INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2004/06–3–468–470
http://www.ijab.org

Impact of Organic Wastes (Bagasse Ash) on the Yield of Wheat (*Triticum aestivum* L.) in a Calcareous soil

M. JAMIL[1], M. QASIM, M. UMAR AND ABDUS SUBHAN
Faculty of Agriculture, Gomal University, D.I. Khan, Pakistan
[1]Corresponding author's e-mail**:** jamil_marwat@hotmail.com

ABSTRACT

Impact of various rates of bagasse ash on Wheat (*Triticum aestivum* L.) in a calcareous soil was studied in a field experiment. It was applied @ 0.1, 0.5, 1.0, 2.0, 5.0 and 10 % along with a basal dose of 120, 90, and 60 kg ha^{-1} of NPK. From the soil analysis, before sowing it was concluded that the soil under discussion was calcareous having 16.3 % $CaCO_3$. The results showed that yield and yield components of wheat increased significantly with various rates of bagasse ash over control. However, significantly 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}) were obtained where bagasse ash was applied @ 2.0 %, respectively. While number of tillers m^{-2} (409.0) and straw yield (8.0 t ha^{-1}) was significantly higher with 10.0 % bagasse ash and 1000-grain weight (41.20 g) with 1.0 % bagasse ash. The overall response of wheat crop was significantly higher by the application of bagasse ash @ 2.0 % to the calcareous soil.

Key Words: Bagasse ash; Wheat; Calcareous soil

INTRODUCTION

Bagasse ash is one of the organic wastes obtained from sugar industry during the process of sugar manufacture. Its use in agriculture as organic fertilizer for crop production is now-a-days becoming an established practice. Researchers consider bagasse ash as a good source of micronutrients like, Fe, Mn, Zn, and Cu (Anguissola *et al*., 1999). It can also be used as soil additive in agriculture due to its capacity to supply the plants with small amounts of nutrients (Carlson & Adriano, 1993). Bagasse ash contains no N, but there are commonly high concentrations of K and P (Page *et al*., 1979), therefore, its use in agriculture for crop production will be proved more beneficial. Along with positive effect on soil nutrient contents, bagasse ash also has produced increased yield of wheat crop (Mlynkowiak, 2001) and sugar cane (Hallmark *et al*., 1998). At the time of Pakistan's independence, there were only two sugar mills in the country. Today there are 75 sugar mills, which produced 2.4 million metric tones sugar during the year 1997-98 along with thousands of tones of bagasse ash as a by-product. Such huge amount of bagasse ash always created disposal problems for the sugar mills owners, municipal administration and environmental organizations. Keeping in view the nutritive importance of this organic waste and its positive effects on the yield of cereal crops (Sharma *et al*., 2001; Kumar *et al*., 1999), its proper doses shall be enquired thoroughly.

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

MATERIALS AND METHODS

A field experiment was conducted at the research area of Department of Soil Science, Faculty of Agriculture, Gomal University, D.I Khan, Pakistan, during Rabi 2002-2003. Bulk soil samples from 0-30 cm depth were collected, ground and passed through a 2 mm sieve. It was analyzed for physico-chemical characteristics according to the methods as described by Page *et al.* (1982), which are presented in Table I. Bagasse ash, which was collected from the dumping site of Chashma Sugar Mills (Pvt) Ltd., Dera Ismail Khan, was analyzed for various characteristics (Table II) according to the methods mentioned above. Wheat variety Fakhr-e-Sarhad was sown on 20th November 2002. The experiment was laid out in a randomized complete block design having four replications using plot size 2 x 5 m^2. Bagasse ash was applied @ 0.1, 0.5, 1.0, 2.0, 5.0 and 10.0 % along with a basal dose of NPK @ 120, 90, and 60 kg ha^{-1}, respectively, before sowing of the crop. Wheat seed was sown in each plot @ 100 kg ha^{-1}.

The crop was irrigated at its appropriate time and weeds were controlled manually. It was harvested at maturity and the data regarding plant height (cm), spike length (cm), number of tillers m^{-2}, number of productive tillers m^{-2}, number of grains $spike^{-1}$, 1000-grain weight (g), grain and straw yield (t ha^{-1}) were recorded and analysed statistically according to the methods described by Steel and Torrie (1984).

RESULTS AND DISCUSSION

The soil of the experimental site had a pH value of 8.2, organic matter content 0.82% and P and K content 7.5 ppm and 172 ppm, respectively. Total N content was low (0.03%) and micronutrients like Zn, Cu, Fe and Mn were

Table I. Physio-chemical characteristics of soil

S. No	Characteristics	Units	Value
1	pH		8.2
2	EC_e	dSm^{-1}	0.38
3	$CaCO_3$	%	16.30
4	Organic matter	%	0.82
5	Available K	ppm	172
6	Total N	%	0.03
7	Available P	ppm	7.5
8	Textural Class	Sandy Clay Loam	
9	Cl^-	ppm	92.60
10	SO_4^{--}	ppm	26.90
11	CO_3^{--}	ppm	26.00
12	HCO_3^-	ppm	100.0
13	$Ca^{++} + Mg^{++}$	ppm	93.80
14	DTPA Ext: Zn	ppm	1.2
15	DTPA Ext: Cu	ppm	6.5
16	DTPA Ext: Fe	ppm	5.4
17	DTPA Ext: Mn	ppm	11.0

Table II. Physico-chemical characteristics of Bagasse ash

S. No	Characteristics	Units	Value
1	pH		9.2
2	$E.C_e$	dSm^{-1}	24.73
3	$Ca^{++} + Mg^{++}$	$mmol_c\ L^{-1}$	24
4	Cl^-	$mmol_c\ L^{-1}$	51.0
5	CO_3	$mmol_c\ L^{-1}$	1.2
6	HCO_3^-	$mmol_c\ L^{-1}$	25.0
7	SO_4	$mmol_c\ L^{-1}$	170.10
8	Soluble Na	ppm	920
9	Available K	ppm	210
10	O.M	%	Nil
11	Total N	%	Nil
12	Available P	ppm	110
13	Fe	ppm	267.0
14	Mn	ppm	194.0
15	Cu	ppm	55.0
16	Zn	ppm	65.0

1.2, 6.5, 5.4 and 11.0 ppm, respectively. Bagasse ash was devoid of N, with high pH value (9.2). It contained sufficient P (110 ppm) and K (210 ppm) and abundant micronutrients like Zn (65 ppm), Cu (55 ppm), Fe (267 ppm) and Mn (194 ppm). The effect of various levels of bagasse ash on the yield and yield components of wheat could be explained as below:

Plant height and spike length. Plant height, mostly in grain crops indicates the influence of various nutrients on plant metabolism. The data shown in Table III indicated that the application of bagasse ash along with fertilizer increased the plant height significantly over control. The maximum plant height (103.5 cm) was obtained from the treatments getting 5.0 and 10.0% bagasse ash, which was statistically at par with treatments receiving bagasse ash @ 1.0 and 2.0%. Similarly the spike length of wheat also increased significantly by the application of different levels of bagasse ash in comparison with the control treatment. Maximum spike length (11.0 cm) was recorded in the treatment receiving 2.0% bagasse ash, followed by 10.8 cm from the treatment getting 5.0% bagasse ash. While minimum spike length (9.75 cm) was obtained from control. The results showed that different doses of bagasse ash almost recorded non-significant differences among one another. The increase in plant height and spike length might be due to sufficient amount of available P and micronutrients supplied by bagasse ash. Upadhayay *et al*. (2001) and Stosio and Tomaszewicz, (1999) also reported increase in plant height, spike length and biomass of three native species of wheat treated with bagasse ash.

Table III. Impact of different rates of bagasse ash on plant height and spike length

Treatments	Rate (%)	Plant height (cm)	Spike length (cm)
T_1	0	83.3D	9.8B
T_2	0.1	86.0C	10.0AB
T_3	0.5	91.3B	10.3AB
T_4	1.0	102.5A	10.5AB
T_5	2.0	102.8A	11.0A
T_6	5.0	103.5A	10.8AB
T_7	10.0	103.5A	10.5AB

Values followed by the same letter are not significantly different at ≤ 0.05.

Table IV. Impact of Different rates of Bagasse ash on the number of tillers and number of productive tillers

Treatments	Rate (%)	No of Tillers m^{-2}	No of Productive Tillers m^{-2}
T_1	0	301.0E	245.0F
T_2	0.1	330.3D	263.5E
T_3	0.5	354.5C	289.0D
T_4	1.0	385.5B	312.0BC
T_5	2.0	400.0A	333.5A
T_6	5.0	406.0A	325.0AB
T_7	10.0	409.0A	310.5C

Values followed by the same letter are not significantly different at ≤ 0.05.

Number of tillers and productive tillers. The statistical analysis of data given in Table IV revealed that application of different rates of bagasse ash along with fertilizer brought significant changes in the number of tillers m^{-2} over control. The maximun number of tillers m^{-2} (409.0) were recorded in the treatment getting 10% bagasse ash, which was statistically at par with the treatments receiving 2.0% and 5.0% bagasse ash. Minimum value of 301.0 tillers m^{-2} was recorded in control.

No of productive tillers m^{-2}, which is a yield-contributing factor, also increased significantly over control after treatment of the soil with different levels of bagasse ash. It was maximum (333.5) in the treatment having 2.0% bagasse ash but was statistically at par with the treatment getting 5% of bagasse ash. However, the minimum number of productive tillers m^{-2} (245.0) was obtained from control. The results suggests that increase in the number of tillers m^{-2} as well as productive tillers m^{-2} be attributed to improvement in soil physical and chemical properties and alleviation of deficiency of some of the essential nutrients after the addition of bagasse ash to soil. Similar results were also reported by Pawar and Dubey (1988), Singh (1992) and Pathan *et al.* (2002).

Number of grains spike^{-1} and 1000-grain weight. The data presented in Table V revealed a significant increase in the number of grains spike^{-1} with increasing doses of bagasse ash over control. Maximum number of 49.5 grains spike^{-1} were found in treatment receiving 2.0% of bagasse ash, followed by 48.5 grains spike^{-1} recorded in the

Table V. Effect of different levels of Bagasse ash on the number of grains spike^{-1} and 1000-grain weight

Treatments	Rate (%)	No of grains spike^{-1}	1000-grain weight (g)
T_1	0	40.8D	36.17E
T_2	0.1	42.8CD	37.2D
T_3	0.5	45.0BC	37.7D
T_4	1.0	47.0AB	41.2A
T_5	2.0	49.5A	40.9AB
T_6	5.0	48.5A	40.2BC
T_7	10.0	47.0AB	39.9C

Values followed by the same letter are not significantly different at ≤ 0.05.

Table VI. Effect of different rates of bagasse ash on the grain and straw yield

Treatments	Rate (%)	Grain yield t ha^{-1}	Straw yield t ha^{-1}
T_1	0	3.2F	5.8D
T_2	0.1	3.7E	6.1D
T_3	0.5	4.3D	6.8C
T_4	1.0	4.6C	7.5B
T_5	2.0	5.2A	7.8AB
T_6	5.0	5.1AB	7.9A
T_7	10.0	4.8BC	8.0A

Values followed by the same letter are not significantly different at ≤ 0.05.

treatment receiving bagasse ash @ 5.0% . The treatments receiving 1.0, 2.0, 5.0 and 10.0% bagasse ash were statistically at par with each other. Minimum number of grains spike^{-1} (40.8) were recorded in the non-treated control Similarly, 1000-grain weight of wheat crop was also increased significantly with different levels bagasse ash as compared to control. Maximum 1000-grain weight (41.2 g) was recorded where 1.0% bagasse ash was applied which was followed by the treatment having 2.0% bagasse ash, both of which were statistically at par with each other. The increase in number of grain spike^{-1} and 1000-grain weight confirms that bagasse ash does improve the soil productivity by enhancing nutrients availability to the crop plants. These results corroborate the findings of Singh *et al*. (2002) and Selvakumari *et al*. (1999).

Grain yield and straw yield. The data recorded on grain yield is presented in Table VI. It revealed that different doses of bagasse ash increased the grain yield significantly over control. Maximum grain yield (5.2 t ha^{-1}) was obtained from treatment receiving 2.0% bagasse ash followed by 5.1 t ha^{-1}, from the treatment receiving 5.0% bagasse ash, both of which were statistically at par with each other. Minimum grain yield (3.2 t ha^{-1}) was recorded in control. The data in Table VI for straw yield of wheat exhibited the same general trend as it also increased significantly with increasing levels of bagasse ash.

Maximum straw yield (7.97 t ha^{-1}) was obtained from the plot, which was treated with 10.0% bagasse ash followed by 7.89 t ha^{-1} from the treatment getting 5.0% bagasse ash. The findings support the hypothesis that addition of bagasse ash leave a favorable impact on the soil physical condition and nutrients availability, which ultimately resulted in enhanced yield of grain and straw. Kalra *et al.* (1998), Malewar *et al.* (1999) and Deshmukh *et al*. (2000) also reported increase in grain and straw yield of wheat due to application of straw ash.

CONCLUSION

Treating the soil with bagasse ash has been found to enrich it with utilizable plant nutrients associated with enhanced yield of wheat crop. Amending the soil with bagasse ash @ 2.0% was found to be the most appropriate dose for higher yield of wheat crop in a calcareous soil.

REFERENCES

Anguissola, S., S. Silva and G. Botteschi, 1999. Effect of fly ash on the availability of Zn, Cu, Ni and Cd to chicory. *Agric. Ecosystems and Environ.*, 72: 159–63

Deshmukh, A.S., D.B. Matte and D.R. Kene, 2000. Effect of graded levels of fly ash and NPK on soil properties and yield of wheat. *J. Soils and Crops*, 10: 260–4

Kumar, A., A.K. Sarkar, R.P. Singh and V.N. Sharma, 1999. Effect of fly ash and fertilizer levels on yield and trace metal uptake by soybean and wheat crops. *J. Indian Soc. Soil Sci*., 47: 744–8

Carlson, C.L. and D.C. Adriano, 1993. Environmental impacts of coal combustion on residues. *J. Environ. Quality*, 22: 227–47

Hallmark, W.B., L.P. Brown, G.L. Hawkins and J. Judice, 1998. Effect of municipal, fish and sugarmill wastes on sugarcane yields. *Louisiana Agric*., 41: 9–10

Kalra, N., M.C. Jain, H.C. Joshi, R. Choudhary, R.C. Harit, B.K. Vatsa, S.K. Sharma and V. Kumar, 1998. Flyash as a soil conditioner and fertilizer. *Bioresource Technology*, 64: 163–7

Malewar, G.U., P.B. Adsul and I. Syed, 1999. Impact of different levels of fly–ash on growth attributes and dry matter yield of various crops. *J. Maharashtra Agric. Universities*, 24: 220–1

Mlynkowiak, W., M. Snieg, T. Tomaszewicz and J.B. Dawidowski, 2001. Impact of fly ash from the "Dolna Odra" power plant on firmness and physico–chemical properties of light silty loam. *Inzynieria Rolnicza,* 5: 237–43

Page, A.L., A.A. Elseewi and I. Straughan, 1979. *Physical and chemical properties of fly ash from coal–fired power plants with reference to environmental impact*. *Residue Rev.,* 71: 83–120

Page, A.I., R.H. Miller and D.R. Keeney, 1982. *Methods of Soil Analysis*. Part–2. 2nd Ed. Agron. 9, Madison, Wisconsin, USA

Pathan, S.M., L.A.G. Aylmore and T.D. Colmer, 2002. Reduced leaching of nitrate, ammonium and phosphorus in sandy soil by fly ash amendment. *Australian J. Soil Res.,* 40: 1201–11

Pawar, K. and P.S. Dubey, 1988. Germination behaviours of some important crop species in flyash incorporated soils. Advancement of crops and monitoring of environment. *Progress in Ecology,* 10: 295

Selvakumari. G., M. Baskar, D. Jayanthi and K.K. Mathan, 1999. Fly ash in integrated plant nutrient system and its impact on soil properties, yield and nutrient uptake of groundnut. *Madras Agric. J*., 36: 556–61

Sharma, S.K., N. Kerala, G.R. Singh and N. Kalra, 2001. Fly ash incorporation effect on the soil health and yield of maize and rice. *J. Scientific and Ind. Res.*, 60: 580–5

Singh, C.B., M.C. Oswal and K.S. Grewal, 2002. Impact of fly ash application on consumptive and water use efficiency in wheat (*Triticum aestivum*) under different soils *Indian J. Agric. Sci.*, 72: 396–9

Singh, S., 1992. Ecological studies on natural vegetation around thermal power plant with special reference to the impact of fly ash and afforestation prospects of fly ash dumps. *Ph. D. Thesis*. H.S. Gour, University, Sagar, India

Steel, R.G.D. and J.H. Torrie, 1984. *Principles and Procedures of Statistics A Biometrical Approach* 2nd Ed. McGraw Hill Book Co. Inc. NY

Stosio, M. and T. Tomaszewicz, 1999. Impact of addition of coal ash from a power plant "Dolna Odra" on chemical properties of medium soil and yield of winter crops. *Inzynieria Rolnicza,* 5: 257–62

Upadhayay, N.C., R.C. Sharma, I.P. Chaubey, D.B. Singh and O.P. Singh, 2001. Impact of addition of sugarcane factory waste (maili) on crops productivity and soil fertility. *J. Indian Potato Assoc.,* 28: 36–7

(Received 04 January 2004; Accepted 10 March 2004)