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IMPACT OF DIFFERENT RICE RESIDUE MANAGEMENT PRACTICES WITH VARYING LEVELS OF NITROGEN APPLICATION ON QUALITY AND PRODUCTIVITY OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Present study was conducted at Student's Research Farm, P.G. Department of Agriculture, Khalsa College, Amritsar, Punjab, India in *rabi* season of year 2021. The field experiment was laid out in split plot design (SPD). The field experiment was comprised of 15 treatment combinations with three main plot treatments including rice residue management practices (burnt, removed and incorporated with decomposer) and five sub plot treatments of nitrogen levels in wheat *viz.,* control, 50% recommended dose of nitrogen fertilizer, 75% recommended dose of nitrogen fertilizer, 100% recommended dose of nitrogen fertilizer and 125% recommended dose of nitrogen fertilizer replicated thrice. Among different rice residue management practices, residue incorporated with decomposer produced significantly higher growth, yield attributes and yield of wheat as compared to residue removal and residue burnt method. The highest grain yield of 50.23 q ha^{-1} was recorded in residue incorporated with decomposer method which was significantly higher than residue removal method (48.32 q ha^{-1}) and residue burnt (44.32 q ha^{-1}). Growth characters like plant height (108.03 cm), LAI (3.73), dry matter accumulation (19.36 g plant^{-1}), number of tillers m^{-2} (367) at periodic intervals as well as yield attributes such as grains spike^{-1}(48.2), weight of grain spike^{-1}(1.73 g), test weight(34.15 g), grain yield (52.60 q ha^{-1}) and straw yield (74.66 q ha^{-1}) were significantly higher with treatment 125% recommended dose of nitrogen fertilizer. Quality parameter *i.e.* protein content in grain (10.93%) and straw (2.62%) were also recorded highest with 125% recommended dose of nitrogen fertilizer treatment.

(Key words: Decomposer, grain yield, nitrogen levels, quality, rice residue management, wheat, yield attributes)

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a major agronomic crop belonging to the family Poaceae. It is a chief staple food which supplies approximately 35 per cent of total food as consumed by the global population (Joo *et al*., 2015). In Punjab, area under wheat cultivation is about 35.20 lakh hectares with production of 176.2 lakh tonnes (Anonymous, 2020). Rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) is the major cropping system in the Indo-Gangetic Plains of South-Asia, which plays a significant role in food security of millions of people. It occupies nearly 13.5 million hectare agricultural land area in Indo-Gangetic Plains, out of which India alone share 10.5 m ha (Tirol-Padre *et al.,* 2016). Rice-wheat cropping system ranks first out of 30 major cropping systems found in India (Das, 2006). In north-western states of India especially Punjab, Haryana and western Uttar Pradesh, 90-95 per cent area of rice is followed by wheat crop (Ladha *et al.,* 2000). With the increase in production of these two crops, residue production has also increased considerably. Rice-wheat cropping system contributes one-fourth of the total residues produced in India (Kaur, 2017). It is estimated that approximately 686 million tonnes (mt) of crop residues are produced annually in India.

State-wise, the production of crop residues is highest in Uttar Pradesh (60 mt) followed by Punjab (51 mt) and Maharashtra (46 mt) but highest surplus crop residues are available in Punjab (Anonymous, 2009). In Punjab, out of total 55.4 mt agricultural residues, 22.3 mt (40.2%) has been found to be surplus, with an average density of 443 t km^{-2} (Singh,2015). Out of this, burning of 95 per cent of rice straw and 25 per cent of wheat straw is done annually (Kaur,2017). Due to high silica content paddy straw is considered as poor feed for animal and remains unutilized (Ankushdeep and Kumar, 2022).The possible management options for rice residue are surface retention, incorporation, mulching and removal of rice straw. Presently, very less farmers incorporate rice straw in their fields due to narrow window between harvesting of rice and sowing of wheat crop, longer period required for decomposition of stubble and high cost incurred on tillage operations for incorporation. Incorporation of rice straw immediately before

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sowing of wheat decreased the grain yield due to immobilization of nitrogen (Singh *et al*., 2008) because of wider C/N ratio of rice straw but it can be managed successfully if sufficient time is provided between residue incorporation and sowing of wheat crop (Singh *et al*., 2004).

Waste decomposer is a product developed by the National Centre of Organic Farming (NCOF), Ghaziabad, Uttar Pradesh. It is a consortium of few beneficial microbes which is isolated by Krishan Chandra in 2004 from native cow dung. It has a shelf-life of 3 years. Besides, it is also validated by the Indian Council of Agricultural Research (ICAR). Interestingly, a single bottle of the waste decomposer could decompose bio-waste of more than 10000 metric tons in 30 days (Kannan,2020). Waste decomposer microorganism was demonstrated to be an excellent candidate for lignocellulose degradation in this work, it showed more robust growth, stronger spore production, faster secretion of lignocellulose-decomposing enzymes and better pH tolerance.

The ill practices of rice residue management followed by the Punjab farmers' *viz*., burning of paddy straw had deteriorated soil health and intensified the pollution growth to its maximum limits.Residues of crop act as mulch and conserve water and add organic matter to the soil (Patel *et al*.,2021). The presence of mulch on the surface and the limitation of vertical soil disturbance protect soil erosion (Echcherki *et al*.,2021).

Residue removal increases evaporation process and diurnal fluctuations in soil temperature. It reduces input of organic matter needed to improve the soil's ability to retain water. It reduces macronutrient (e.g. N, P, K, Ca, and Mg) and micronutrient (e.g. Fe, Mn, B, Zn, and S) in the soil. Nitrogen is one of the major nutrient which reduce the yield of wheat if not applied in proper amount as it is needed for fast growth of plants and to get high production ha^{-1}. Nitrogen play important role in all the metabolic processes of plants. Nitrogen is the main component and major constituent of plants especially in living tissues formation. Every single indispensable process in the plant is related with protein, of which nitrogen is a fundamental constituent. To get the maximum yield of wheat, application of nitrogen in adequate amount is considered as a key to success. Availability of nitrogen to wheat during various phases of its growth and development is an important factor influencing the yield and quality of grain (Yousaf *et al*., 2014). Considering the above facts, present investigation was undertaken to study the impact of different rice residue management practices with varying levels of nitrogen application on quality and productivity of wheat.

MATERIALS AND METHODS

The present study was conducted at Student's Research Farm, P.G. Department of Agriculture, Khalsa College, Amritsar, Punjab, India during *rabi* 2021. The geographical coordinates of the experimental site were 31^0 38'19" N and $74^0$49'50" E and the height above the sea level was 230 m. Amritsar is characterised by semi-arid climate, typical of north-west India and experiences mainly four seasons i.e. winter season (December to March), summer season (April to June), monsoon season (July to September) and post-monsoon season (October to November), where both winters and summers are extreme. The monsoon generally starts in the first week of July and mean annual rainfall fluctuate around 75 cm. The crop was sown on November 24, 2021 and harvested on April 23, 2022. The soil of experiment field was sandy loam, having normal pH (8.4) determined by 1:2 soil:water suspension (Jackson ,1967), normal EC (0.26 dSm^{-1}) by 1:2 soil:water supernatant Solubridge conductivity meter (Jackson ,1967), medium organic carbon (0.42 %) which was determined by Walkley and Black's rapid titration method (Piper ,1966), low available nitrogen (194.79 kg ha^{-1}) by modified alkaline potassium permaganate method (Subbiah and Asija, 1956), medium available phosphorus (20.17 kg ha^{-1}) by 0.5 N sodium bicarbonate extractable P by Olsen's method (Olsen *et al.,*1954) and medium available potassium (249.71 kg ha^{-1}) by ammonium acetate extractable K method (Merwin and Peech, 1950) before the experiment. The field experiment was laid out in split plot design with three main plot treatments (burnt, removal and incorporated with decomposer) and five sub plot treatments of nitrogen levels in wheat *viz.,*control, 50%, 75%, 100% and 125% recommended dose of nitrogen fertilizer replicated thrice.The net plot size was 20.25 m^{-2}. Observations on periodic plant height, leaf area index, number of tillers $m^{-2}$and dry matter accumulation were recorded at 30, 60, 90,120 DAS and at harvesting. Observations on yield attributes such as grains $spike^{-1}$, grain weight $spike^{-1}$, test weight and grain yield, straw yield, harvest index and protein content (%) were also recorded. Harvest index (HI) was calculated by formula:

HI (%) = Economic (grain) yield / Biological yield × 100

Protein content (%) was calculated by formula:

Protein (%) = Per cent nitrogen × 6.25 (constant)

RESULTS AND DISCUSSION

Growth parameters and yield attributes of wheat

The data revealed that rice residue incorporated with decomposer had a significant effect on growth parameters (plant height, LAI,number of tillers m^{-2} and dry matter accumulation at harvest) and on yield attributing parameters (grains $spike^{-1}$, grain weight $spike^{-1}$and test weight) of wheat (Table 1 and 2). Among the rice residue management practices rice residue incorporated with decomposer produced the tallest plant (102.88 cm), having the maximum LAI (3.70), maximum number of tillers m^{-2} (370), DMA (18.02 q ha^{-1}), grains $spike^{-1}$ (46.5), grain weight $spike^{-1}$ (1.70 g) and maximum test weight (33.06 g).These results are in agreement with the results reported by Singh (2005), which states that rice residue incorporation had significant effect on dry matter production, plant height, LAI, number of tillers at all the successive stages of wheat crop.

Among the varying levels of nitrogen application 125% recommended dose of nitrogen fertilizer produced significantly taller wheat plants (108.03 cm), higher LAI (3.73), maximum number of tillers m^{-2}(367), higher DMA (19.36 g $plant^{-1}$), grains $spike^{-1}$ (48.2), grain weight $spike^{-1}$ (1.73 g) and maximum test weight (34.15 g). It might be due to adequate quantity and balanced proportion of plant nutrients supplied to the crop as per need during the growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in yield of wheat crop.Similar results were observed by Reddy and Meenakshi (2021), who reported that number of effective tillers m^{-2}, spike length and number of grains $spike^{-1}$ was significantly higher due to dose of nitrogen 150% N + crop residue,which was statistically at par with 125% N + 100% P + crop residue.

Interaction effect of different rice residue management practices with varying levels of nitrogen treatment with respect to plant growth parameters *viz.,* plant height, dry matter accumulation, leaf area index, number of tillers m^{-2} and yield attributes such as grains $spike^{-1}$, grain weight $spike^{-1}$ and test weight were found to be non-significant.

Yield and quality parameter of wheat

Rice residue management practices had significant effect on yield and quality parameter of wheat (grain yield, straw yield, biological yield, harvest index and protein content). The highest grain yield of (50.23) q ha^{-1} was recorded in residue incorporated with decomposer method which was significantly higher than residue removal method (48.32 q ha^{-1}) and residue burnt (44.32 q ha^{-1}).Residue incorporated with decomposer produced higher straw yield (73.50 q ha^{-1}) and harvest index. The highest protein content (10.62%) also recorded with same treatment. Chandra (2018), observed the significant effect of residue on grain, straw and biological yield of wheat.

In case of levels of nitrogen treatments grain yield (52.60 q ha^{-1}) and straw yield (74.66 q ha^{-1}) was observed significantly higher with 125% RDNF. Harvest index was also recorded significantly higher with 125% RDNF. Among all the nitrogen levels application of 125% RDNF had the significantly higher grain protein content *i.e.* 10.93% as compared to other nitrogen levels. The results are conformity with the findings of Yousaf *et al.*(2014), who reported that the treatment dose of 120 kg N ha^{-1} gave highest grain yield as compared to other treatments.

Interaction effect of different rice residue management practices with varying levels of nitrogen treatments with respect to grain yield, straw yield, biological yield, harvest index and protein content were found to be non-significant.

It is stated from the results that among different rice residue management practices, residue incorporated with decomposer produced significantly higher growth and yield attributes of wheat as compared to residue burnt and residue removed method. The highest grain yield of (50.23) q ha^{-1} was recorded in residue incorporated with decomposer method which was significantly higher than residue removal method (48.32 q ha^{-1}) and residue burnt (44.32 q ha^{-1}). 125% RDNF level of nitrogen recorded significantly higher values of growth, yield and quality parameter than other levels of nitrogen and was found to be best suited combination with rice residue incorporated with decomposer.

Table 1. Impact of different rice residue management practices with varying levels of nitrogen on growth parameters of wheat

Treatments	Plant height (Days after sowing) (cm)					Dry matter accumulation (Days after sowing) (g)					Leaf area index (Days after sowing)				No. of tillers m^{-2}				
	30	60	90	120	At Harvest	30	60	90	120	At Harvest	30	60	90	120	30	60	90	120	At Harvest
Rice residue management practices																			
Burnt	18.66	36.95	78.01	94.78	96.85	2.54	7.59	8.44	11.28	14.90	0.46	2.78	3.81	3.17	220	356	382	372	358
Removed	20.50	39.52	82.30	98.26	100.64	3.39	8.18	9.28	12.56	16.48	0.50	2.84	3.96	3.28	222	362	389	377	360
Incorporated with decomposer	20.70	42.02	85.97	101.12	102.88	3.94	9.05	10.77	13.75	18.02	0.52	3.01	4.05	3.70	223	367	393	383	370
SE(m)±	0.53	1.07	1.77	1.46	1.04	0.17	0.22	0.27	0.32	0.41	0.01	0.09	0.16	0.20	0.88	4.60	4.00	5.48	4.90
CD at 5 %	1.60	3.13	5.14	4.40	3.13	0.52	0.64	0.82	0.98	1.21	-	0.29	0.48	0.62	-	13.80	11.60	15.90	14.70
Nitrogen levels																			
Control	17.67	36.74	72.91	80.82	84.30	2.15	6.64	7.54	9.51	12.98	0.46	2.79	3.70	3.22	217	350	370	362	344
50% RDNF	19.10	37.92	75.80	95.40	98.52	2.73	7.75	8.52	11.22	15.01	0.48	2.86	3.86	3.40	218	353	373	366	350
75% RDNF	19.50	39.31	83.11	101.73	103.61	3.22	8.08	9.62	12.44	16.04	0.49	2.89	3.90	3.49	218	357	378	370	356
100% RDNF	20.70	40.62	87.44	105.26	106.16	3.76	8.78	10.28	14.17	18.05	0.53	2.94	3.98	3.61	219	360	384	375	361
125% RDNF	22.70	42.90	91.22	107.05	108.03	4.58	10.01	11.52	15.32	19.36	0.57	2.97	4.06	3.73	220	366	390	381	367
SE(m)±	0.52	1.14	1.89	1.31	1.15	0.15	0.35	0.40	0.41	0.66	0.01	0.06	0.18	0.19	0.50	4.13	3.51	4.66	4.37
CD at 5%	1.58	3.33	5.67	3.82	3.45	0.47	1.03	1.16	1.20	2.00	-	0.20	0.53	0.57	-	12.40	10.20	14.00	12.70
Interactions																			
SE(m)±	0.72	1.06	1.37	1.14	1.07	0.38	0.59	0.63	0.64	0.81	0.1	0.24	0.42	0.43	0.70	2.03	1.87	3.74	3.56
CD at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

RDNF= Recommended dose of nitrogen fertilizer

Table 2. Impact of different rice residue management practices with varying levels of nitrogen on yield attributes, yield and quality of wheat

Treatments	Grains spike^{-1}	Grain weight spike^{-1}(g)	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)	Protein (%)
Rice residue management practices								
Burnt	42.70	1.66	29.74	44.32	70.21	116.49	0.39	10.31
Removed	44.30	1.67	31.38	48.32	71.63	119.88	0.40	10.50
Incorporated with decomposer	46.50	1.70	33.06	50.23	73.50	124.13	0.41	10.62
SE(m)±	0.65	0.04	0.71	1.61	0.83	1.25	0.005	0.06
CD at 5 %	1.89	0.12	2.14	4.83	2.42	3.65	-	0.19
Nitrogen levels								
Control	41.70	1.58	0.36	43.29	68.73	115.67	0.36	10.00
50% RDNF	43.80	1.64	0.38	46.34	70.54	117.68	0.38	10.31
75% RDNF	44.00	1.66	0.40	47.36	71.06	120.28	0.40	10.50
100% RDNF	46.30	1.69	0.42	49.65	73.37	122.13	0.42	10.62
125% RDNF	48.20	1.73	0.44	52.6	74.66	125.07	0.44	10.93
SE(m)±	1.36	0.05	0.01	0.84	1.28	0.91	0.01	0.09
CD at 5%	4.08	0.16	-	2.54	3.85	2.74	-	0.28
Interactions								
SE(m)±	1.16	0.22	0.10	0.91	1.13	0.95	0.10	0.30
CD at 5%	-	-	-	-	-	-	-	-

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