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ORIGINAL ARTICLE

Influences of residual management and various organic source of nutrient on productivity and uptake studies of Wheat (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was conducted during the two continuous rabi season 2020-21 and 2021-22 at the Crop Research farm of Agronomy, S. G. R. R. University, Dehradun (U.K.) to conclude the response of late sown wheat (*Triticum aestivum* L.) to residual management and various organic source of nutrient in split plot design with fourteen treatments replicated thrice. Observations were recorded at pre harvest stage and post-harvest & analyzed statistically. The results revealed that application of $M_{1.}$ Residue management with decomposer proved superior with increased plant height, dry matter accumulation, number of tillers per plant, test weight, grain yield and stover yield. Further analysis of the data indicated that application of $M_{1.}$ Residue management with decomp application of $M_{1.}$ Residue management with decomposer exerted significant maximum Nitrogen, phosphorus and potassium uptake during both the years. In case of organic manures S_7 Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha recorded maximum plant height, dry matter accumulation, number of tillers per plant, test weight, grain yield and straw yield during both the years of experiment. Maximum Nitrogen, phosphorus and potassium uptake was also recorded in abovesaid treatment. Interaction effect of main plot and sub plot recorded unchanged during both the years of experiment

Key words: *wheat, Triticum aestivum, decomposer, Nutrients management, INM, organic manures*

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INTRODUCTION

The rice-wheat cropping system is characterized by an annual transition of the soil environment from anaerobic to aerobic and back to aerobic conditions. Over time, the physical characteristics of the soil have been damaged due to traditional methods of growing rice and wheat [20]. Additionally, the handling of crop residues, particularly rice residue, has become a significant concern due to increased mechanization. Rice residue burning is frequently adopted by farmers because of the limited time available between rice harvest and wheat sowing. This has not only affected the long-term environment but has also accelerated the deterioration of soil health and food security. Increased mechanization, especially the use of combine harvesters (from 2000 in 1986 to 10,000 in 2010), is the primary factor driving forced residue burning. Furthermore, the reduction in the traditional use of crop residues for purposes such as roof thatching, animal feeding, composting, packaging, and domestic fuel has aggravated the problem of residue burning [18]. Currently, no effective methods are in place for managing crop residues, and as a result, the majority of farmers burn rice residues in the field, severely degrading the environment, harming human health, and deteriorating soil health.

Indian soils are poor to medium in available phosphorus. Only about 30 per cent of the applied phosphorus is available for crops and remaining part converted into insoluble phosphorus Kaur and Reddy [21]. Phosphorus fertilization occupies an important place amongst the non-renewable inputs in modern agriculture. Crop recovery of added phosphorus seldom exceeds 20 per cent and it may be improved by the judicious management. As the concentration of available P in the soil solution is normally insufficient to support the plant growth, continual replacement of soluble P from inorganic and organic sources is necessary to meet the P requirements of crop Sarma *et al.* (2007)[34]. Additional application of P is Increase nodule formation which increase nitrogen fixation and finally productivity of green gram. It plays an important role in virtually all major metabolic processes in plant including photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis and respiration Milosevic *et al.* [25].

Improved in-situ residue management has the potential to eliminate crop residue burning. This can be achieved either through residue incorporation or retention on the soil surface, provided suitable seeding equipment is available. Microbial breakdown of rice waste in-situ can also be accelerated, allowing wheat to be sown into decomposed residues using zero-till machines without the need for burning. The decomposition of crop residues and nitrogen release are influenced by native soil bacteria, the decomposition process duration, and soil and environmental factors. Gram-positive bacteria predominantly account for the microorganisms involved in decomposition, while fungi and actinomycetes play crucial roles in breaking down refractory substances in the later stages; Bahadur *et al.* [3].

The Green Revolution era led to remarkable achievements in food grain production through the adoption of intensive agriculture, involving increased use of synthetic inputs like inorganic fertilizers, pesticides, fungicides, and the greater exploitation of surface and groundwater resources to produce more from each unit of land. However, this overexploitation of resources and indiscriminate use of inputs have created various problems, disrupting the ecological balance and endangering life. In India, there is a shortage of organic carbon in the soil due to poor use of organic manures and rapid decomposition of organic matter, which reduces the soil's efficiency in absorbing fertilizers and achieving higher yields Kaur and Reddy [21]. Organic carbon is mainly produced through humus or decomposed residues from hay and straw left after each harvest. Organic manures are essential for building organic carbon in soil, creating favorable air and water conditions for plant roots, and serving as carriers of micronutrients, besides influencing microbial and faunal activities in the soil [15]. Nutritional capacity of Single Super Phosphate (SSP) was further improved by PSB inoculation due to its ability to convert sparingly soluble inorganic phosphate into soluble forms by secreting organic acids Gupta *et al.,* [17]. Application of phosphorus along with phosphate solubilizing bacteria (PSB) improved phosphorus uptake by plants and yields indicating that the PSB are able to solubilize phosphates and to mobilize phosphorus in crop plants Milosevic *et al.* [25]. In this respect, biofertilization technology has taken a part to minimize production costs and at the same time avoid the environmental hazards Kaduwal *et al.,* [20].

Many soil microorganisms, including bacteria and fungi, are able to mobilize phosphorus from sparingly soluble rock phosphates, and they have an enormous potential in providing soil phosphates for plant growth [15]. These organisms are ubiquitous but vary in density and mineral/rock phosphate solubilising ability from soil to soil or from one production system to another Bhattacharya and Chandra (2013)[6]. Phosphate solubilizing bacteria inoculation enhances the mineralization of organic forms of phosphorus and solubilization of inorganic phosphorus, improving the availability of native soil phosphorus to plants and thereby increase yield attributes resulting to higher grain yield Chung *et al*., [9].

MATERIAL AND METHODS

The present investigation entitled "Response of late sown wheat (*Triticum aestivum* L.) to residual management and various organic source of nutrient in Uttarakhand", was carried out during 2020-21 and 2021-22 at Research Farm of Department of Agronomy, Sri Guru Ram Rai University, Dehradun, Uttarakhand. The research farm of Department of Agronomy, Sri Guru Ram Rai University, Dehradun is situated in Dehradun which lies between 78. 0295° E longitude and 30.3025° N latitude, at an elevation of 435 m above MSL and in the lesser Himalayan region. The field experiment was laid out in split plot design with 3 replication of each treatment and the wheat seeds were used as variety DBW 173. The sed was sown at the seed rate of 80 kg/ha. Main plot treatment comprises as $M_{1.}$ Residue management with decomposer and $M_{2.}$ Residue management without decomposer (Conventional method); and sub plot *viz.* S_1 Vermiwash @ 2.5 litre/ ha (Soil Application), S_2 Azotobactor @ 30 ml/kg of seed (Seed Inoculation), S_3 Phosphate Solubilizing Bacteria (PSB) @ 30 ml/kg of seed (Seed Inoculation), S_4 Vermiwash @ 2.5 litre/ ha + Azotobactor @ 30 ml/kg of seed, S_5 Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed , S_6 Azotobactor @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed and S_7 Azotobactor @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha comprises fourteen treatment combinations with with three replications. Observation i.e. plant height, dry matter accumulation, number of tillers per plant, test weight, grain yield, stover yield and uptake of nutrients was taken and presented in appropriate place.

The data collected was subjected to the Fisher's analysis of variance (ANOVA) technique and the treatment's means were compared with the table value of 'F' at 5% level of significance Casida *et al.,* [7].

RESULTS AND DISCUSSION

Growth characteristics: plant height, dry matter accumulation and number of tillers per plant was significantly influenced by both the factors i.e. residue management and organic nutrient management. Perusal of the mean data showed in table 4.1 exerted significant variation in plant height, dry matter accumulation and number of tillers per plant at pre harvest stage among different residue management during both the year of experiment. Maximum plant height, dry matter accumulation and number of tillers per plant was recorded by M_1. Residue management with decomposer in main plot during both the years of experiment. Higher plant height, dry matter accumulation and number of tillers per plant in M1 might be due to residue management with decomposer practices has potential for increasing the nutrient supply to crops through changes in the mineralization and immobilization of nutrients by microbial biomass and provide an eco-protective environment for sustainable production of crops another reason might be due to better nutrient uptake [23]. A close examine of mean data on organic nutrient management exerted significant variation during both the years of experiment. S_7 Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha recorded maximum plant height, dry matter accumulation and number of tillers per plant during both the years. Higher plant height, dry matter accumulation and number of tillers per plant in S7 might be due to better availability of nutrients, beside to increased uptake of nitrogen and phosphorus by the plants, which was made available through organic sources which provide plant to grow its potential and acquire maximum plant height, dry matter accumulation and number of tillers per plant. Similar findings were also reported by **Nath *et al.* [28]**. S_5 Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed was found to be at par with S_7 during both the years of experiment. This could be ascribed to the application of vermiwash with biofertilizer PSB. Vermiwash contains several enzyme, plant growth hormones like cytokinins, gibberlines and vitamins along with micro and macro nutrients which promote growth of plants and combined application of vermiwash & biofertilizers promote growth of plants in greater extent. Similar findings were also reported by **Milosevic *et al.* [25]; Minaxi *et al.* [26].**

Productivity: Wheat grain yield and stover yield showed in table 4.2 exhibited a significant increase under M_1. Residue management with decomposer in main plot during both the years of experiment. However, minimum performance of growth analytic characters was recorded by M_2. Residue management without decomposer. This result collaborated with the result of **Shah and Kumar [36]; Chand *et al.* [8];** The higher grain yield with M1 might be due to optimum utilization of nutrients. While, at later stage of crop the availability of nutrients increases and gave maximum growth attributes, the plant growth and ultimately yield may increase [11]. These results in straw yield could be attributed to the significant increase in plant height and dry matter production. In case of sub plot treatments organic nutrient management S_7 Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha recorded maximum grain yield and stover yield during both the years of experiments. However, S_5 Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed was found to be at par with S_7 during both the years of experiment. Similar findings were also recorded by Kumar *et al.* [22]. Better yield in S_5 and S_7 might be due to better availability of nutrients, beside to increased uptake of nitrogen and phosphorus by the plants, which was made available through organic sources which provide plant to grow its potential and acquire maximum grain yield and stover yield. Similar findings were also reported by Bahadur *et al.* [3].

Uptake studies: Nitrogen, phosphorus and potassium uptake showed in table 4.3, 4.4 and 4.5 exhibited a significant increase under M_1. Residue management with decomposer in main plot during both the years of experiment. However, minimum performance of growth analytic characters was recorded by M_2. Residue management without decomposer. This result collaborated with the result of Chand *et al.* [8]. The higher Nitrogen, phosphorus and potassium uptake with M1 might be due to optimum utilization of nutrients. These results in uptake could be attributed to the significant increase in plant height and dry matter production. In case of sub plot treatments organic nutrient management S_7 Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha recorded maximum Nitrogen, phosphorus and potassium uptake during both the years of experiments. However, S_5 Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed was found to be at par with S_7 during both the years of experiment. Similar findings were also recorded by Kumar *et al.* [22]. Better uptake in S_5 and S_7 might be due to better availability of nutrients, beside to increased uptake of nitrogen and phosphorus by the plants, which was made available through organic sources which provide plant to grow its potential and acquire maximum Nitrogen, phosphorus and potassium uptake. Similar findings were also reported by; Bahadur *et al.* [3]; Minaxi *et al.* [26].

Table 4.1: Effect of residue management and organic nutrient management on growth attributes of wheat

Treatments		Plant height (cm) at 90 DAS		Dry weight (g) at 90 DAS		No. of tillers/ Plant (No.) at 90 DAS	
		2020	2021	2020	2021	2020	2021
Main Plot (Residue management)							
M1	Residue management with decomposer	84.06	85.38	95.83	98.84	8.15	8.10
M2	Residue management without decomposer	78.01	79.26	88.99	91.76	7.56	7.50
Sem ±		1.12	1.16	1.29	1.35	0.11	0.12
C.D. (5%)		2.30	2.38	2.63	2.76	0.22	0.23
Sub Plot (Organic Nutrient Management)							
S1	Vermiwash @ 2.5 litre/ ha (Soil Application)	78.27	81.77	89.23	94.67	7.59	7.75
S2	Azotobactor @ 30 ml/kg of seed (Seed Inoculation)	78.41	81.92	89.39	94.84	7.60	7.77
S3	Phosphate Solubilizing Bacteria @ 30 ml/kg of seed (Seed Inoculation)	80.49	81.65	91.77	94.52	7.80	7.74
S4	Vermiwash @ 2.5 litre/ ha + Azotobactor @ 30 ml/kg of seed	81.98	83.15	93.46	96.26	7.95	7.88
S5	Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed	83.56	84.75	95.26	98.12	8.10	8.04
S6	Azotobactor @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed	79.79	77.03	91.15	89.19	7.72	7.26
S7	Azotobactor @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha	84.76	85.98	96.64	99.54	8.22	8.15
Sem ±		2.10	2.17	2.40	2.52	0.20	0.21
C.D. (5%)		4.31	4.45	4.92	5.16	0.42	0.42

Table 4.2: Effect of residue management and organic nutrient management on yield of wheat

Treatments		Grain yield ($t\ ha^{-1}$)		Stover yield ($t\ ha^{-1}$)		Seed index (g)	
		2020	2021	2020	2020	2021	2020
Main Plot (Residue management)							
M1	Residue management with decomposer	4.34	4.47	5.25	5.57	0.3423	0.3530
M2	Residue management without decomposer	4.03	4.16	4.88	5.17	0.3204	0.3298
Sem ±		0.06	0.07	0.07	0.08	0.0036	0.0040
C.D. (5%)		0.12	0.15	0.14	0.15	0.0075	0.0082
Sub Plot (Organic Nutrient Management)							
S1	Vermiwash @ 2.5 litre/ ha (Soil Application)	4.04	4.28	4.89	5.33	0.3187	0.3381
S2	Azotobactor @ 30 ml/kg of seed (Seed Inoculation)	4.04	4.29	4.90	5.34	0.3276	0.3443
S3	Phosphate Solubilizing Bacteria @ 30 ml/kg of seed (Seed Inoculation)	4.15	4.28	5.03	5.32	0.3277	0.3376
S4	Vermiwash @ 2.5 litre/ ha + Azotobactor @ 30 ml/kg of seed	4.23	4.35	5.12	5.42	0.3338	0.3438
S5	Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed	4.31	4.44	5.22	5.53	0.3402	0.3504
S6	Azotobactor @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed	4.14	4.07	5.01	5.02	0.3261	0.3202
S7	Azotobactor @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha	4.37	4.50	5.29	5.60	0.3451	0.3555
Sem ±		0.11	0.11	0.13	0.14	0.0068	0.0075
C.D. (5%)		0.22	0.23	0.27	0.29	0.0140	0.0153

Table 4.3: Effect of residue management and organic nutrient management on nitrogen uptake by wheat

Treatments		N uptake by grain (Kg ha-1)		N uptake by straw (Kg ha-1)		N uptake by crop (Kg ha-1)	
		2020	2021	2020	2021	2020	2021
Main Plot (Residue management)							
M_1	Residue management with decomposer	19.84	21.11	31.97	32.80	51.81	53.91
M_2	Residue management without decomposer	17.13	18.22	27.55	28.21	44.68	46.44
Sem ±		0.49	0.54	0.41	0.43	0.78	0.84
C.D. (5%)		1.01	1.11	0.83	0.88	1.60	1.72
Sub Plot (Organic Nutrient Management)							
S_1	Vermiwash @ 2.5 litre/ ha (Soil Application)	17.16	19.32	27.69	30.04	44.85	49.36
S_2	Azotobacter @ 30 ml/kg of seed (Seed Inoculation)	17.37	19.55	27.77	30.14	45.14	49.68
S_3	Phosphate Solubilizing Bacteria @ 30 ml/kg of seed (Seed Inoculation)	18.18	19.29	29.29	29.96	47.47	49.24
S_4	Vermiwash @ 2.5 litre/ ha + Azotobacter @ 30 ml/kg of seed	18.86	20.01	30.43	31.13	49.29	51.14
S_5	Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed	19.59	20.78	31.59	32.32	51.18	53.10
S_6	Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed	17.98	17.28	28.98	26.67	46.96	43.94
S_7	Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha	20.23	21.46	32.57	33.31	52.80	54.77
Sem ±		0.92	1.01	0.76	0.80	1.46	1.57
C.D. (5%)		1.89	2.07	1.55	1.64	2.99	3.22

Table 4.4: Effect of residue management and organic nutrient management on phosphorus uptake by wheat.

Treatments		P uptake by grain (Kg ha-1)		P uptake by straw (Kg ha-1)		P uptake by crop (Kg ha-1)	
		2020	2021	2020	2021	2020	2021
Main Plot (Residue management)							
M_1	Residue management with decomposer	7.93	8.44	7.99	8.75	15.93	17.19
M_2	Residue management without decomposer	6.85	7.29	6.89	7.52	13.74	14.81
Sem ±		0.20	0.22	0.10	0.11	0.26	0.29
C.D. (5%)		0.40	0.44	0.21	0.23	0.54	0.59
Sub Plot (Organic Nutrient Management)							
S_1	Vermiwash @ 2.5 litre/ ha (Soil Application)	6.87	7.73	6.92	8.01	13.79	15.74
S_2	Azotobacter @ 30 ml/kg of seed (Seed Inoculation)	6.95	7.82	6.94	8.04	13.89	15.86
S_3	Phosphate Solubilizing Bacteria @ 30 ml/kg of seed (Seed Inoculation)	7.27	7.72	7.32	7.99	14.59	15.70
S_4	Vermiwash @ 2.5 litre/ ha + Azotobacter @ 30 ml/kg of seed	7.54	8.00	7.61	8.30	15.15	16.30
S_5	Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed	7.83	8.31	7.90	8.62	15.73	16.93
S_6	Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed	7.19	6.91	7.24	7.11	14.44	14.02
S_7	Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha	8.09	8.58	8.14	8.88	16.23	17.47
Sem ±		0.37	0.40	0.19	0.21	0.49	0.54
C.D. (5%)		0.76	0.83	0.39	0.44	1.01	1.11

CONCLUSION

It may be concluded that growth attributes, yield and uptake of the wheat crop was recorded by main plot treatment M_1. Residue management with decomposer. In case of sub plot treatments organic nutrient management S_7 Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha recorded maximum growth attributes, yield and uptake of the wheat crop.

Table 4.5: Effect of residue management and organic nutrient management on potassium uptake by wheat.

Treatments		K uptake by grain (Kg ha-1)		K uptake by straw (Kg ha-1)		K uptake by crop (Kg ha-1)	
		2020	2021	2020	2021	2020	2021
Main Plot (Residue management)							
M1	Residue management with decomposer	15.87	16.89	13.70	15.00	29.57	31.88
M2	Residue management without decomposer	13.70	14.58	11.81	12.90	25.51	27.48
Sem ±		0.39	0.43	0.17	0.20	0.50	0.56
C.D. (5%)		0.81	0.88	0.36	0.40	1.03	1.14
Sub Plot (Organic Nutrient Management)							
S1	Vermiwash @ 2.5 litre/ ha (Soil Application)	13.73	15.45	11.87	13.73	25.60	29.19
S2	Azotobacter @ 30 ml/kg of seed (Seed Inoculation)	13.89	15.64	11.90	13.78	25.80	29.41
S3	Phosphate Solubilizing Bacteria @ 30 ml/kg of seed (Seed Inoculation)	14.54	15.43	12.55	13.69	27.10	29.12
S4	Vermiwash @ 2.5 litre/ ha + Azotobacter @ 30 ml/kg of seed	15.09	16.01	13.04	14.23	28.13	30.24
S5	Vermiwash @ 2.5 litre/ ha + PSB @ 30 ml/kg of seed	15.67	16.62	13.54	14.77	29.21	31.40
S6	Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed	14.38	13.82	12.42	12.19	26.80	26.01
S7	Azotobacter @ 30 ml/kg of seed + PSB @ 30 ml/kg of seed + Vermiwash @ 2.5 litre/ ha	16.18	17.17	s	15.23	30.14	32.40
Sem ±		0.74	0.81	0.33	0.37	0.94	1.04
C.D. (5%)		1.51	1.65	0.67	0.75	1.93	2.13

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