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Micronutrient uptake of wheat as influenced by application of fly ash and bagasse ash in an Inceptisol

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Abstract
A field experiment was conducted during the year 2016-17 at the Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, to study the "Effect of fly ash and bagasse ash on soil properties, yield and quality of wheat in an Inceptisol". The experimental soil belongs to Masala series of Inceptisol order (*Vertic Haplustept*), The soil was moderately alkaline with medium status of organic carbon and high in calcium carbonat content. Low in available N, medium in available P, very high in available K and deficient in Zn and Fe. Increased in availability of DTPA-Fe, Mn, Zn and Cu in soil at CRI and harvest stages observed in application of bagasse ash as source of K_2O as compared to fly ash treatments.

Keywords: Fly ash, bagasse ash, chlorophyll, test weigh, crude protein, gluten

Introduction
Fly ash - a coal combustion residue of thermal power plants has been regarded as the problematic solid waste all over the world. The dust collection system removes the fly ash, as a fine particulate residue, from the combustion gases before they are discharged into the atmosphere The management of fly ash has been troublesome in view of its disposal because of its potential of causing pollution of air and water.
Every year Indian thermal power plants produce more than 100 million tones of fly ash, which is expected to reach 200 million tonnes in near future and their disposal is a major problem all over the world due to limited use and possible toxic outcomes. While having look on recent fly ash production (2016-17) in India, we will found it is around 180 million tonnes and its utilization is around 62 per cent.
Practical value of fly ash in agriculture especially in wheat can be established after repeated field experiments. Bakri *et al.* (2012) [3] reported 0.85 per cent K_2O in fly ash. Arivazhagan *et al.* (2011) studied the effect of coal fly ash on agricultural crops. They stated that use of coal fly ash in agriculture is one way of disposal of fly ash and at the same time it improves the yield of variety of agricultural crops and physico-chemical properties of soil They revealed that application of coal ash increase the yield of cereal crops to 15 to 20 per cent, sugarcane to 20 to 30 per cent, maize to 40 per cent, red gram to 50 per cent, potato to 25 per cent, plantation crops to 30 per cent, mustard and vegetable to 10 per cent. Besides increasing the yields of crops it also improved nutrient uptake in plants it improves the yield of variety of agricultural crops.
Bagasse ash is one of the organic waste obtained from sugar industries during the process of sugar manufacturing. Bagasse ash poses a significant environmental problem. Sugarcane production in India is over 300 million tons/year leaving about 10 million tonnes of as unutilized and hence, waste material.
Bagasse ash use in agriculture as organic fertilizer for crop production is now-a-days becoming an established practice.
Bagasse ash use in agriculture as as soil additive in agriculture due to its capacity to supply the plants with small amounts of nutrients (Carlson and Adriano, 1993) [4]. Bagasse ash contains high concentrations of K and P without nitrogen (Page *et al.*, 1979), therefore, its use in agriculture for crop production will be proved more beneficial.
Ash from co-combustion of sugarcane bagasse with wood proved to be providing nutrients to plants. Plants grown on ash amended soils achieved greater biomass production compared to control or treatments using other soil amendments.

2. Material and Methods

2. 1. Details of field experiment

The representative soil samples were collected plot wise to assess the initial soil fertility status of experimental plot. The experiment was laid out in a randomized block design (Fig.1) with 10 treatments and 3 replications. The gross plot size was 3.6 m. x 3.2 m. and net plot size was 3.15 m. x 3.0 m. The recommended inter row spacing of 22.5 cm was adopted.

The general recommended fertilizer dose of wheat is 120:60:40 kg ha^{-1} N, P_2O_5 and K_2O respectively along with FYM @10 t ha^{-1}. All the nutrients, fly ash and bagasse and FYM were added in soil as per treatment.The treatment comprised of

T_1	:	Absolute control
T_2	:	GRDF (120:60:40 kg ha^{-1} N:P_2O_5:K_2O + 10 t ha^{-1} FYM)
T_3	:	GRDF of N & P_2O_5 + 125% K_2O through fly ash
T_4	:	GRDF of N & P_2O_5 + 100% K_2O through fly ash
T_5	:	GRDF of N & P_2O_5 + 75% K_2O through fly ash
T_6	:	GRDF of N & P_2O_5 + 50% K_2O through fly ash
T_7	:	GRDF of N & P_2O_5 + 125% K_2O through bagasse ash
T_8	:	GRDF of N & P_2O_5 + 100% K_2O through bagasse ash
T_9	:	GRDF of N & P_2O_5 + 75% K_2O through bagasse ash
T_{10}	:	GRDF of N & P_2O_5 + 50% K_2O through bagasse ash

Healthy wheat seeds of variety Samadhan, recently released by university obtained from Chief Seed Sale Counter, M.P.K.V., Rahuri.

The recommended dose of fertilizers for wheat was 120:60:40 kg ha^{-1} N, P_2O_5 and K_2O. The N was given through urea, P through single super phosphate and K_2O through muriate of potash in T_2 treatment, however K_2O was given @ 50,40,30 and 20 kg ha^{-1} through fly ash in T_3 to T_6 and bagasse ash in treatments of T_3 to $T_{10,}$ respectively. Organic manures i.e farm yard manure was given @ 10 t ha^{-1} to all the treatments except T_1 treatment (Absolute control).

In order to study the chemical properties of soil (micronutrient), before the beginning of the experiment, a representative composite soil sample was collected from experimental field. Surface soil samples (0-15 cm) were drawn before sowing, at crown root initiation and after harvest of the wheat crop.

Results and Discussion

The DTPA-Fe, Mn, Zn and Cu content in soil as influenced by application of fly ash and bagasse ash at initial, CRI and harvest stage are presented in table 1and 2.

The DTPA-Fe status in soil was found deficient (3.71 mg kg^{-1}) at initial stage however, significant results were observed at CRI and harvest stage. The DTPA-Fe status in soil was found significantly higher in T_7 (4.31 mg kg^{-1}) over all the treatments except treatment T_3, T_7 and T_9 which were at par at CRI stage. At harvest stage, DTPA-Fe status in soil was significantly higher in treatment T_7 (3.80 mg kg^{-1}) over all the treatments except T_2, T_4 and T_3 which were at par. Overall, at all the growth stages, DTPA-Fe status was found deficient in soil, as critical limit of iron is 4.5 mg kg^{-1}.

The DTPA-Mn content in soil was found sufficient (14.22 mg kg^{-1}) at initial stage, however, significant results were found in CRI and harvest stage. The DTPA-Mn content in soil was found significantly higher in T_7 (14.98 mg kg^{-1}) over all the treatment except treatment T_3 (14.85 mg kg^{-1}) which was at par at CRI stage. At harvest stage, the DTPA-Mn content in soil was significantly higher in treatment T_7 (13.88 mg kg^{-1}) over all the treatments except T_2, T_3 and T_8 which were at par. Overall, at all the growth stages, the DTPA-Mn contents were found sufficient in soil as a critical limit of Mn is 2.0 mg kg^{-1}.

Table 1: Available DTPA Fe and Mn in soil as influenced by application of fly ash and bagasse ash in soil

Tr. No.	DTPA - Fe (mg kg^{-1})			DTPA - Mn (mg kg^{-1})		
	Initial	**CRI**	**Harvest**	**Initial**	**CRI**	**Harvest**
T_1	3.87	3.56	3.27	14.18	13.84	13.08
T_2	3.70	3.94	3.66	14.01	14.20	13.61
T_3	3.41	4.08	3.68	14.17	14.85	13.58
T_4	4.03	3.98	3.61	13.97	14.36	13.10
T_5	3.60	4.01	3.52	13.69	14.08	12.98
T_6	3.71	3.56	3.47	14.40	14.48	12.47
T_7	3.54	4.31	3.80	14.46	14.98	13.88
T_8	3.72	4.20	3.68	14.42	14.79	13.77
T_9	3.62	3.69	3.52	14.30	14.56	13.21
T_{10}	3.86	3.80	3.51	14.65	14.70	12.96
S.E.($\pm$)		0.10	0.05		0.08	0.11
CD at 5%		0.32	0.17		0.24	0.33

The DTPA-Zn content in soil was found deficient (0.48 mg kg^{-1}) at initial stage, however, significant results were found in CRI and harvest stage. The DTPA-Zn content in soil was found significantly higher in T_7 (0.68 mg kg^{-1}) over all the treatments except treatment T_3 (0.64 mg kg^{-1}) which was at par at CRI stage. At harvest stage, the DTPA-Zn content in soil was significantly higher in treatment T_7 (0.51 mg kg^{-1}) over all the treatments except T_3, T_4, T_6, T_8 and T_9 which were at par. Overall, at all the growth stages, the DTPA-Zn content in soil was found deficient in initial and harvest stage however, it was sufficient at CRI stage except control as critical limit of Zn is 0.6 mg kg^{-1}. The sufficiancy status of the DTPA-Zn at CRI stage in treatment of fly ash and bagasse ash treatments may be due to application of $ZnSO_4$ @ 20 kg ha^{-1} at sowing and also contribution of Zn from the source of FYM and bagasse ash applied in soil.

Table 2: Available DTPA Zn and Cu in soil as influenced by application of fly ash and bagasse ash in soil

Tr. No.	DTPA - Zn (mg kg^{-1})			DTPA - Cu (mg kg^{-1})		
	Initial	**CRI**	**Harvest**	**Initial**	**CRI**	**Harvest**
T_1	0.48	0.42	0.38	0.71	0.64	0.51
T_2	0.45	0.61	0.46	0.68	0.66	0.54
T_3	0.48	0.64	0.50	0.70	0.74	0.62
T_4	0.45	0.62	0.49	0.68	0.70	0.61
T_5	0.48	0.60	0.44	0.71	0.72	0.64
T_6	0.50	0.62	0.46	0.66	0.70	0.57
T_7	0.45	0.68	0.51	0.68	0.76	0.66
T_8	0.48	0.63	0.50	0.70	0.71	0.62
T_9	0.50	0.61	0.48	0.71	0.74	0.60
T_{10}	0.48	0.59	0.42	0.68	0.70	0.54
S.E.($\pm$)		0.02	0.02		0.01	0.02
CD at 5%		0.06	0.06		0.04	0.06

The DTPA-Cu content in soil was found sufficient (0.69 mg kg^{-1}) at initial stage, however, significant results were found in CRI and harvest stage. The DTPA-Cu content in soil was found significantly higher in T_7 (0.76 mg kg^{-1}) over all the treatments except treatment T_3 (0.74 mg kg^{-1}) which was at par at CRI stage. At harvest stage, the DTPA-Cu content in soil wa significantly higher in treatment T_7 (0.66 mg kg^{-1})

over all the treatments except T_3, T_4, T_5 and T_8 which were at par. Overall, at all the growth stages, the DTPA-Cu content in soils were found sufficient, as a critical limit of copper is 0.2 mg kg^{-1}.

Similar findings were also reported by Inthasan *et al*. (2002) [7] and Tejasvi and Kumar. (2012) [8].

Summary and Conclusion

The DTPA-Fe content in soil was significantly higher (4.31 and 3.80 mg kg^{-1}) at CRI stage and harvest stage, respectively due to 125 per cent and 100 per cent K_2O applied through fly ash, respectively. However the DTPA-Mn, Zn and Cu content in soil were significantly higher in (14.98, 0.68 and 0.76 mg $kg^{-1,}$ respectively) at crown root initiation and (13.88 and 0.51 and 0.66 mg kg^{-1}, respectively) at harvest stage due to soil application of 125 % K_2O through bagasse ash along with the recommended dose of N and P_2O_5 + FYM @ 10 t ha^{-1}.

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