

# Original Research Article

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

### **ABSTRACT**

Burning of residues results in immense loss to soil fertility and smoke from burning will release greenhouse gas emissions into atmosphere thereby disturbs the environment. A Field experiment was conducted ascertain the crop residue management 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 and nutrient uptake was significantly influenced by crop residue management practices. Highest grain yield 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 was observed in residue incorporation treatments. The best to subsidize the huge amount of left over residue of paddy was incorporating of straw before sowing of succeeding crop and with an application of extra 20% nitrogen gives the best outcome.

*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 (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 its 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<sub>2</sub>, 0.037 Mt of SO<sub>x</sub>, 0.23 Mt of NO<sub>x</sub>, 1.21 Mt of particulate matter (Jain *et al.* 2014). 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 (Pulicino *et al*[6].) due to poor soil nutrient availability by immobilization. On decomposition 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 mind 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 at Regional Agricultural Research Station (RARS), Polasa, Jagtial situated in Northern Telangana Zone of Telangana state which is 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<sub>1</sub> (Residue burning + 100 % N (2 splits *i.e.* ( 50% Basal + 50% at flowering), T<sub>2</sub> (Removal of straw + 100% N (2 splits *i.e.* (50% Basal + 50% at flowering), T<sub>3</sub> (Residue incorporation + 100% RDN (2 splits *i.e.* (50% Basal + 50% at flowering), T<sub>4</sub> (Residue incorporation +100 % RDN (3 splits *i.e.* (3 splits *i.e.* 20% Basal +30% at 15 DAS + 50% at flowering), T<sub>5</sub> (Residue incorporation +110 % RDN (3 splits *i.e.* (3 splits *i.e.* 10% Basal +50% at 15 DAS + 50% at flowering), T<sub>6</sub> (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 ( $176 \text{ kg ha}^{-1}$ ), medium in available phosphorous ( $12.7 \text{ kg/ha}$ ), medium in available potassium ( $178 \text{ kg ha}^{-1}$ ) and high in available sulphur (30.9 ppm). After harvesting of paddy, left over straw was incorporated in to the soil with the help of rotary mulcher. While incorporation, PJTSAU microbial consortium of 2 % of 200 L per ton straw was used to hasten the decomposition process. NRCHB 101 variety of mustard with duration of 110 days was used as test crop. Mustard crop was sown with a spacing of 45 cm x 15 cm and supplied with recommended dose of half of nitrogen, and full dose of potassium as basal. Half of the recommended dose of phosphorus was applied at the time of incorporation and remaining half was applied as basal (last ploughing) in the form SSP. Remaining dose of N, extra 10% and 20% N was applied as per scheduled treatments. 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 extract was estimated by reacting the diacid extract with vanadomolybdate forming yellow colour complex in  $\text{HNO}_3$  medium. The colour was developed in about 30 minutes and the absorbance of the solution was read on spectrophotometer at 420 nm or using blue filter in calorimeter (Jackson [8]). The content of potassium in di-acid extract was determined by using flame photometer (Jackson [9]). and was expressed as 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

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

### 3. RESULTS AND DISCUSSION

At 15 DAS, dry matter was significantly high in residue burning treatment ( $85.6 \text{ kg ha}^{-1}$ ) which was statistically on par with residue removal treatment ( $79.6 \text{ kg ha}^{-1}$ ) and lowest was recorded in residue incorporation treatments i.e.  $T_3$  ( $63.8 \text{ kg ha}^{-1}$ ),  $T_4$  ( $57.8 \text{ kg ha}^{-1}$ ),  $T_5$  ( $51.4 \text{ kg ha}^{-1}$ ) and  $T_6$  ( $56.4 \text{ kg ha}^{-1}$ ). 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 1). These results were in consistent with Vijayabhasakhar *et al*. [11].

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 ( $2653 \text{ kg ha}^{-1}$ ), whereas, it was statistically on par with yield of  $2535 \text{ kg ha}^{-1}$  obtained due to application of 10 % extra nitrogen than recommended along with

residue incorporation ( $T_5$ ). The lowest yield of  $1766 \text{ kg ha}^{-1}$  was obtained in residue burning treatment and the on par yield was also recorded in residue removal treatment ( $2121 \text{ kg ha}^{-1}$ ). Several other studies 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  $2313 \text{ kg ha}^{-1}$ , respectively over  $T_6$  treatment (table 1). Dhar *et al.* [12] 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 ( $1194 \text{ kg ha}^{-1}$ ), whereas, it was statistically on par with yield of  $1172 \text{ kg ha}^{-1}$  obtained due to application of 10 % extra nitrogen than recommended along with residue incorporation ( $T_5$ ). The lowest yield of  $854 \text{ kg ha}^{-1}$  was obtained in residue burning treatment and the on par yield was also recorded in residue removal treatment ( $989 \text{ kg ha}^{-1}$ ). Several studies have found yield increase through residue incorporation over burning and removal (Dotaniya [13], Sharma *et al.* [14], Khatri [15], Khan *et al.* [16]). Application of RDN both in two and three splits along with residue incorporation recorded significantly lower yield of  $1058$  and  $1080 \text{ kg ha}^{-1}$ , respectively over  $T_6$  treatment (table 1).

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 to 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:** Plant samples collected at 15 DAS showed that concentration of nitrogen was significantly high in burning treatment (1.69 %) followed by residue removal treatment (1.65 %) and the lowest recorded in residue incorporated treatments. Further, from the analysis of collected plant samples at 45 DAS, stover and in seed it was observed that there was increase in the nutrient concentration of nitrogen in residue incorporated treatments than burning treatment. It is 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 2).

Nitrogen uptake in plants at 15 DAS was recorded significantly high under burning treatments ( $1.45 \text{ kg ha}^{-1}$ ) which was on par with residue removal treatments ( $1.32 \text{ kg ha}^{-1}$ ) and lowest was recorded in residue incorporation treatments *i.e.*  $T_3$  ( $0.98 \text{ kg ha}^{-1}$ ),  $T_4$  ( $0.84 \text{ kg ha}^{-1}$ ),  $T_5$  ( $0.73 \text{ kg ha}^{-1}$ ) and  $T_6$  ( $0.83 \text{ kg ha}^{-1}$ ). Application of 20 percent excess nitrogen along with residue incorporation 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 [13], Sharma *et al.* [14], Sattur *et al.* [17] (table 2).

**Phosphorous concentration:** Burning treatment has recorded significantly higher phosphorus (0.35 %) content at 15 DAS followed by in residue removal (0.34%) and the lowest P content was observed in residue incorporation treatments. Whereas at 45 DAS, seed and stover has showed

greater P content while incorporation of crop residue 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 3).

At 15 DAS, higher P uptake of  $0.30 \text{ kg ha}^{-1}$  was recorded in residue burning treatment and residue incorporation has decreased the P uptake. Application of 20 per cent excess nitrogen along with residue incorporation recorded significantly higher P uptake of 5.86, 5.32 and  $6.89 \text{ kg ha}^{-1}$  at 45 DAS, by stover and seed, and the lowest was recorded in burning treatment. These results are found similar with Dotaniya [13], Sattar *et.al* [17] (see table 3).

**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). 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.

Residue burning treatment has recorded highest K uptake of  $1.64 \text{ kg ha}^{-1}$  during 15 DAS. At 45 DAS the highest P uptake of  $23.6 \text{ kg ha}^{-1}$  was recorded with 20 % Excess nitrogen application over RDN along with straw incorporation and the lowest K uptake of  $19.54 \text{ kg ha}^{-1}$  was recorded in burning treatment. Similar to 45 DAS, it was found that seed and stover also accumulated high potassium ( $6.45$  and  $40.86 \text{ kg ha}^{-1}$ , respectively) in  $T_6$  treatment and the lowest was observed in residue burning treatment ( $4.85$  and  $27.75 \text{ kg ha}^{-1}$ , respectively). The same trend was followed by stover and seed during harvest of crop. Dotaniya [13], Narolia *et.al* [18]. (table 4).

**Sulphur concentration:** Data depicted in table 5, showed that, residue incorporation has recorded higher S content during all the stages of (15DAS, 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  $\text{SO}_x$  Jain *et.al* [4]

At 45 DAS, application of 20 per cent excess nitrogen along with residue incorporation recorded significantly higher S uptake of  $6.29 \text{ kg ha}^{-1}$  and the lowest of  $4.33 \text{ kg ha}^{-1}$  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  $14.65 \text{ kg ha}^{-1}$  were recorded by seed and stover respectively in  $T_6$  treatment. Similar trend also reported by several workers Narolia *et.al* [18] (table .5)

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 significantly differ with residue removal and burning. 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,

concentration was recorded highest in burning treatments at all stages of analysis but uptake of potassium by plants was highest in residue incorporated treatments from 45 DAS to harvest. Coming to sulphur its concentration and uptake was reported highest in residue incorporated treatments at all stages of analysis.

**Conclusion:**

Treatment	Dry matter (kg ha <sup>-1</sup> )	Seed yield (kg ha <sup>-1</sup> )	Stover yield (kg ha <sup>-1</sup> )
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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 by improving N, P, K and S uptake by mustard crop.

**Table 1. Influence of residue incorporation, burning and nitrogen application on drymatter production and yield (kg ha<sup>-1</sup>) of mustard**

	15 DAS	45 DAS		
T <sub>1</sub> - Residue burning + 100 % N ( 2 splits i.e.(50%Basal + 50% at flowering)	85.6	932	854	1766
T <sub>2</sub> - Removal of straw +100% N (2 splits i.e. 50% Basal+ 50% at flowering	79.6	1021	989	2122
T <sub>3</sub> - Residue incorporation +100% RDN (2 splits i.e. 50% Basal + 50% at flowering	63.8	1126	1058	2262
T <sub>4</sub> - Residue incorporation +100% RDN (3 splits i.e. 20% at basal + 30% 15 DAS + 50% at flowering	57.8	1105	1080	2314
T <sub>5</sub> - Residue incorporation +110% RDN (3 splits i.e. 10% at basal + 50% 15 DAS + 50% at flowering	51.4	1197	1172	2536
T <sub>6</sub> - 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 2. Influence of residue incorporation, burning and nitrogen application on Nitrogen content (%) and uptake (kg ha<sup>-1</sup>) of mstard**

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	N (%)	N(kg ha <sup>-1</sup> )	N (%)	N(kg ha <sup>-1</sup> )	N (%)	N(kg ha <sup>-1</sup> )	N (%)	N(kg ha <sup>-1</sup> )
T <sub>1</sub> - 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 <sub>2</sub> - 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 <sub>3</sub> - 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 <sub>4</sub> - 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 <sub>5</sub> - 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 <sub>6</sub> - 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 3. Influence of residue incorporation, burning and nitrogen application on Phosphorous content (%) and uptake (kg ha<sup>-1</sup>) of mustard**

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	P (%)	P (kg ha <sup>-1</sup> )	P (%)	P (kg ha <sup>-1</sup> )	P (%)	P (kg ha <sup>-1</sup> )	P (%)	P (kg ha <sup>-1</sup> )
T <sub>1</sub> - 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 <sub>2</sub> - 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 <sub>3</sub> - 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 <sub>4</sub> - 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 <sub>5</sub> - 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 <sub>6</sub> - 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 4 Influence of residue incorporation, burning and nitrogen application on potassium concentration (%) and uptake (kg ha<sup>-1</sup>) of mustard**

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	K (%)	K (kg ha <sup>-1</sup> )	K (%)	K (kg ha <sup>-1</sup> )	K (%)	K (kg ha <sup>-1</sup> )	K (%)	K (kg ha <sup>-1</sup> )
T <sub>1</sub> - Residue burning + 100 % N ( 2 splits <i>i.e.</i> (50%Basal + 50% at flowering)	1.92	1.64	2.10	19.54	1.57	27.75	0.57	4.85
T <sub>2</sub> - Removal of straw +100% N (2 splits <i>i.e.</i> 50% Basal+ 50% at flowering	1.86	1.48	1.98	20.17	1.41	29.88	0.47	4.66
T <sub>3</sub> - Residue incorporation +100% RDN (2 splits <i>i.e.</i> 50% Basal + 50% at flowering	1.83	1.17	1.99	22.44	1.46	33.10	0.49	5.16
T <sub>4</sub> - Residue incorporation +100% RDN (3 splits <i>i.e.</i> 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 <sub>5</sub> -Residue incorporation +110% RDN (3 splits <i>i.e.</i> 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 <sub>6</sub> - Residue incorporation +100% RDN (3 splits <i>i.e.</i> 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 5. Influence of residue incorporation, burning and nitrogen application on sulphur concentration (%) and S uptake (kg ha<sup>-1</sup>) of mustard**

TREATMENT	15 DAS		45 DAS		STOVER		SEED	
	S (%)	S (kg ha <sup>-1</sup> )	S (%)	S (kg ha <sup>-1</sup> )	S (%)	S (kg ha <sup>-1</sup> )	S (%)	S (kg ha <sup>-1</sup> )
T <sub>1</sub> - 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 <sub>2</sub> -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 <sub>3</sub> -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 <sub>4</sub> -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 <sub>5</sub> -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 <sub>6</sub> -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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