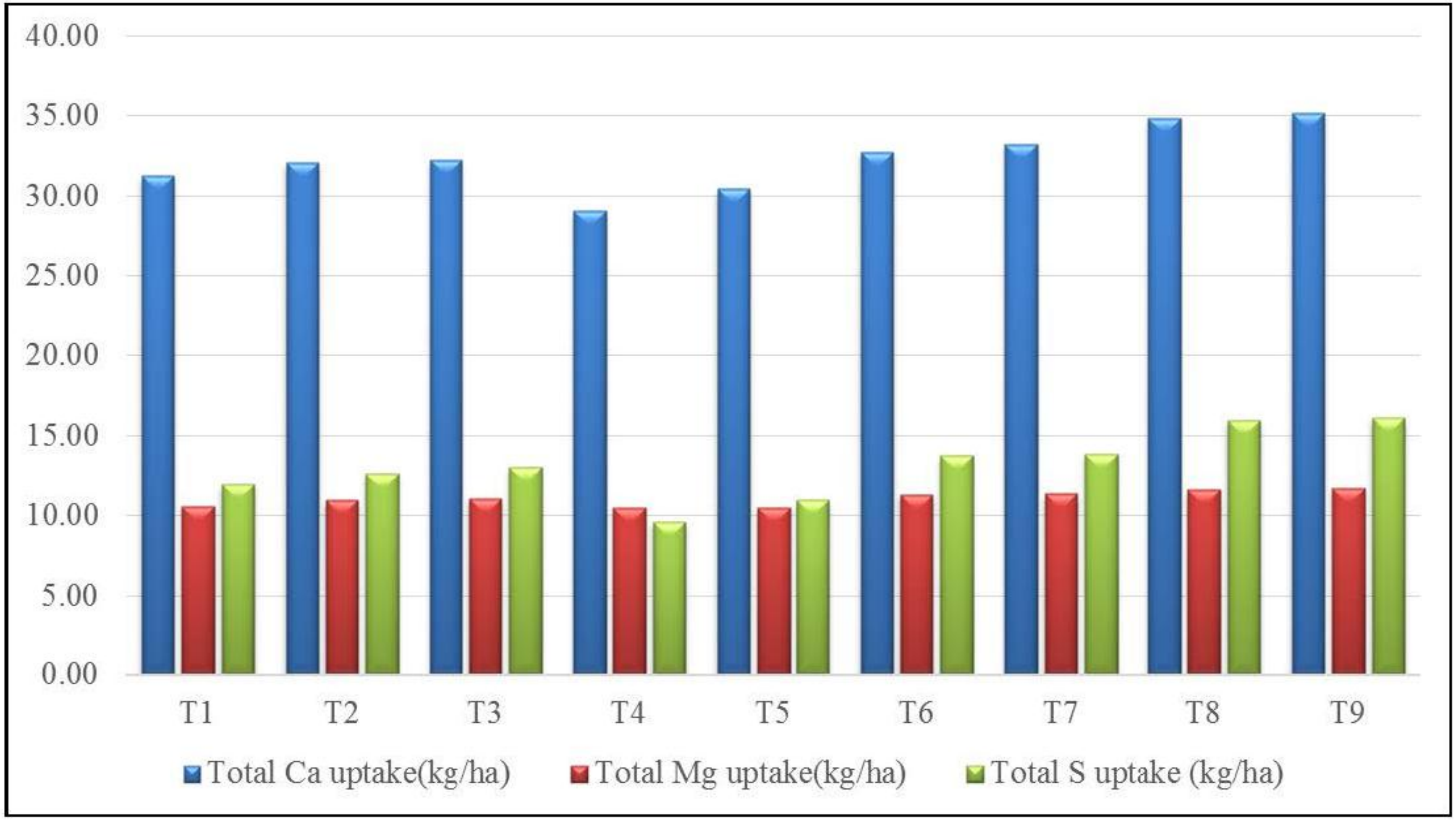

Fig 10. Effect of sugarcane boiler ash on total secondary nutrients uptake by plant

5.5.7 Total iron uptake

The total iron uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 11. Amongst the treatments, T_9 showed higher (1.17 kg ha^{-1}) total iron uptake by plant where 50 per cent of MOP was replaced by sugarcane boilerash as source of potassium. It also showed higher iron content (leaf, stem, fruit and root) of 159.96, 158.96, 162.14 and 146.53 mg/kg respectively. The increased uptake of iron by brinjal plant might be due to the presence of high concentration of iron in both incineration ash and FYM. Similar findings were reported by Hamsa (2015).

5.5.8 Total copper uptake

The total copper uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 11. Amongst the treatments, T_9 showed higher (0.12 kg ha^{-1}) total copper uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as source of potassium. It also showed higher copper content (leaf, stem, fruit and root) of 19.86, 17.86, 18.76 and 8.27 mg/kg respectively. The increased uptake of copper by brinjal plant might be due to combined effect of incinerated ash and inorganic sources. Similar finding was reported by Jayasinghe *et al.* (2009).

5.5.9 Total manganese uptake

The total manganese uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 11. Amongst the treatments, T_9 showed higher (0.40 kha^{-1}) total manganese uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as source of potassium. It also showed higher manganese content (leaf, stem, fruit and root) of 59.68, 56.59, 57.01 and 44.01 mg/kg respectively. The increased uptake of manganese by brinjal plant was due to increased activity of ionic transporter and also due to higher manganese availability in both incineration ash and FYM. Similar findings were reported by Rautaray*et al.* (2003) and Ramteke (2016).

5.5.10 Total zinc uptake

The total zinc uptake by plant showed that there was substantial difference amongst the treatments. It was handed out in fig. 11. Amongst the treatments, T_9 showed higher (0.20 kg ha^{-1}) total zinc uptake by plant where 50 per cent of MOP was replaced by sugarcane boiler ash as source of potassium. It also showed higher zinc content (leaf, stem, fruit and root) of 29.57, 30.07, 35.22 and 17.52 mg/kg respectively. The increased uptake of zinc by brinjal plant might be due to combined effect of incinerated ash and inorganic sources. Similar finding was reported by Jayasinghe *et al.* (2009).

5.6 Benefit cost ratio of brinjal with the sugarcane boiler ash

Economic analysis of current study revealed that the treatment T_9 obtained higher (Rs 511600/ha, Rs 422615/ha and 1: 4.74) gross return, net return and B: C ratio where 50 per cent of sugarcane boiler ash was replaced with MOP. This might be due to increased fruit yield and lower cost of sugarcane boiler ash as potassium source. This result was in line with Veena (2018).

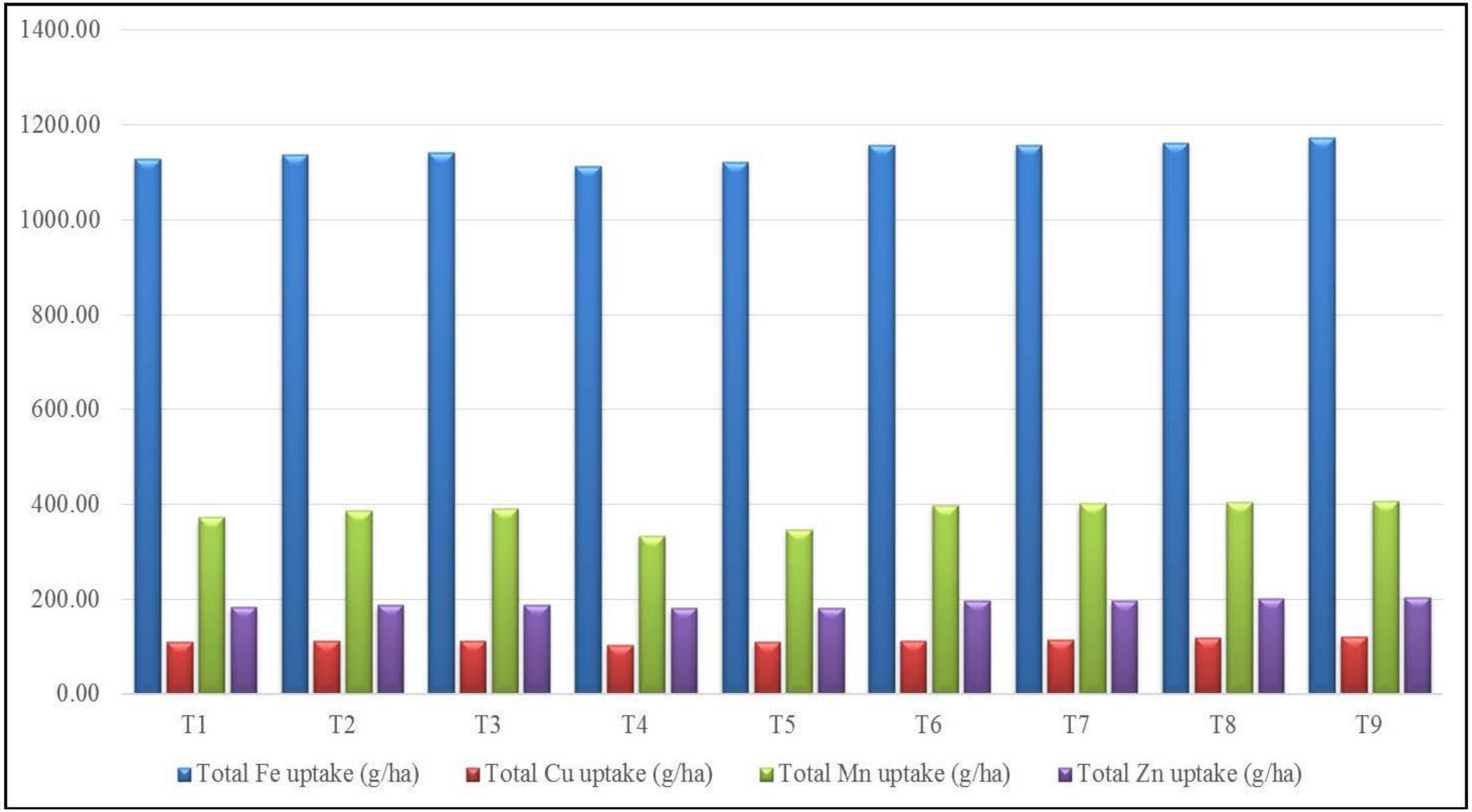

Fig 11. Effect of sugarcane boiler ash on micronutrients uptake by plant

6. SUMMARY AND CONCLUSION

A field experiment was conducted during *rabi* season of 2021-22 at College of Horticulture, sector no. 41, in the University of Horticultural sciences, Bagalkot on "Effect of sugarcane boiler ash on growth, yield and quality of brinjal". The experiment consisted of different combination of sugarcane boiler ash a potassium source and chemical fertilizers laid out with three replications and nine treatments in a randomized block design. The salient features of present investigation are summarized below.

The growth attributes like plant height, number of leaves, number of branches and days to 50% flowering reading were significant among the treatments with application of sugarcane boiler ash as a potassium source. Amongst the treatments, the treatment T_9 where 50 per cent of MOP was supplemented with sugarcane boiler ash recorded higher plant height, number of leaves and number of branches and took less number of days for days to 50% flowering compared with other treatments and control (RDF only).

Application of sugarcane boiler ash a potassium source showed significant difference in quality parameters of brinjal among the treatments. The treatment T_9 (50 % K through sugarcane boiler ash + 50% MOP) recorded higher firmness, score for sensory evaluation (color, texture & appearance) and vitamin C less physiological loss of weight over other treatments and control (RDF only).

The data pertaining to yield and yield attributes of brinjal revealed that there was significant difference among the treatments with application of sugarcane boiler ash a potassium source. Amongst the treatments, T_9 (50% K through sugarcane boiler ash + 50 % MOP) recorded maximum number of fruits per plant, fruit yield per plant, fruit yield per plot and yield per hectare over other treatments.

The soil pH and EC was found to increase with higher doses of application of sugarcane boiler ash as a source of potassium. The soil pH and EC was found alkaline with application of only sugarcane boiler ash, intermediate in application of sugarcane boiler ash and chemical fertilizers and lower in application of chemical fertilizer.

The organic carbon content of soil was found higher in treatmentT_9 where 50 per cent of MOP was replaced with sugarcane boiler ash compared with other treatments.

Availability of macronutrients and micronutrients in soil was found significant among the treatments. Amongst the treatments, treatment T_9 (50% K through sugarcane boiler ash + 50% MOP) recorded higher availability of soil macronutrients and micronutrient over other treatments.

Application of sugarcane boiler ash as potassium source showed significant difference in total nutrient uptake such as nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, copper, manganese and zinc among the treatments. The treatment T_9 recorded higher nutrient uptake compare with other treatments where 50 per cent of MOP was supplemented with sugarcane boiler ash.

Gross return, net return and B:C ratio was found higher in treatment T_9 where 50 per cent of MOP was supplemented with sugarcane boiler ash compared with subsequent treatments.

Conclusion

Overall results revealed that, when the 50 per cent potassium requirement was met through sugarcane boiler ash the performance with respect to growth and quality parameters was good but when entire potassium requirement was met through sugarcane boiler ash the performance was not up to the mark. This may be attributed to the inherent K concentration in the material besides nature of release of the additional nutrients along with intended potassium.

On the contrary, when RDF K was partly replaced with sugarcane boiler ash an entirely different picture emerged. With 50 per cent and 75 per cent replacement better results were obtained owing to the fact that the sugarcane boiler ash was found to replenish the potash requirement more steadily and constantly which might have synchronized the plant requirement. In addition to potassium the material was found to contain P, Ca and Mg which might have contributed to augment the growth, yield and quality attributes.

Finally, the entire requirement of K met with only inorganic fertilizers remained intermediate in the performance as far as yield and quality parameters are concerned. This might be due to fast dissolution of readily soluble material besides associated chloride ion which might have hampered the performance of the crop.

Future line of work

- Long term investigation should be carried out for careful monitoring of toxiclevel of nutrients in soil with the application of sugarcane boiler ash.
- The optimum use of sugarcane boiler ash for diverse agro-climatic conditions under various agricultural crops should be tried.
- The different levels of sugarcane boiler ash along with other organic manures and biofertilizers can be explored.
- The different levels of sugarcane boiler ash can also be tested in perennial crops like palm, arecanut, coconut and oil palm etc. which require more potassium.

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Appendix - I

Monthly meteorological data at MHREC, UHS, Bagalkot during 2021-22

Month	Rainfall (mm)	Temperature (°C)		RH (%)	
		Max Temp	Mini Temp	Morning	Afternoon
Jan	0.0	30.5	16.2	81	69
Feb	0.0	32.5	17.1	74	53
Mar	9.9	35.2	20.0	74	40
Apr	18.8	29.2	18.3	62	31
May	9.4	33.8	20.5	64	28
Mean	7.62	32.24	18.42	71	44.2

Appendix II: Cost of cultivation

Sl. No	Particulars	Required units/ha	Unit price (Rs.)	Total cost (Rs.)
	Land preparation: requirements			
1.	M.B Plough Cultivator Ploughing tractor	1 hr. 1 hr 1 hr.	600/hr 600/hr 600/hr	600 600 600
	Seed and other inputs			
2.	Seeds	250 g	125 Rs /10 g	3125
	Urea	217.39 kg	5.6/kg	1350
	DAP	241.09 kg	26/kg	5652
	MOP	250.00 kg	21/kg	5250
	Sugarcane boiler ash	250.00 kg	2/kg	500
	Inter cultivation			
3.	Transplanting	5 labour	250	1250
	Irrigation Weeding	Drip 10 labours	- 350	20,000 3500
	Harrowing by tractor	1 hr.	600	600
	Labour for foliar spraying	3 labours	350	1050
	Plant protection chemicals			
4.	Copper oxy chloride	400 g	1015/250 g	1625
	Streptomycin sulphate	500 g	1250/50 g	2500
	Imidacloprid 2.5 E.C	250 ml	1623/250 ml	1623
	Corazen	200 ml	325/30 ml	2166
	Emamectin benzoate	200 g	725/125 g	1160
	Beneva	200 ml	5790/500 ml	2316
	chloropyriphos	1 liter	1080/1 litre	1080

5.	**Harvesting and cleaning**			
	Harvesting Cleaning	5 labours 3 labours	350/labour 350/labour	1750 1050
6.	**Transportation and marketing**			
	Transport vehicle Transportation Marketing	11 trips 11 labours 3 labours	1000/trip 350/labour 350/labour	11000 3850 3850

EFFECT OF SUGARCANE BOILER ASH ON GROWTH, YIELD AND QUALITY OF BRINJAL (*Solanum melongena* L.)

PRAJWAL R **2022** **Dr. S. M. PRASANNA**
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ABSTRACT

A field experiment was carried out to study the effect of sugarcane boiler ash on growth, yield and quality of brinjal during the year 2021-22. The experiment laid out in Randomized Complete Block Design (RCBD) comprised of nine treatments with three replications. Sugarcane boiler ash was used as indigenous source of potassium from sugar industry in different combinations along with Muriate of Potash (MOP). Amongst the different combinations of treatments where 50 per cent of MOP was supplemented with indigenous potassium source that is sugarcane boiler ash recorded higher growth parameters like plant height (41.47 cm), number of branches (8.67), number of leaves (39.4 3) and least (47.67) number of days to 50 per cent flowering and also recorded higher quality and yield attributes like higher firmness (17.76 N), vitamin C (16.96 mg/100g) and lesser physiological loss of weight (8.66 %), yield per plot (206.27 kg/plot) and yield per hectare (51.16 t ha^{-1}).

The treatment T_9 (50% K through sugarcane boiler ash + 50% MOP) showed lower soil pH (8.21), EC (0.13 dsm^{-1}) and higher OC (0.69%). As far as available macro and micro nutrients in soil also the treatment T_9 recorded higher nitrogen (238.45 kg $ha^{-1)}$, phosphorus (61.14 kg ha^{-1}), potassium (228.51 kg ha^{-1}), calcium (13.39 c mol (p^+) kg^{-1} soil), magnesium (8.68 c mol (p^+) kg^{-1} soil), sulphur (28.28 ppm), iron (7.83 mg/kg), copper (1.15 mg/kg), manganese (7.14 mg/kg) and zinc (1.69 mg/kg) compared with control (RDF only).

Similarly, the plant nutrient uptake such as nitrogen (141.95 kg ha^{-1}), phosphorus (37.71 kg ha^{-1}), potassium (150.89 kg ha^{-1}), calcium (35.20 kg ha^{-1}), magnesium (11.71 kg ha^{-1}) and sulphur (16.12 kg ha^{-1}), iron (1174.16 g/ha), copper (120.48g/ha), manganese (407.59 g/ha) and zinc (204.01 g/ha) was found higher in treatment T_9 compared with other treatments where 50 per cent of MOP was supplemented with sugarcane boiler ash and also the B:C ratio was also found higher (1:4.46) in treatment T_9 where 50 per cent of K was supplied through sugarcane boiler ash. The outcome of the current research (50% boiler ash + 50% MOP) could be recommended for the farmers for higher returns.

ಕಬ್ಬಿನ ಬಾಯ್ಲರ್ ಬೂದಿಯ ಬಳಕೆಯಿಂದ ಬದನೆಕಾಯಿ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟಗಳ ಮೇಲೆ ಆಗುವ ಪರಿಣಾಮಗಳು

ಪ್ರಜ್ವಲ್ .ಆರ್ **2022** **ಡಾ. ಎಸ್. ಎಮ್. ಪ್ರಸನ್ನ**
ಪ್ರಧಾನ ಮಾರ್ಗದರ್ಶಕರು

ಸಾರಾಂಶ

ಕಬ್ಬಿನ ಬಾಯ್ಲರ್ ಬೂದಿಯ ಪರಿಣಾಮವನ್ನು ಅಧ್ಯಯನ ಮಾಡಲು 2021–22ನೇ ವರ್ಷದಲ್ಲಿ ಬದನೆಕಾಯಿ ಬೆಳೆಯಲ್ಲಿ ಕ್ಷೇತ್ರ ಪ್ರಯೋಗವನ್ನು ನಡೆಸಲಾಯಿತು. ಇದರಲ್ಲಿ ಒಂಬತ್ತು ಉಪಚಾರಗಳುಳ್ಳ ಮೂರು ಪುನರಾವರ್ತನೆಗಳನ್ನು ಕ್ಷೇತ್ರ ಪ್ರಯೋಗದಲ್ಲಿ ಅಳವಡಿಸಿಕೊಂಡು ಸಕ್ಕರೆ ಕಾರ್ಖಾನೆಯ ತ್ಯಾಜ್ಯವಾದ ಬಾಯ್ಲರ್ ಬೂದಿ ಪೊಟ್ಯಾಷಿಯಂನ ಸ್ಥಳೀಯ ಮೂಲವನ್ನಾಗಿ ಮತ್ತು ಮ್ಯುರೈಟ್ ಆಫ್ ಪೊಟ್ಯಾಷ್ ರಸಗೊಬ್ಬರದೊಂದಿಗೆ ಬಳಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಉಪಚಾರಗಳ ವಿವಿಧ ಸಂಯೋಜನೆಗಳ ಪೈಕಿ ಎಮ್.ಓ.ಪಿ ಯ 50 ಪ್ರತಿ ಶತವು ಸ್ಥಳೀಯ ಪೊಟ್ಯಾಷಿಯಂ ಮೂಲವಾದ ಬಾಯ್ಲರ್ ಬೂದಿಯೊಂದಿಗೆ ಉಪಚರಿಸಿದ ತಾಕಿನಲ್ಲಿ ಗಿಡದ ಉದ್ದ (41.47 ಸೆಂ.ಮೀ), ರೆಂಬೆಗಳ ಸಂಖ್ಯೆ (8.67), ಎಲೆಗಳ ಸಂಖ್ಯೆ (39.43), ಮತ್ತು ಶೇಕಢ 50 ರಷ್ಟು ಹೂ ಬಿಡುವಿಕೆಗೆ ಕನಿಷ್ಠ (47.67) ದಿನಗಳ ದಾಖಲೆ ಕಂಡು ಬಂದಿದೆ. ಅದೇ ರೀತಿ ಇಳುವರಿ ಗುಣಮಟ್ಟ ಸೂಚಿಸುವ ಲಕ್ಷಣಗಳಾದ ದೃಢತೆ (17.76 N), ವಿಟಮಿನ್ ಸಿ ಅಂಶ (16.96 ಮಿ. ಗ್ರಾಂ ಪ್ರತಿ 100 ಗ್ರಾಂ ಗೆ) ಮತ್ತು ಕನಿಷ್ಠ (8.66%) ತೂಕದ ಶಾರೀರಿಕ ನಷ್ಟ, ಇಳುವರಿ ಪ್ರತಿ ತಾಕಿಗೆ (206.27 ಕೆ.ಜಿ. ಪ್ರತಿ ತಾಕಿಗೆ) ಮತ್ತು ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ (51.16 ಟನ್ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ದಾಖಲಿಸಿದೆ.

ಉಪಚಾರ 9 (50% ಬಾಯ್ಲರ್ ಬೂದಿ ಮತ್ತು 50% ಎಮ್.ಓ.ಪಿ) ರಲ್ಲಿ ಮಣ್ಣಿನ ರಸಸಾರ (8.21), ವಿದ್ಯುದ್ವಾಹಕತೆ (0.13 ಡೆ. ಸೈ. ಪ್ರತಿ ಮೀ ಗೆ) ಮತ್ತು ಸಾವಯವ ಇಂಗಾಲ (0.61%) ಕಂಡುಬಂದಿರುತ್ತದೆ. ಇದೇ ಉಪಚಾರದಲ್ಲಿ ಮಣ್ಣಿನಲ್ಲಿ ಲಭ್ಯವಿರುವ ಪೋಷಕಾಂಶಗಳಾದ ದೊರೆಯುವ ಸಾರಜನಕ (238.45 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ರಂಜಕ (61.14 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಪೊಟ್ಯಾಷ್ (228.51 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಸುಣ್ಣ (13.39 ಸಿ. ಮೋಲ್. ಪ್ರತಿ ಕೆ.ಜಿ. ಮಣ್ಣಿಗೆ), ಮೆಗ್ನಿಷಿಯಂ (8.68 ಸಿ. ಮೋಲ್. ಪ್ರತಿ ಕೆ.ಜಿ. ಮಣ್ಣಿಗೆ), ಗಂಧಕ (28.28 ಪಿಪಿಎಂ), ಕಬ್ಬಿಣ (7.83 ಮಿ. ಗ್ರಾಂ ಪ್ರತಿ ಕೆ.ಜಿ. ಮಣ್ಣಿಗೆ), ತಾಮ್ರ (1.15 ಮಿ. ಗ್ರಾಂ ಪ್ರತಿ ಕೆ.ಜಿ. ಮಣ್ಣಿಗೆ), ಮ್ಯಾಂಗನೀಸ್ (7.14 ಮಿ. ಗ್ರಾಂ ಪ್ರತಿ ಕೆ.ಜಿ. ಮಣ್ಣಿಗೆ), ಸತು (1.69 ಮಿ. ಗ್ರಾಂ ಪ್ರತಿ ಕೆ.ಜಿ. ಮಣ್ಣಿಗೆ) ತಟಸ್ಥ ಉಪಚಾರಕ್ಕಿಂತ ಹೆಚ್ಚಾಗಿರುವುದು ಕಂಡುಬಂದಿದೆ.

ಅಂತೆಯೇ, ಬೆಳೆ ಹೀರಿಕೊಂಡಿರುವ ಒಟ್ಟು ಸಾರಜನಕ (141.95 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ರಂಜಕ (37.71 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಪೊಟ್ಯಾಷ್ (150.89 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಸುಣ್ಣ (35.20 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಮೆಗ್ನಿಷಿಯಂ (11.71 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಗಂಧಕ (16.12 ಕೆ.ಜಿ. ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಕಬ್ಬಿಣ (1174.16 ಗ್ರಾಂ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ತಾಮ್ರ (120.48 ಗ್ರಾಂ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಮ್ಯಾಂಗನೀಸ್ (407.59 ಗ್ರಾಂ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಸತು (204.01 ಗ್ರಾಂ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ) ಗಳು ಕೂಡ 9ನೇ ಉಪಚಾರದಲ್ಲಿ ಹೆಚ್ಚಿರುವುದು ಕಂಡುಬಂದಿದೆ. ಆದಾಯ: ಖರ್ಚು ಅನುಪಾತವು ಅತಿ ಹೆಚ್ಚು (1:4.46) 9ನೇ ಉಪಚಾರದಲ್ಲಿ ಮೂಡಿಬಂದಿದೆ. ಸದರಿ ಸಂಶೋಧನಾ ಫಲಿತಾಂಶವನ್ನು ರೈತರ ಉತ್ತಮ ಆದಾಯಕ್ಕೆ 50 ಶೇಕಡ ಕಬ್ಬಿನ ಬಾಯ್ಲರ್ ಬೂದಿ ಮತ್ತು 50 ಶೇಕಡ ಎಮ್.ಓ.ಪಿ ಯನ್ನು ಶಿಫಾರಸ್ಸು ಮಾಡಬಹುದಾಗಿದೆ.