Original Research Article

Effect of paddy straw incorporation and nitrogen levels on yield and nutrient uptake by mustard (*Brassica juncea* L.)

ABSTRACT

Burning of crop residues results in immense loss to soil fertility, in addition to this burning causes greenhouse gas emissions into atmosphere thereby disturbs the environment. A Field experiment was conducted to ascertain the crop residue and fertilizer management practices on yield and nutrient uptake of mustard at Regional Agricultural Research Station (RARS), Polasa, Jagtial situated in Northern Telangana Zone of Telangana State during *rabi*, 2020-21. Grain yield, nutrient content and nutrient uptake were significantly influenced by crop residue and fertilizer management practices. Highest grain and stover yield of 1194 and 2654 kg ha^{-1} were recorded, when 20 % excess nitrogen was applied than RDN along with residue incorporation. Nutrient uptake was significantly higher in burning treatment during initial stages of crop growth later more uptakes were observed in residue incorporation treatments. Among the treatments lowest yields and nutrient contents (N and P) were recorded in residue burning treatments. This study concluded that, instead of burning, paddy straw was to be incorporated along with 20 % excess nitrogen to obtain better yields and nutrients uptake in succeding mustard crop.

Key words: crop residue management, incorporation, burning, nitrogen application, mustard.

1. INTRODUCTION

Rice is the basic food crop of the country and in fact, the dominant crop of the country. It is an important staple food of almost half of the world's population. Total production of rice during 2019-20 is 118.4 MT in an area of 437.8 Lakh hectare (2019-20) and productivity of 2705 kg ha^{-1} (2019-20). [1]

Most of the farmers are following the method of harvesting of paddy is by use of combine harvesters, machines that harvest the grains and leaves behind the stubbles with a height of 20-30 cm. Thus, it brings about large amount of rice straw as by product whose management is challenging. The facts showed that presently in India, around 49.14 MT of crop residues is being burnt yearly with a larger part is from rice (48%) (FAO STAT)[2]. Because of it's having high silica content and low digestibility it is less usage as animal feed. Presence of high lignin content in paddy straw causes the consequences of the slow degradation rate which leads to short-term negative effect of nitrogen immobilization as well as poor yield. As it is not completely decomposed prior to sowing of succeeding crop and in turn it gives temporary nitrogen immobilization. So, the farmers opt an easy way to manage this left over straw by burning it on the field as it is convenient to them and takes less period of time to go for the next crop in the season.

The practice of open field burnt has increased in North West parts of India in recent years (Kumar *et al.* [3]. Out of 620 Mt of produced crop residues in India yearly, of which 16% is burnt in field and major share of it is paddy straw (43%) (Jain *et al* [4].It is estimated that upon burning of crop residues releases 8.57 Mt of CO, 141.15 Mt of CO_2, 0.037 Mt of SO_x, 0.23 Mt of NO_x, 1.21 Mt of particulate matter (Jain *et al.*[4]). And also it causes loss of nutrients and creates unfavourable growth conditions to micro-organisms. Rice straw contains 0.57 per cent N, 0.07 per cent P, 1.5 to per cent K, 0.10 per cent S and 5 per cent silica (Si) in its dry matter (chivenge *et al.* [5]). However, the high C: N ratio and presence of polymers such as cellulose and lignin in paddy straw may act as natural barrier for its biological degradation. Application paddy straw causes immobilization which significantly affect nutrient availability for plant uptake in rice based cropping (Pullicino *et al.* [6].) due to poor soil nutrient availability by immobilization. On incorporation this straw provides an abundant source of C and nutrients for microorganisms and enhancing their activity which may play a key role in marinating or restoration of soil health. So, keeping in view the harmful effects of open field burning of rice residues as well as an economical and eco-friendly approach should be adopted for effective utilization of rice residues. In Northern Telangana Zone (NTZ) of Telangana State mustard is cultivated during *Rabi* season under irrigated areas. During *rabi,* 2019-20 mustard was cultivated in 2468 ha in NTZ of Telangana State (Season and Crop Report, Telangana. [7]). The area under mustard may increase further as government of Telangana encouraging crop diversification and cultivation of oil seed crops. In NTZ the area under rice – mustard is increasing year by year. In general farmers will burn the paddy residue before preparation of land for mustard cultivation. However, residue recycling is a key measure to enhance the soil fertility and productivity in crop production systems.

The objective of the current investigation is to study the effect of nitrogen levels along with paddy straw incorporation on concentration and uptake of nutrients and yield of the mustard crop in rice follow mustard crop.

2. MATERIAL AND METHODS

A field experiment was conducted during *rabi*, 2020-2021 at a rice cultivated field of Regional Agricultural Research Station (RARS), Polasa, Jagtial situated in Northern Telangana Zone of Telangana State which was located between 18˚83′98" N latitude and 78˚94′22" E longitude at an altitude of 243.4 m above mean sea level (MSL). Crop residue of paddy straw was used in this study. The experiment was laid out in Randomized Block Design (RBD) with four replications and 6 treatments. The treatments comprises of T_1 (Residue burning + 100 % N (2 splits *i.e.*(50% Basal + 50% at flowering), T_2 (Removal of straw + 100% N (2 splits *i.e.* (50% Basal + 50% at flowering), T_3 (Residue incorporation + 100% RDN (2 splits *i.e.* (50% Basal + 50% at flowering), T_4 (Residue incorporation +100 % RDN (3 splits *i.e.* (3 splits *i.e.* 20% Basal +30% at 15 DAS + 50% at flowering), T_5 (Residue incorporation +110 % RDN (3 splits *i.e.* (3 splits *i.e.* 10% Basal +50% at 15 DAS + 50% at flowering), T_6 (Residue incorporation +120 % RDN (3 splits *i.e.*

(3 splits i.e. 20% Basal +50% at 15 DAS + 50% at flowering). The experimental soil was sandy clay loam in texture, slightly alkaline in reaction (pH: 7.90), medium in organic carbon (0.50%) content, low in available nitrogen (176 kg ha^{-1}), medium in available phosphorous (12.7 kg ha^{-1}), medium in available potassium (178 kg ha^{-1}) and high in available sulphur (30.9 ppm). After harvesting of paddy, to impose the treatments left over straw was burned, removed and incorporated in to the soil as per the treatments. Paddy straw was incorporated with the help of tractor drawn rotary mulcher. While incorporation (*in situ*), 200 L of PJTSAU microbial consortium was sprayed @ 2 % per ton paddy straw to hasten the decomposition process. NRCHB 101 variety of mustard with duration of 110 days was used as a test crop. Mustard crop was sown with a spacing of 45 cm x 15 cm to obtain optimum plant population and fertilizer was applied as per the Table1.

Table 1. Details of fertilizers applied

Treatment	Nitrogen	Phosphorus	Potassium
T1, T2 and T3	50 % RDN at basal + 50 % RDN at flowering stage	50 % RDP at the time of straw incorporation + 50 % RDP at the time of sowing as basal	50 % RDK at the time of straw incorporation + 50 % RDK at the time of sowing as basal
T4	20 % RDN at basal + 30 % at 15 DAS + 50 % RDN at flowering stage		
T5	10 % RDN at basal + 50 % at 15 DAS + 50 % RDN at flowering stage		
T6	20 % RDN at basal + 50 % at 15 DAS + 50 % RDN at flowering stage		

To evaluate the nutrient concentrations of N, P, K and S, plants samples were collected at 15, 45 DAS and after harvest and nutrient uptake by the crop were calculated with help of produced dry matter and respective nutrient concentrations.

Nitrogen content in plant sample was determined by micro kjeldhal distillation method using kelpus equipment (Jackson [8]). Phosphorous content in the di-acid extract was estimated by reacting the extract with vanadomolybdate forming yellow colour complex in HNO_3 medium. The colour was developed in about 30 minutes and the absorbance of the solution was read on spectrophotometer at 420 nm (Jackson [8]). The content of potassium in di-acid extract was determined by using flame photometer (Jackson [9]). and was expressed in percentage. Sulphur content in the extract was determined by developing turbidity with supplementing of stabilizing agent, gum acacia and a pinch of barium chloride to the di-acid extract. The turbidity was measured on spectrophotometer at 420 nm (Cottenie *et al* [10]).

NUTRIENT UPTAKE

$$= \frac{Nutrient\ \ concentration\ \ (\%) \times dry\ matter}{100}$$

The obtained was subjected to statistically analysed by Analysis of Variance outlined by Panse and Sukhatme [11]. Critical Difference (CD) values were given table at 5 per cent level of significance.

3. RESULTS AND DISCUSSION

At 15 DAS, dry matter was significantly high in residue burning treatment (85.6 kg ha^{-1}) which was statistically on par with residue removal treatment (79.6 kg ha^{-1}) and lowest was recorded in residue incorporation treatments *i.e.* T_3 (63.8 kg ha^{-1}), T_4 (57.8 kg ha^{-1}), T_5 (51.4 kg ha^{-1}) and T_6 (56.4 kg ha^{-1}). Application of 20 per cent excess nitrogen along with residue incorporation recorded significantly high dry matter produce at 45 DAS and the lowest was recorded in residue burning treatment (table 2). These results were in consistent with Vijayabhasakhar *et al.* [12].

Straw yield of mustard was significantly affected by residue management practise. Among the treatments, application of 20 % excess nitrogen along with straw incorporation (T_6) recorded significantly higher straw yield (2653 kg ha^{-1}), whereas, it was statistically on par with yield of 2535 kg ha^{-1} obtained due to application of 10 % extra nitrogen than recommended along with residue incorporation (T_5). The lowest yield of 1766 kg ha^{-1} was obtained in residue burning treatment and the on par yield was also recorded in residue removal treatment (2121 kg ha^{-1}). Several other studied have found yield increase through residue incorporation over burning and removal. Application of RDN both in two and three splits along with residue incorporation recorded significantly lower straw yield of 2262 and 2313 kg ha^{-1}, respectively over T_6 treatment (table 2) Dhar *et al.* [13] was also reported that straw yield was increased through residue incorporation over burning.

Mustard seed yield was significantly influenced by residue management practices. Among the treatments, application of 20 % excess nitrogen along with straw incorporation (T_6) recorded significantly higher grain and haulm yields (1194 kg ha^{-1}), whereas, it was statistically on par with yield of 1172 kg ha^{-1} obtained due to application of 10 % extra nitrogen than recommended along with residue incorporation (T_5). The lowest yield of 854 kg ha^{-1} was obtained in residue burning treatment and the on par yield was also recorded in residue removal treatment (989 kg ha^{-1}). Several studied have found yield increase through residue incorporation over burning and removal (Dotaniya [14], Sharma *et al.* [15], Khatri [16], Khan *et al.* [17]). Application of RDN both in two and three splits along with residue incorporation recorded significantly lower yield of 1058 and 1080 kg ha^{-1}, respectively over T_6 treatment (table 2)

The increased grain, straw yields and dry matter produce might be due to sprayed consortium at the time of incorporation to accelerate the straw decomposition and application of extra dose of nitrogen at the time of flowering to mitigate immobilization by that increase in the levels of nutrients in soil solution causes easy absorption of these nutrients by the plant. That leads increase the plant height, no. of branches per plant, increase in the no. of pods which ultimately results in more yield. So, the combined use of crop residues and chemical fertilizers improved both biomass and grain yield of mustard crop.

Nitrogen concentration and uptake: At 15 DAS**,** significantly higher nitrogen content of 1.69 % was recorded in residue burning treatment (T1) followed 1.65 % nitrogen was detected in by residue removal treatment. Residue incorporated treatments has recorded lowest nitrogen content (Table 3). Further, it was observed that plant samples collected at 45 DAS, stover and seed during harvest, recorded highest nitrogen content in residue incorporation treatments, whereas, residue burning treatments has recorded lowest N content in plants samples It might be due to release of immobilized nitrogen in soil so that plant build up high N content and carried out the physiochemical activities of plant (table 3).

Similar to nitrogen content, the highest nitrogen uptake of 1.32 kg ha^{-1} was recorded in residue burning treatment which was on par with the N uptake of 1.45 kg ha^{-1} recorded in residue removal treatment at 15 DAS. The lowest N uptake was recorded in residue incorporation treatments *i.e.* T_3 (0.98 kg ha^{-1}), T_4 (0.84 kg ha^{-1}), T_5 (0.73 kg ha^{-1}) and T_6 (0.83 kg ha^{-1}). Application of 20 percent excess nitrogen along with residue incorporation has recorded significantly higher N uptake at 45 DAS and the lowest was recorded in burning treatment. The same trend was followed by stover and seed during harvest of crop. These results are in consistent with Dotaniya [14], Sharma *et.al* [15], Sattur *et.al* [18] (table 3).

Phosphorous concentration: Burning treatment has recorded significantly higher phosphorus (0.35 %) content at 15 DAS followed by residue removal (0.34%) treatment has recorded statistically similar P content. The lowest P content was observed in residue incorporation treatments at 15 DAS. Whereas at 45 DAS, seed and stover has showed greater P content in residue incorporation treatments and lowest was recorded in residue burning treatment. It is due release of immobilized phosphorous in to soil solution so that plant build high P content in residue incorporated treatments (table 4).

At 15 DAS, higher P uptake of 0.30 kg ha^{-1} was recorded in residue burning treatment and it was found that P content was decreased in residue incorporation treatments. Application of 20 per cent excess nitrogen along with residue incorporation has recorded significantly higher P uptake of 5.86, 5.32 and 6.89 kg ha^{-1} at 45 DAS, by stover and seed, and the lowest was recorded in burning treatment. These results are in corroborate with the findings of Dotaniya [14], Sattar *et.al* [18] (see table 4).

Potassium concentration: Unlike nitrogen and phosphorus residue burning treatments has showed highest K content of 1.92 and 2.10 percent during 15 and 45 DAS, respectively. Similar trend was also observed in seed and stover content (0.57 and 1.57 percent, respectively in burning treatment) also. Burning of rice residue increases K content in the surface soil as compared to residue removal and incorporation. Straw burning maintain more K in soil facilitates to absorb more K in plant samples. During harvest, straw removal treatment has recorded lowest K content of 0.47 and 1.41 percent, in seed and stover, respectively (Table 5).

Residue burning treatment has recorded highest K uptake of 1.64 kg ha^{-1} during 15 DAS. At 45 DAS the highest K uptake of 23.6 kg ha^{-1} was recorded with 20 % excess nitrogen application over RDN along with straw incorporation and the lowest K uptake of 19.54 kg ha^{-1} was recorded in burning treatment. Similar to 45 DAS, it was found that seed and stover also accumulated high potassium (6.45 and 40.86 kg ha^{-1}, respectively) in T_6 treatment and the lowest was observed in residue burning treatment (4.85 and 27.75 kg ha^{-1}, by seed and stover respectively). The same trend was followed by stover and seed during harvest of crop. Dotaniya [14], Narolia *et.al* [19]. (table 5).

Sulphur concentration: Data depicted in table 6, showed that, residue incorporation has recorded higher S content during all the stages of (15, 45 DAS, seed and stover) crop growth. The lowest S content of 0.29 and 0.47 percent was recorded in burning treatment at 15 and 45 DAS, respectively. Similar to this trend seed and stover also recorded lowest S content of 0.49 and 0.44 percent in burning treatment. Burning of crop residues causes loss of sulphur to the air in the form SO_x Jain *et.al* [4]

At 45 DAS, application of 20 per cent excess nitrogen along with residue incorporation recorded significantly higher S uptake of 6.29 kg ha^{-1} and the lowest of 4.33 kg ha^{-1} was recorded in residue burning treatment. The same trend was followed by stover and seed during harvest of crop. Highest S uptake of 7.34 and 14.65 kg ha^{-1} were recorded by seed and stover respectively in T6 treatment. Similar trend also reported by several workers Narolia *et.al* [19] (table .6)

Nutrient uptake of nitrogen and phosphorous were initially recorded highest in burning and found as significantly differ with residue incorporation treatments at 15 DAS. This is due to the lower nutrient concentrations in residue incorporation treatments because of immobilization. Later on 45 DAS, residue incorporation treatments showed the increased in trend and T_6 was the highest and significantly differ with residue removal and burning treatments. And same pattern was observed in case of stover and seed. This is due to the release of immobilized nutrients in to soil solution by the process of mineralization during the decomposition of straw. In case of potassium, highest concentration was recorded in burning treatments during all the stages of crop growth but uptake of potassium by plants was highest in residue incorporated treatments from 45 DAS to harvest. Sulphur concentration and uptake was reported highest in residue incorporated treatments during all stages of crop growth.

Conclusion:

The experimental data revealed that grain yield, straw yield, dry matter production, nutrient content and uptake by mustard crop was significantly influenced by crop residue management practices and performed well under residue incorporated treatments over burning and removal treatment. Application of 20 % excess nitrogen along with rice straw incorporation could increase the yield of mustard by improving N, P, K and S uptake. So, incorporation of rice straw as a source of energy with excess nitrogen over burning attains the optimum yield by maintaining sustainable soil health.

Future aspects

- As the response of mustard was observed with 20 per cent excess nitrogen which was the maximum dose imposed in the current experiment, the response trend at higher N levels needs to be examined.
- Emission of greenhouse gases with residue incorporation in upland and low land conditions may be studied.
- Physical, chemical and biological parameters of soil quality can be examined under residue management practices.

Table 2.Influence of residue incorporation, burning and nitrogen application on dry matter production and yield (kg ha^{-1}) of mustard

Treatment	Dry matter (kg ha^{-1})		Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
	15 DAS	45 DAS		
T_1- Residue burning + 100 % N (2 splits *i.e.*(50%Basal + 50% at flowering)	85.6	932	854	1766
T_2- Removal of straw +100% N (2 splits i.e. 50% Basal+ 50% at flowering	79.6	1021	989	2122
T_3- Residue incorporation +100% RDN (2 splits i.e. 50% Basal + 50% at flowering	63.8	1126	1058	2262
T_4- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 30% 15 DAS + 50% at flowering	57.8	1105	1080	2314
T_5- Residue incorporation +110% RDN (3 splits i.e. 10% at basal + 50% 15 DAS + 50% at flowering	51.4	1197	1172	2536
T_6- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 50% 15 DAS + 50% at flowering	56.4	1230	1194	2654
Mean	65.8	1101.8	1057.89	2276
SEM	5.06	44.05	37.35	95.03
SED	7.16	62.3	52.8	134.4
CD	15.3	133	113	286.4
CV	15.4	8.00	7.06	8.4

Table 3. Influence of residue incorporation, burning and nitrogen application on Nitrogen content (%) and uptake (kg ha^{-1}) of mstard

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	N (%)	N(kg ha^{-1})	N (%)	N(kg ha^{-1})	N (%)	N(kg ha^{-1})	N (%)	N(kg ha^{-1})
T_1- Residue burning + 100 % N (2 splits *i.e.*(50%Basal + 50% at flowering)	1.69	1.45	1.61	15.0	0.53	9.3	2.52	21.6
T_2- Removal of straw +100% N (2 splits i.e. 50% Basal+ 50% at flowering	1.65	1.32	1.64	16.7	0.55	11.6	2.56	25.4
T_3- Residue incorporation +100% RDN (2 splits i.e. 50% Basal + 50% at flowering	1.54	0.98	1.67	18.8	0.59	13.3	2.64	28.0
T_4- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 30% 15 DAS + 50% at flowering	1.45	0.84	1.77	19.6	0.61	14.1	2.69	29.0
T_5- Residue incorporation +110% RDN (3 splits i.e. 10% at basal + 50% 15 DAS + 50% at flowering	1.42	0.73	1.79	21.4	0.62	15.6	2.73	32.0
T_6- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 50% 15 DAS + 50% at flowering	1.46	0.83	1.82	22.4	0.64	16.9	2.75	32.8
Mean	1.5	1.03	1.7	19.0	0.6	13.5	2.6	28.1
SEM	0.02	0.10	0.02	0.73	0.01	0.70	0.04	1.10
SED	0.03	0.14	0.03	1.03	0.02	0.99	0.06	1.55
CD	0.07	0.29	0.07	2.19	0.04	2.10	0.12	3.31
CV	3.00	18.96	2.68	7.64	4.67	10.33	3.06	7.81

Table 4.Influence of residue incorporation, burning and nitrogen application on Phosphorous content (%) and uptake (kg ha^{-1}) of mustard

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	P (%)	P (kg ha^{-1})	P (%)	P (kg ha^{-1})	P (%)	P (kg ha^{-1})	P (%)	P (kg ha^{-1})
T_1- Residue burning + 100 % N (2 splits *i.e.*(50%Basal + 50% at flowering)	0.35	0.30	0.45	4.21	0.15	2.65	0.50	4.29
T_2- Removal of straw +100% N (2 splits i.e. 50% Basal+ 50% at flowering	0.34	0.27	0.47	4.77	0.17	3.62	0.53	5.21
T_3- Residue incorporation +100% RDN (2 splits i.e. 50% Basal + 50% at flowering	0.32	0.20	0.48	5.38	0.18	4.04	0.55	5.80
T_4- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 30% 15 DAS + 50% at flowering	0.29	0.16	0.48	5.28	0.19	4.36	0.56	6.07
T_5- Residue incorporation +110% RDN (3 splits i.e. 10% at basal + 50% 15 DAS + 50% at flowering	0.28	0.15	0.49	5.86	0.21	5.32	0.59	6.89
T_6- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 50% 15 DAS + 50% at flowering	0.30	0.17	0.52	6.43	0.23	6.03	0.61	7.25
Mean	0.3	0.21	0.5	5.32	0.2	4.34	0.6	5.92
SEM	0.01	0.02	0.01	0.21	0.01	0.22	0.01	0.28
SED	0.01	0.03	0.01	0.30	0.01	0.30	0.02	0.39
CD	0.02	0.06	0.03	0.64	0.02	0.65	0.04	0.83
CV	5.31	17.73	3.45	7.95	6.20	9.94	4.60	9.34

Table 5. Influence of residue incorporation, burning and nitrogen application on potassium concentration (%) and uptake (kg ha^{-1}) of mustard

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	K (%)	K (kg ha^{-1})	K (%)	K (kg ha^{-1})	K (%)	K (kg ha^{-1})	K (%)	K (kg ha^{-1})
T_1- Residue burning + 100 % N (2 splits *i.e.*(50%Basal + 50% at flowering)	1.92	1.64	2.10	19.54	1.57	27.75	0.57	4.85
T_2- Removal of straw +100% N (2 splits i.e. 50% Basal+ 50% at flowering	1.86	1.48	1.98	20.17	1.41	29.88	0.47	4.66
T_3- Residue incorporation +100% RDN (2 splits i.e. 50% Basal + 50% at flowering	1.83	1.17	1.99	22.44	1.46	33.10	0.49	5.16
T_4- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 30% 15 DAS + 50% at flowering	1.78	1.03	1.97	21.78	1.48	34.24	0.51	5.49
T_5-Residue incorporation +110% RDN (3 splits i.e. 10% at basal + 50% 15 DAS + 50% at flowering	1.76	0.90	1.98	23.60	1.52	38.62	0.53	6.19
T_6- Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 50% 15 DAS + 50% at flowering	1.81	1.01	2.01	24.69	1.54	40.86	0.54	6.45
Mean	1.8	1.21	2.0	22.04	1.5	34.07	0.5	5.47
SEM	0.02	0.10	0.03	0.80	0.02	1.39	0.01	0.22
SED	0.03	0.14	0.04	1.13	0.03	1.97	0.01	0.31
CD	0.06	0.29	0.08	2.42	0.04	4.20	0.02	0.66
CV	2.21	16.13	2.51	7.27	2.37	8.18	3.07	8.01

Table 6. Influence of residue incorporation, burning and nitrogen application on sulphur concentration (%) and S uptake (kg ha^{-1}) of mustard

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	S (%)	S (kg ha^{-1})	S (%)	S (kg ha^{-1})	S (%)	S (kg ha^{-1})	S (%)	S (kg ha^{-1})
T_1- Residue burning + 100 % N (2 splits *i.e.*(50%Basal + 50% at flowering)	0.29	0.25	0.47	4.33	0.44	7.76	0.49	4.18
T_2-Removal of straw +100% N (2 splits i.e. 50% Basal+ 50% at flowering	0.33	0.26	0.48	4.88	0.46	9.67	0.53	5.22
T_3-Residue incorporation +100% RDN (2 splits i.e. 50% Basal + 50% at flowering	0.35	0.22	0.50	5.60	0.50	11.19	0.57	6.00
T_4-Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 30% 15 DAS + 50% at flowering	0.36	0.21	0.51	5.67	0.51	11.75	0.58	6.21
T_5-Residue incorporation +110% RDN (3 splits i.e. 10% at basal + 50% 15 DAS + 50% at flowering	0.37	0.19	0.53	6.29	0.53	13.46	0.61	7.11
T_6-Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 50% 15 DAS + 50% at flowering	0.38	0.21	0.54	6.68	0.55	14.65	0.62	7.34
Mean	0.3	0.22	0.5	5.57	0.5	11.41	0.6	6.01
SEM	0.01	0.02	0.01	0.21	0.01	0.60	0.01	0.26
SED	0.01	0.03	0.01	0.30	0.02	0.85	0.02	0.36
CD	0.02	NS	0.03	0.64	0.04	1.82	0.04	0.77
CV	4.44	17.13	3.65	7.60	4.84	10.57	4.63	8.51

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