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CHARACTERIZATION OF BIOCHAR PREPARED FROM DIFFERENT PLANT WASTES AND EVALUATION OF BIOCHAR WITH FERTILIZER ON FODDER MAIZE

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ABSTRACT

A pot experiment was carried out at the Department of Soil Science and Agricultural Chemistry, Navsari Agricultural University, Navsari during *kharif* season of year 2023-24. The pot experiment was conducted on fodder maize by integrating the biochar prepared from residue of coconut leaves, brinjal plant and pigeon pea plant with chemical fertilizers in different proportions. The experimental soil had neutral pH, normal EC, high OC, low available N, medium available P_2O_5, high available K_2O and soil of the experiment was clayey. The experiment was laid out in completely randomized design with eight treatments of different doses of coconut leaves biochar, pigeon pea residue biochar and brinjal residue biochar. Maximum biochar yield was obtained from brinjal residue followed by coconut leaves and pigeon pea residue. The recommended dose of fertilizer (80 N: 30 P_2O_5 kg/ha) were commonly applied for all treatments except absolute control. The results revealed that application of treatment 1.0 t ha^{-1} coconut leaves biochar with 100 % RDF demonstrated superior in growth and yield attributes *viz*., plant height, green and dry fodder yield also in nutrient content and uptake by fodder maize. No significant differences were observed in soil pH of post-harvest soil but in other soil physico-chemical properties, available nutrients and micronutrients significantly increased due to application of 1.0 t ha^{-1} coconut leaves biochar with 100 % RDF after harvest of maize.
***Keywords* :** Biochar, Fodder maize, Coconut, Pigeon pea, Brinjal.

Introduction

The agricultural production systems in India are based on mixed farming, where the two major enterprises are crop production and animal husbandry. Livestock is the backbone of Indian agriculture. Milk production largely depends on the availability of good quality fodder. Currently, the country faces a net deficit of 61.1 per cent in green fodder, 21.9 per cent in dry crop residues, and 64 per cent in concentrate feeds. (Anon., 2024a)

Maize is native of America. Fodder maize (*Zea mays* L.) is the most nutritious, succulent and sweet with lactogenic effect and palatable *kharif* fodder which is considered good for milch animals and it occupies 0.9 m ha area. On an average, it contains about 9-11 per cent CP (Crude protein), 60-64 per cent NDF (Neutral detergent fibre), 38-41 per cent ADF (Acid-detergent fibre), 28-30 per cent cellulose, 23-25 per cent hemi-cellulose at milk to early dough stage (Subrahmanya *et al*., 2019). It can be used to make excellent silage and it hasexcellent growth characters like quick growing nature, fodder quality free from toxicants. Fodders available for feeding livestock differ in their chemical composition depending on factors such as the variety of fodder, composition of soil, type of fertilizer, irrigation pattern, harvesting pattern and stage of maturity at the time of harvest, but most importantly it is depending on soil health, its productivity and physical, chemical and biological properties of soil.

Anthropogenic activities have deteriorated the quality of soil all across the globe. It becomes extensively essential to improve the soil quality to support various life systems and sustain the planet. Several options, such as agro-chemicals, nanotechnology, phytoremediation, *etc*., have been sought for to boost the quality of soil. A simple, cheap, renewable, and sustainable material called biochar has been used by farmers for enhancing the soil quality since time immemorial (Kumar and Bhattacharya, 2023).

Biochar is a potential soil amending solid material produced during pyrolysis, a process of thermo conversion of biomass under little or no oxygen. Biochar (charcoal or agri-coal) is a carbon rich product derived from the pyrolysis of organic material having potential use as an amendment to enhance soil properties and agricultural systems productivity (Lehmann and Joseph, 2009). In India, crop production produces a huge amount of plant residues and wastes, which can be incorporate into soil in form of biochar. The application of biochar to soil could play a substantial role in mitigating greenhouse gas emissions and climate change effects. The highly porous nature of biochar improves the soil water retention ability as well as plant available water. Additionally, biochar aids in waste management, crop productivity enhancement, clean energy production, and climate change mitigation (Weber and Quicker, 2018).

Materials and Methods

The experimental pots were arranged at the department of soil science and agricultural chemistry, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India. The experimental site belongs to the class of clayey soil (2.086 % sand, 21.95 % silt and 57.19 % clay) containing low available N (215.2 kg ha^{-1}), medium available P_2O_5 (41.52 kg ha^{-1}), high available K_2O (390.12 kg ha^{-1}) and micronutrients Fe, Mn, Zn and Cu (4.3, 9.2, 0.60 and 0.65 mg kg^{-1}, respectively) during the year 2023. Also, soil had soil had neutral pH 7.58, normal EC 0.42 dS m^{-1}, high OC 1.12 per cent.

Firstly, preparation of biochar was done by pyrolysis of waste biomass of coconut leaves, brinjal residue and pigeon pea residue at 450 °C in muffle furnace. The waste biomass was collected and chopped the biomass to reduce size to 5-6 cm. After that the waste biomass were dried in shade. Crush and grind the waste biomass into powder (2 mm). Pyrolysis in digital temperature set in muffle furnace. The heating rate was 5 °C min^{-1} and residence time was 2 hr at temperature 450 °C. Physico-chemical characteristics *viz*., pH, EC, OC, N,P_2O_5, K_2O, micronutrients and bulk density of biochar was analysed.

The pot experiment was conducted on fodder maize by integrating the biochar prepared from residue of coconut leaves, brinjal plant and pigeon pea plant with chemical fertilizers in different proportions. The treatment comprised of eight treatments *viz*., T_1: Control (100 per cent RDF), T_2 : Absolute control, T_3 : 0.5 t ha^{-1} coconut leaves biochar + 100 % RDF, T_4 : 0.5 t ha^{-1} brinjal residue biochar +100 RDF, T_5: 0.5 t ha^{-1} pigeon pea residue biochar + 100 % RDF, T_6 : 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF, T_7 : 1.0 t ha^{-1} brinjal residue biochar + 100 % RDF, T_8 : 1.0 t ha^{-1} pigeon pea residue biochar +100 % RDF. Standard procedures were followed for data collection to relevant parameters at specific growth stages. The experimental data were subjected to statistical analysis using the Analysis of Variance (ANOVA) technique for a completely randomized design. The standard error of the mean (SEm±) and the critical difference (CD) at the 5% level of significance were computed for each observation following the methodology recommended by Gomez and Gomez (1984).

Table 1 : Initial physico-chemical properties of soil of the experiment

Sr. No.	Particulars		Method employed	Reference
A	**Physical properties**			
	Mechanical fraction (%)		International pipette Method	Piper (1966)
1	Sand	20.86		
2	Silt	21.95		
3	Clay	57.19		
4	Texture class	Clayey		
B	**Chemical properties**			
1	pH (1: 2.5)	7.58	Potentiometry	Jackson (1973)
2	EC (1: 2.5) (dS m^{-1})	0.42	Conductometry	Jackson (1973)

3	Organic carbon (%)	1.12	Wet oxidation method	Jackson (1973)
5	Available Nitrogen (kg ha^{-1})	215.2	Alkaline $KMnO_4$ method	Subbiah and Asija (1956)
6	Available P_2O_5 (kg ha^{-1})	41.52	0.5 M $NaHCO_3$ extractant method	Olsen *et al.* (1954)
7	Available K_2O (kg ha^{-1})	390.12	Neutral Normal ammonium acetate extractant method	Jackson (1973)
8	Micronutrients (mg kg^{-1})			
	Fe	4.3	DTPA extractant Atomic Absorption Spectrophotometer	Lindsay and Norvell (1978)
	Mn	9.2		
	Zn	0.60		
	Cu	0.65		

Results and Discussion

Effect on growth and yield attributes

The periodical plant height responded positively to the different treatments over time, except initially at 30 DAS and at harvest showed significant changes due to coconut leaves biochar with RDF. Higher plant height (62.16 cm and 144.32 cm, respectively) achieved under T_6 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF recorded at 30 DAS and at harvest, respectively as compared to other treatment. At harvest, treatment T_6 significantly at par with T_7 1.0 t ha^{-1} brinjal residue Biochar + 100 % RDF and T_8 1.0 t ha^{-1} pigeon pea residue biochar + 100 % RDF. The increase in the plant height under biochar could be mainly due to fact that biochar had a certain degree of adsorption and certain amount of mineral elements of soils which may provide nutrients for plant growth. Results in accordance with increased growth and yield parameters due to interaction between biochar and fertilizer were reported by Van zwieten *et al.* (2010).

In case of green fodder yield at 30 DAS and at harvest showed significant higher values 64.66 g pot^{-1} and 122.47 g pot^{-1}, respectively in treatment T_6. While, treatment T_6 significantly at par with treatment T_7 1.0 t ha^{-1} brinjal residue biochar + 100 % RDF in green fodder yield at harvest. Total green fodder yield directly depending on plant height and number of branches. These findings are in agreement with those obtained earlier in basil (*Ocimum basilicum* L.) by (Pandey *et al.*, 2016).

Dry fodder yield at 30 DAS and at harvest showed significant higher values 10.36 g pot^{-1} and 46.15 g pot^{-1}, respectively in treatment T_6 (1.0 t ha^{-1} coconut leaves biochar + 100 % RDF) . The range of green fodder yield at harvest in the treatments varied from 24.83 g pot^{-1} to 46.15 g pot^{-1}. This was supported by Pandey *et al.* (2016) observed an increase in dry matter with Bagasse biochar seed treatment as compared to without seed treatment.

Effect on nutrient content at harvest

Integration of biochar with chemical fertilizer significantly increased the plant N content compared to absolute control (1.62%). However, treatment T_6 1.0 t ha^{-1} coconut leaves biochar+ 100% RDF showed the highest plant N content (2.08 %). The range of Nitrogen content in plant at harvest in the treatments varied from 1.62 % to 2.08 %. Biochar might also reduce the leaching losses as it has higher surface area. Biochar increases the nitrogen use efficiency by improving the nitrification process (Van Zwieten *et al.*, 2010).

Plant P content also showed similar trend as plant N. Co-application of biochar and chemical fertilizer significantly increased the plant P content as compared to absolute control (0.11 %). Application of treatment T_6 recorded the highest plant P content (0.53 %). The range of Phosphorous content in plant at harvest in the treatments varied from 0.11 % to 0.53 %. By the addition of biochar, phosphorus availability improved due to increased colonization by arbuscular mycorrhizal fungi (Blackwell *et al.*, 2015).

The treatment T_6 recorded the highest plant K content (3.52%) followed by treatment T_7 1.0 t ha^{-1} brinjal residues biochar + 100% RDF (3.47%) and treatment T_8 1.0 t ha^{-1} pigeon pea residue biochar + 100% RDF (3.35%). The range of Potassium content in plant at harvest in the treatments varied from 2.23 % to 3.52 %. Similar kind of results was found in previous study where, application of cattle dung biochar on sandy loam soil increases the content and uptake of K (Sukartono *et al.*, 2012).

Effect on plant nutrient uptake at harvest

Integration of biochar with chemical fertilizer significantly increased the plant N uptake compared to absolute control (0.40 g pot^{-1}). However, treatment T_6 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF showed the highest plant N uptake (0.88 g pot^{-1}). The range of nitrogen uptake in plant at harvest in the treatments varied from 0.44 g pot^{-1} to 0.88 g pot^{-1}. Nitrogen uptake (kg ha^{-1}) by seed significantly increased by fertilizer, biochar and humic acid levels and their interaction in maize (*zea mays* L.) in Andhra Pradesh (Madhavi, 2014).

The range of phosphorus uptake in plant at harvest in the treatments varied from 0.02 g pot^{-1} to 0.23 g pot^{-1}. Application of treatment T_6 recorded the highest plant P uptake (0.23 g pot^{-1}). Increase in the uptake of P by plants in the soils supplied with biochar and AMF (Arbuscular mycorrhizal fungi) inoculation was observed (Mau and Utami, 2014).

Treatment T_6 gave the highest plant K uptake (1.58 g pot^{-1}). The range of Potassium uptake in plant at harvest in the treatments varied from 0.54 g pot^{-1} to 1.58 g pot^{-1}. Higher cation exchange capacity of the biochar reduced losses of potassium and thus increased the potassium uptake. Biochar compound fertilizers increase plant potassium uptake after application without additional organic fertilizer (Farrar *et al.*, 2022).

Effect on soil pH, EC and Organic carbon after harvest of fodder maize

The range of pH in the treatments varies between 7.54 to 7.84. The highest pH (7.84) was recorded in the treatment T_6 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF. However, the lowest pH treatment T_2 (7.54) was obtained in absolute control. This might be because pH of biochar use was slightly alkaline. Nigussie *et al.* (2012) also reported the increased soil pH in biochar-amended soil to ash accumulation.

application of treatment T_6 showed highest soil EC as compared to control (0.42 dSm^{-1}) followed by treatment T_7 1.0 t ha^{-1} brinjal residues biochar + 100% RDF (0.37dSm^{-1}). The range of soil EC varied from after harvest of fodder maize is 0.25 dS m^{-1} to 0.42dS m^{-1}. Significant improvement in soil EC was observed due to application of biochar prepared from feedstock like corn stover and switch grass (Chintala *et al.*, 2014).

The treatment T_6 recorded the highest SOC content (2.62 %) followed by treatment T_7 1.0 t ha^{-1} brinjal residues biochar + 100 % RDF (1.90 %) and treatment T_8 1.0 t ha^{-1} pigeon pea residue biochar + 100 % RDF (1.53 %). However, the range of organic carbon in the different treatments varied from 0.49 % to 2.62 %. It might be due to the reason that biochar is a mixture of two carbon components. Significant improvement of SOC was observed due to biochar application under maize-wheat cropping system (Arif *et al.*, 2017).

Effect on nutrient status of soil

The range of available N in the treatments varied from 216.73 kg ha^{-1} to 252.92 kg ha^{-1}. The highest nitrogen content (252.92 kg ha^{-1}) was recorded in the treatment T_6 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF. Biochar has high adsorption capacity. It is understood that biochar can take up N *via* ion exchange, remove NH_3 *via* adsorption, and stimulate immobilization with flow on consequences for NO_3^- leaching. Doan *et al.* (2015) also shows the increase in nitrogen content after the combined application of biochar and vermi-compost.

The treatment T_6 1.0 t ha^{-1} coconut leaves biochar + 100% RDF recorded the highest available P_2O_5 (53.23 kg ha^{-1}) in soil which was significantly at par with treatment T_7 1.0 t ha^{-1} brinjal residues biochar + 100 % RDF (50.0 kg ha^{-1}). The range of available phosphorus in the treatments varied from 41.13 kg ha^{-1} to 53.23 kg ha^{-1}. The pH of the soil plays an important role in nutrient availability by influencing the soil pH which could be another reason for boosting soil nutrient availability. Similar kind of results has been reported earlier by (Saha *et al.*, 2019) where, biochar and chemical fertilizer improved available P_2O_5.

Treatment T_6 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF recorded the highest available K_2O (444.85 kg ha^{-1}) in soil which was significantly at par with treatment T_7 1.0 t ha^{-1} brinjal residues biochar + 100 % RDF (437.40 kg ha^{-1}) and the range of available K_2O in soil after harvest is 392.15 kg ha^{-1} to 444.85 kg ha^{-1}. This increase was due to the high concentration of K_2O found in the biochar (Chan *et al.*, 2008).

Effect on DTPA extractable micronutrients in soil

The range of Fe content in the treatments varied from 4.41 mg kg^{-1} to 6.28 mg kg^{-1}. The highest Iron content (6.28 mg kg^{-1}) was recorded in the treatment T_6 1.0 t ha^{-1} coconut leaves biochar + 100 % RDF.

The range of Mn content in the treatments varied from 9.53 mg kg^{-1} to 12.03 mg kg^{-1}.The highest Mn content (12.03 mg kg^{-1}) was recorded in the treatment T_6 1.0 t ha^{-1}coconut leaves biochar + 100 % RDF which was significantly at par with treatment T_7 1.0 t ha^{-1} brinjal residues biochar + 100 % RDF (11.99 mg kg^{-1}) and treatment T_8 1.0 t ha^{-1}pigeon pea residue biochar + 100 % RDF (11.68 mg kg^{-1}).The range of Zn content in the treatments varied from 0.59 mg kg^{-1} to 1.06 mg kg^{-1}. The highest Zn content (1.06 mg kg^{-1}) was recorded in the treatment T_6.The range of Cu content in the treatments varied from 0.75 mg kg^{-1} to 2.02 mg kg^{-1}. The highest Cu content (2.02 mg kg^{-1}) was recorded in the treatment T_6. After the application of biochar available micronutrients in soil significantly increased at limited level were also reported by Sarmah *et al*. 2023.

Biochar Yield

Maximum Biochar yield (50.82 %) was obtained from brinjal residue followed by Coconut leaves (44.7 %) and pigeon pea residue (42.86 %).

Conclusion

Among all the treatments, T_6 : 1.0 t ha^{-1} coconut leaves Biochar + 100% RDF consistently demonstrated superior results. These findings underscore the potential of biochar in enhancing maize growth, soil health, and nutrient availability in agricultural systems.

Table 2 : Physico-chemical characterization of biochar

Sr. No.	Parameters	Coconut leaves Biochar	Brinjal residue Biochar	Pigeon pea residue Biochar
1	pH (1:5)	8.73	8.61	7.54
2	EC (ds m^{-1})	1.15	2.1	1.67
3	Cation Exchange Capacity [cmol (p+)kg^{-1}]	14.70	44.33	21.36
4	Total C (g kg^{-1})	432	380	540
5	Total Kjeldahl Nitrogen (g kg^{-1})	9.4	9.10	11
6	Phosphorus (g kg^{-1})	3.2	2.7	2.10
7	Potassium (g kg^{-1})	10.4	6.7	6.2
8	Fe (mg kg^{-1})	8.3	8.7	9.2
9	Mn (mg kg^{-1})	29.7	24.4	25.7
10	Zn (mg kg^{-1})	23.8	22.9	26.5
11	Cu (mg kg^{-1})	30.4	28.5	27.6
12	Bulk density (Mg cm^{-3})	0.15	0.21	0.26

Table 3 : Effect of different treatments on growth attributes of fodder maize

Treatments		Plant height (cm)		Green fodder yield (g pot^{-1})		Dry fodder yield (g pot^{-1})	
		30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest
T_1	Control (100 per cent RDF)	39.00	107.00	42.00	92.33	6.59	25.43
T_2	Absolute control	34.33	93.00	40.65	87.74	6.35	24.83
T_3	0.5 t ha^{-1}Coconut leaves Biochar + 100% RDF	48.00	125.12	56.53	113.79	7.90	37.23
T_4	0.5 t ha^{-1} Brinjal residues Biochar + 100% RDF	45.00	124.33	52.33	108.90	7.71	36.21
T_5	0.5 t ha^{-1} Pigeon pea residue Biochar + 100% RDF	40.00	112.66	52.12	108.13	6.81	33.65
T_6	1.0 t ha^{-1}Coconut leaves Biochar + 100% RDF	62.16	144.32	64.66	122.47	10.36	46.15
T_7	1.0 t ha^{-1} Brinjal residues Biochar + 100% RDF	57.33	138.00	59.00	119.94	8.23	41.96
T_8	1.0 t ha^{-1}Pigeon pea residue Biochar + 100% RDF	56.00	137.67	57.33	114.92	7.87	39.06
SEm ±		0.86	2.24	1.48	1.83	0.21	0.89
CD at 0.05		2.59	6.72	4.45	5.50	0.63	2.67
CV %		3.13	3.16	4.58	2.93	4.47	4.34

Table 4 : Effect of different treatments on nutrient content and uptake of fodder maize

Treatments		Plant nutrient content (%)			Plant nutrient uptake (%)		
		N	P	K	N	P	K
T_1	Control (100 per cent RDF)	1.63	0.18	2.87	0.40	0.04	0.70
T_2	Absolute control	1.62	0.11	2.23	0.40	0.02	0.54
T_3	0.5 t ha^{-1}Coconut leaves Biochar + 100% RDF	1.75	0.33	3.20	0.63	0.12	1.15
T_4	0.5 t ha^{-1} Brinjal residues Biochar + 100% RDF	1.72	0.27	3.16	0.62	0.10	1.14
T_5	0.5 t ha^{-1} Pigeon pea residue Biochar + 100% RDF	1.66	0.21	3.15	0.55	0.06	1.04
T_6	1.0 t ha^{-1}Coconut leaves Biochar + 100% RDF	2.08	0.53	3.52	0.88	0.23	1.58
T_7	1.0 t ha^{-1} Brinjal residues Biochar + 100% RDF	1.92	0.48	3.47	0.80	0.20	1.45
T_8	1.0 t ha^{-1}Pigeon pea residue Biochar + 100% RDF	1.83	0.37	3.35	0.74	0.14	1.31
SEm ±		0.04	0.006	0.03	0.01	0.003	0.01
CD at 0.05		0.12	0.02	0.11	0.03	0.01	0.04
CV %		3.97	3.83	2.05	3.14	5.32	2.06

Table 5 : Effect on soil properties (pH, EC and Organic carbon) after harvest of fodder maize

Treatments		Soil pH $_{1.25}$	EC (ds m^{-1})	Soil organic carbon (%)
T_1	Control (100 per cent RDF)	7.57	0.27	0.51
T_2	Absolute control	7.54	0.25	0.49
T_3	0.5 t ha^{-1}Coconut leaves Biochar + 100% RDF	7.68	0.34	1.12
T_4	0.5 t ha^{-1} Brinjal residues Biochar + 100% RDF	7.72	0.30	1.43
T_5	0.5 t ha^{-1} Pigeon pea residue Biochar + 100% RDF	7.65	0.28	0.87
T_6	1.0 t ha^{-1}Coconut leaves Biochar + 100% RDF	7.84	0.42	2.62
T_7	1.0 t ha^{-1} Brinjal residues Biochar + 100% RDF	7.81	0.37	1.90
T_8	1.0 t ha^{-1}Pigeon pea residue Biochar + 100% RDF	7.76	0.35	1.53
SEm ±		0.10	0.008	0.019
CD at 0.05		NS	0.02	0.058
CV %		2.43	4.76	2.56

Table 6 : Effect on nutrient status of soil after harvest of fodder maize

Treatment		Available Nutrients (Kg ha^{-1})			Micronutrients (mg kg^{-1})			
		N	P_2O_5	K_2O	Fe	Mn	Zn	Cu
T_1	Control (100 per cent RDF)	219.40	42.79	393.65	4.41	10.06	0.62	0.79
T_2	Absolute control	216.73	41.34	392.15	4.48	9.53	0.59	0.75
T_3	0.5 t ha^{-1}Coconut leaves Biochar + 100% RDF	230.63	47.98	411.56	5.27	11.30	0.74	0.92
T_4	0.5 t ha^{-1} Brinjal residues Biochar + 100% RDF	224.36	46.47	406.22	5.24	10.90	0.71	0.87
T_5	0.5 t ha^{-1} Pigeon pea residue Biochar + 100% RDF	220.84	44.15	398.00	5.17	10.26	0.69	0.82
T_6	1.0 t ha^{-1}Coconut leaves Biochar + 100% RDF	252.92	53.23	444.85	6.28	12.03	1.06	2.02
T_7	1.0 t ha^{-1} Brinjal residues Biochar + 100% RDF	241.53	50.00	437.40	6.01	11.99	0.90	1.82
T_8	1.0 t ha^{-1}Pigeon pea residue Biochar + 100% RDF	232.87	49.32	427.41	5.86	11.68	0.82	1.12
SEm ±		2.56	1.10	5.20	0.07	0.24	0.01	0.01
CD at 0.05		7.69	3.30	15.61	0.22	0.72	0.05	0.05
CV %		1.93	4.07	2.17	2.41	3.81	4.48	2.87

Table 7 : Biochar yield and recovery

Batch no.	Coconut leaves Biochar		Brinjal residues Biochar		Pigeon pea residue Biochar	
	Feed stock input (gm)	Biochar yield (%)	Feed stock input (gm)	Biochar yield (%)	Feed stock input (gm)	Biochar yield (%)
1	162.6	36.7	163.10	56.47	153.2	42.56
2	148.2	47.2	167.34	51.03	159.4	43.48
3	143.2	40.6	159.40	46.49	148.7	47.88
4	150.4	54.1	149.60	53.34	162.3	46.40
5	144.6	44.9	146.40	46.79	159.2	33.98
Average	149.8	44.7	157.17	50.82	156.56	42.86

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