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Yield Attributes and Yield of Maize as Influenced by Different Paddy Straw Management Options and Nitrogen Levels in Rice-maize Cropping Systems

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during 2021-22 and 2022-23 at Regional Agricultural Research Station, Arepally, Warangal district. It is situated in the Central Telangana Zone. A total of 18 treatments replicated thrice in factorial RBD design. The study is conducted to know the yield

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attributes and yield of maize as influenced by different paddy straw management options and Nitrogen levels in rice-maize cropping systems. The results of the experiment concluded that highest grain yield, straw yield, cob length (cm), cob girth (cm), number of cobs per plant, number of rows per kernal, 100 seed weight (gms) was obtained in incorporation and least was obtained in cutting and removal. With the different nitrogen levels highest was obtained in T6 130% RDN (20% at basal, 42% 15 days after sowing, 42% knee high stage (30 DAS) and 26 % tasselling stage (60 DAS) and the least was obtained in T1 100 % RDN (33.3 % at basal, 33.3% knee high stage (30 DAS) and 33.3% tasselling stage (60 DAS). There is no significant effect of crop residue management and N levels on yield attributes of maize and there is no significant interaction between the two factors.

Keywords: Grain yield; cob length; cob girth; incorporation; nitrogen.

1. INTRODUCTION

Maize is one of the most versatile emerging crops having wider adaptability and compatibility under diverse soil and climatic conditions and hence is cultivated in sequence with different crops under various agro-ecologies of the country [1]. It is the third most important food crop after rice and wheat in India [2]. Globally, this crop is known as queen of cereals because of its highest genetic yield potential among the cereals [3]. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 % (782 m t) in the global grain production. In India, average area of cultivation is 8.7 m ha mainly during *Kharif* season which covers 80% of the area. The average productivity in India is 2.43 t ha^{-1} lower than the global average (4.92 t ha^{-1}) [4]. USA is the largest producer of maize contributes nearly 35% of the total production in world and highest productivity (>9.6 t ha^{-1}) which is double than the global average (4.92 t ha^{-1}). India contributes nearly 9% in the national food basket. About 25% of N and P, 50% of S and 75% of K taken up by cereal crops are retained in the crop residue, making them viable nutrient sources. Also, residues return carbon (C) to the soil, which improves soil structure, the ability of the soil to hold nutrients, and water holding capacity. The use of organic inputs such as crop residue and manures has great potential for improving soil productivity and crop yield through improvement of the soil chemical properties and nutrient supply [5]. Incorporation of crop residues can contribute to sustainability mainly through improvement of soil fertility as judged by organic carbon, available P and potassium (K) content. Straw incorporation returns valuable nutrients back into the soil, particularly P and K, leading to potential economic savings through reduced additions of organic and inorganic fertilisers [6].

2. MATERIALS AND METHODS

A field experiment was conducted during 2021-22 and 2022-23 at Regional Agricultural Research Station, Arepally, Warangal district. It is situated in the Central Telangana Zone. The experiment was conducted in Factorial randomized block design. The soil was sandy clay loam in texture. The variety choosed for maize is NK-7884 syngenta hybrid corn. Spacing adopted for maize was 60 X 20 cm (Maize) with plot size of 6 X 4 =24 Sq. Meters.

2.1 Treatmental Details

Factor 1 (paddy straw management options) Factor 2 (fertilizer N levels). Among paddy straw management options it has burning (one week before land preparation), incorporation (a week before land preparation consortium is sprayed, week after its spray paddy straw will be incorporated), Cutting and removal of straw (one week before land preparation paddy straw removed and consortium will be sprayed, week after spray paddy straw is incorporated).

Among fertilizer N levels T_1 100 % RDN (33.3 % at basal, 33.3% knee high stage (30 DAS) and 33.3% tasselling stage (60 DAS), T_2 100% RDN (40 % at basal, 30% knee- high stage (30 DAS), 30% tasselling stage (60 DAS), T_3 100% RDN (10% at basal, 30% 15 days after sowing, 30% knee high stage (30 DAS) and 30% tasselling stage (60 DAS), T_4 100% RDN (15% at basal, 30% 15 days after sowing, 30% knee high stage (30 DAS) and 25% tasselling stage (60 DAS), T_5 115% RDN (18 % at basal, 36% 15 days after sowing, 36% knee high stage (30 DAS) and 25% tasselling stage (60 DAS), T_6 130% RDN (20% at basal, 42% 15 days after sowing, 42% knee high stage (30 DAS) and 26 % tasselling stage (60 DAS).

2.2 Microbial Consortium

Consists of decomposers belonging to *genera Phanerochaeta, Asperigillus, Trichoderma.* RDF for *Rabi* maize - 240-80-80 kg N-P-K kg ha^{-1}. Recommended doses of phosphorus, potassium and FYM (10 t ha^{-1}) will be applied in equal quantities in all treatments.

Five randomly selected plants from each plot were taken and measured for cob length, cob girth, number of cobs per plant, number of grains per cob, 100 seed weight and average values were calculated.

3. RESULTS AND DISCUSSION

Yield attributes: There is no significant effect of paddy straw and nitrogen management on yield attributes of maize. There is no significant interaction between the two factors.

Cob length (cm): The highest was obtained in incorporation 23.15 cm followed by burning 21.04 cm and cutting and removal 20.16 cm.

Among the nitrogen levels the highest cob length was reported in 21.95 cm T_3 followed by T_2 21.58 cm and the least was observed in T_1 20.94 cm.

Cob girth (cm): The highest cob girth was obtained in paddy straw incorporation incorporation 17.19 cm followed by burning 16.50 cm and cutting and removal 16.20 cm.

Regarding response of cob girth to different N levels the highest was observed (17.96 cm) in 130 % RDN (20 % at basal, 42 % 15 days after sowing, 42 % knee high stage (30 DAS) and 26 % tasselling stage (60 DAS) I.e. T6 followed by T_5 (17.37 cm) and the least was observed in (15.18 cm) T_1.

Number of cobs per plant: The highest number of cobs per plants was obtained in incorporation (1.05) followed by burning (1.04) and cutting and removal (1.03).

Among the N levels T6 recorded the highest number of cobs per plants (1.05) but found at par with T5. The least number of cobs per plants (1.03) was observed in T1.

Number of rows per kernal: Regarding effect of different paddy straw options the highest (30.20) was obtained in treatment incorporation followed by burning (28.69) and cutting and removal (28.31).

Similarly, Fertilizer N levels affect number of rows per kernel and the highest (30.31) was observed in T6 followed by T5 (29.76) and the least was observed in T1 (27.86).

100 seed weight (gms): The highest 100 seeds weight was obtained in incorporation treatment i.e. 29.43 gms.

followed by burning (29.13 gms) and cutting and removal (29.02 gms).

With effect of different N levels the highest (29.92 gms) was observed in T6 followed by T5 (29.61gms) and the least was reported in T1 (28.46 gms).

Singh et al., [7] reported that plant height, number of effective tillers, no of grain per spike and test weight remained significantly higher under residue incorporation treatment over residue burning and residue removal during 2019 and 2020, respectively. This might be due to presence of residue under incorporation and retention treatment improved the physical, chemical and biological properties of soil by increasing organic matter content over the burning and removal practice. Present study the yield attributes was lower under removal treatments. This was mainly due to scracity of nutrient because there was not any other source of nutrient addition except the fertilizer.

Anil et al. [8] revealed that application of nitrogen 180 kg ha^{-1} with 4 splits given the better plant height, tiller number m^{-2}; dry matter production, root volume and root dry weight that contributed for higher grain yield.

Grain and stover yield (kg ha^{-1}): Different treatments significantly affect the grain yield of Maize and the highest grain (8266.6 kg ha^{-1}) yield was obtained in incorporation treatments, but found at par with burning (8089.5 kg ha^{-1}) while cutting and removal showed significantly less grain yield 7639.5 kg ha^{-1}.

Different Nitrogen levels and its time of application significantly affect grain yield of Maize and treatment T6 recorded the highest (8529.7 kg ha^{-1}) grain yield of maize which was at par with T5 (8362.1 kg ha^{-1}) and T4 (8138.7 kg ha^{-1}) lowest was recordedin T1 (7399.5 kg ha^{-1}).

Table 1. Grain yield and straw yield (kg ha^{-1}) of maize as influenced by paddy straw management options and fertilizer N levels

	Grain Yield			Straw Yield			Harvest Index (%)		
Treatments	**2021-22**	**2022-23**	**pooled data**	**2021-22**	**2022-23**	**pooled data**	**2021-22**	**2022-23**	**pooled data**
Burning	8052.7	8126.3	8089.5	10038.2	10158.2	10098.2	44.48	44.42	44.45
Incorporation	8230.5	8302.7	8266.6	10483.7	10543.6	10513.6	44.00	44.11	44.06
Cutting and removal	7576.3	7702.7	7639.5	9260.3	9540.3	9400.3	45.02	44.76	44.89
SE(m)±	172.31	160.74	103.01	206.94	198.21	189.21	0.45	0.75	0.40
CD	495.23	461.98	296.07	594.75	569.67	543.80	1.30	2.17	1.16
Nitrogen levels and time of application									
T1	7354.5	7444.6	7399.5	9204.5	9357.8	9281.1	44.45	44.34	44.40
T2	7619.2	7709.3	7664.2	9624.1	9777.4	9700.8	44.19	44.12	44.15
T3	7851.9	7941.9	7896.9	9804.7	9958.0	9881.3	44.42	44.30	44.36
T4	8091.6	8185.8	8138.7	10109.5	10262.8	10186.1	44.47	44.43	44.45
T5	8317.2	8407.1	8362.1	10320.3	10473.6	10396.9	44.70	44.69	44.70
T6	8484.7	8574.6	8529.7	10501.3	10654.7	10578.0	44.76	44.70	44.73
SE(m)±	243.69	227.32	145.69	292.66	280.31	267.58	0.64	1.07	0.57
CD	700.36	653.34	418.70	841.11	805.63	769.05	1.84	3.07	1.64

T1:100 % RDN (33.3 % at basal, 33.3% knee high stage (30 DAS) and 33.3% tasselling stage (60 DAS)
T2:100% RDN (40 % at basal, 30% knee- high stage (30 DAS), 30% tasselling stage (60 DAS)
T3:100% RDN (10% at basal, 30% 15 days after sowing, 30% knee high stage (30 DAS) and 30% tasselling stage (60 DAS)
T4:100% RDN (15% at basal, 30% 15 days after sowing, 30% knee high stage (30 DAS) and 25% tasselling stage (60 DAS)
T5:115% RDN (18 % at basal, 36% 15 days after sowing, 36% knee high stage (30 DAS) and 25% tasselling stage (60 DAS)
T6:130% RDN (20% at basal, 42% 15 days after sowing, 42% knee high stage (30 DAS) and 26 % tasselling stage (60 DAS)

Table 2. Yield attributes of maize as influenced by different paddy straw management options and fertilizer N levels

	Cob length (cm)			Cob girth (cm)			Number of cobs per plant			Number of rows per kernal			100 seed weight (gms)		
Treatments	**2021-22**	**2022-23**	**Pooled data**	**2021-22**	**2022-23**	**pooled data**	**2021-22**	**2022-23**	**pooled data**	**2021-22**	**2022-23**	**Pooled data**	**2021-22**	**2022-23**	**pooled data**
Burning	20.83	21.24	21.04	16.30	16.71	16.50	1.04	1.04	1.04	28.48	28.89	28.69	28.92	29.33	29.13
Incorporation	22.93	23.38	23.15	16.97	17.42	17.19	1.05	1.05	1.05	29.98	30.43	30.20	29.20	29.65	29.43
Cutting and removal	19.97	20.36	20.16	16.00	16.39	16.20	1.03	1.04	1.03	28.11	28.51	28.31	28.82	29.22	29.02
SE(m)±	0.87	0.87	0.87	0.47	0.47	0.47	0.00	0.00	0.00	0.56	0.56	0.56	0.68	0.68	0.68
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels and time of application															
T1	20.73	21.16	20.94	14.97	15.39	15.18	1.03	1.03	1.03	27.64	28.07	27.86	28.24	28.67	28.46
T2	21.37	21.79	21.58	15.60	16.02	15.81	1.04	1.04	1.04	28.01	28.43	28.22	28.49	28.91	28.70
T3	21.73	22.17	21.95	16.30	16.73	16.52	1.04	1.04	1.04	28.72	29.16	28.94	28.87	29.30	29.08
T4	21.23	21.66	21.44	16.73	17.16	16.94	1.04	1.05	1.04	29.10	29.52	29.31	29.17	29.59	29.38
T5	21.17	21.58	21.37	17.17	17.58	17.37	1.05	1.05	1.05	29.56	29.97	29.76	29.40	29.81	29.61
T6	21.22	21.61	21.42	17.77	18.16	17.96	1.05	1.05	1.05	30.11	30.50	30.31	29.72	30.11	29.92
SE(m)±	1.23	1.23	1.23	0.67	0.66	0.66	0.00	0.00	0.00	0.80	0.80	0.80	0.96	0.96	0.96
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

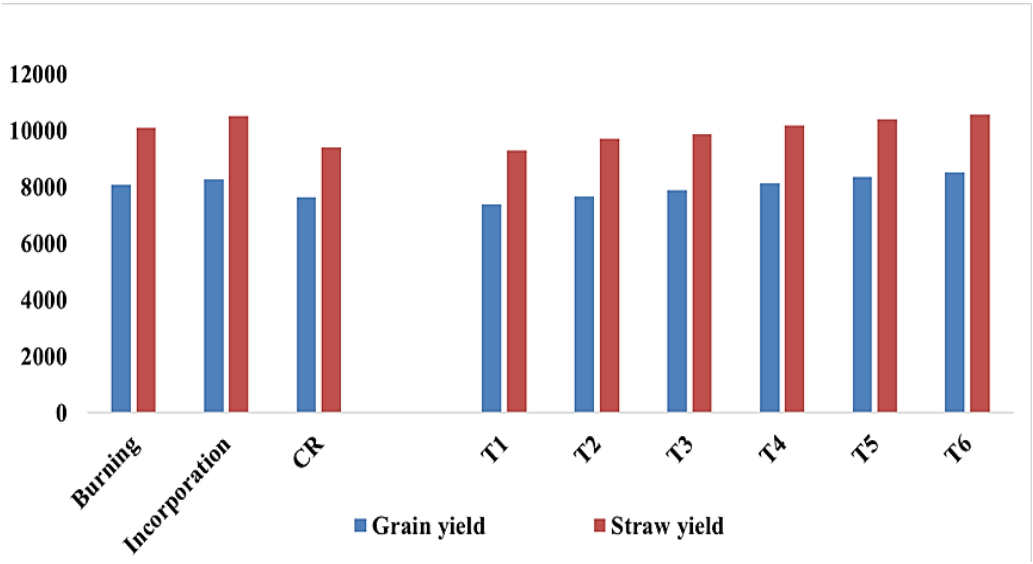

Fig. 1. Grain and Stover Yield in Maize (kg ha^{-1})

Burning of paddy residue recorded higher stover yield of 10098.2 kg ha-1 which is on par with incorporation of rice residue 10513.6 kg ha-1, while cutting and removal showed lower stover yield of 9400.3 kg ha-1.

Among different levels of nitrogen and time of application stover yield was highest in T6 10578.0 kg ha-1 followed by T3, T4 and T5 but found at par with each other, where nitrogen was applied in 4 splits. The lowest stover yield T1 (9281.1 kg ha-1) was recorded in which 100 % RDN was applied in 3 equal splits.

Similar results were observed by Han et al. [9], with an increase in crop yields due to increased biomass production. However, there was a decrease in crop yields where straw burning was done, possibly due to loss of NPK with burning and thereby reducing the fertility of the soil [10].

Due to the incorporation of straw, there was an increase in grain and straw yield, possibly due to the rise in the availability of nutrients in the soil, which will increase plant biomass production [11]. There was an increase in grain yield by incorporating straw and fertilizer N due to the availability of mineral N, which plays an important role in grain yield [12].

4. CONCLUSION

paddy straw and nitrogen management significantly produced higher grain, stover yield and yield atributes in maize. The highest was found in incorporation treatments followed by burning and cutting and removal. With respect to factor 2 the highest was observed in T6 130% RDN (20% at basal, 42% 15 days after sowing, 42% knee high stage (30 DAS) and 26 % tasselling stage (60 DAS) and T5 115% RDN (18 % at basal, 36% 15 days after sowing, 36% knee high stage (30 DAS) and 25% tasselling stage (60 DAS) where higher doses of nitrogen was applied in four different splits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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