E-ISSN: 2618-0618
P-ISSN: 2618-060X
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www.agronomyjournals.com
2024; 7(7): 202-205
Received: 16-04-2024
Accepted: 20-05-2024

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Effect of integrated nutrient management on growth yield and economics of late sown wheat (*Triticum aestivum* L.)

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i7c.1019

Abstract
The present investigation entitled, "Effect of integrated nutrient management on growth yield and ecomics of late sown wheat (*Triticum aestivum* L.)" was carried out at Research farm of the department of agriculture, Maharishi Markandeshwar university, Mullana, Ambala during *Rabi* season of 2022.The experiment was laid out in randomized block design using wheat variety HD -3086 with eight treatments *viz*. T_1- control,T_2-50% RDF +40 Kg Sulphur/ha, T_3- 50% RDF +25 Kg$ZnSo_4$ /ha,T_4- 75% RDF, T_5- 75% RDF +25 Kg $ZnSo_4$/ha+40 Kg Sulphur/ha, T_6-100%RDF, T_7-75% RDF+25% N through FYM + *Azotobacter*, T_8- 100% RDF + 25% N through Vermicompost +25 Kg $ZnSo_4$/ha. The treatments were replicated thrice. On the basis of results obtained all the growth and yield parameters were recorded best with the treatment of T_8-100% RDF + 25% N through Vermicompost +25 Kg $ZnSo_4$/ha having grain yield of 48.82 qt/ha and highest straw yield of 60.07 qt/ha among the all other treatments. The benefit cost ratio was also higher 2.30 in the treatment T_8- 100% RDF + 25%N through Vermicompost +25 Kg $ZnSo_4$/ha.

Keywords: Integrated nutrient management, zinc sulphate, yield and yield attributes

Introduction
Wheat (*Triticum aestivum L.*) is one of the most significant cereal crop and essential food for a large part of the world's society. Globally wheat production worldwide is around 765.77 million tons (MT) in the year 2022 (Bahaudin *et al.* 2022) [2]. Wheat is grown in counties like China, India, Russia, USA and some parts of Africa. After China, India is leading producer of wheat in the world. India ranks first in area and second in production of wheat in the world. India total area under wheat crop during 2021-22 was 304.69 lakh hectare and production of wheat during 2021-22 was estimated at 106.84 million tons (MT) (GOI Annual Report, 2022-23). It makes about 25 percent of the nation's total grain production and is the second most important food crop after rice in terms of consumption. In Haryana, wheat is grown over an area of about 2.55 million ha with production of 12.57 million tonnes and productivity of 4.92 t/ha (DESA, Haryana, 2020).
The approximate chemical composition of the wheat kernel is starch 63-71%; protein10-12%; water 8-17%; cellulose 2-3%; faT_1.5-2%; sugar2-3%; and mineral matter 1.5-2%. Gluten of the wheat kernel contains about 17.6% nitrogen (Anonymous, 2017) [1]
Nitrogen plays a prominent role in plant metabolism. All key functions in the plant are related with protein, and nitrogen is a crucial component (Singh *et al.* 2019) [13]. A sufficient nitrogen supply is essential for strong vegetative growth, chlorophyll synthesis, and effective glucose utilization. Despite this importance, grains often utilize nitrogen inefficiently.
To preserve both soil fertility and crop productivity, it is crucial to utilize both inorganic and organic nitrogen sources concurrently. Coordinated nitrogen management has been effective in enhancing soil organic carbon levels and improving the availability of nutrients for plants. The combination of chemical and organic sources, when managed properly, has demonstrated promising results, not only in sustaining yields but also in promoting soil health. (Singh *et al.* 2017) [10]

The integrated approach not only ensures higher yields and economic benefits but also promotes ecological sustainability, aligning with principles of sustainable agriculture. At its core, INM aims to maintain and enhance soil fertility for sustained crop productivity. The use of diverse organic-inorganic sources has resulted in increased yields, improved economic efficiency, and enhanced residual soil fertility (Singh *et al.* 2017) [10].

Integrated nutrient management (INM) is a flexible strategy for judicious application of inorganic fertilizers and organic manures to enhance production efficiency and farmers' profitability (Panday *et al.* 2018) [7]. Recently, multiple researchers revealed that the combined use of inorganic fertilizers and organic manures (FYM, compost, vermicompost, etc.) with bio-inoculants is becoming a promising technique for achieving sustainable crop output and supporting soil health (Sarkar *et al.* 2021) [9]. Aside from that, INM has a positive residual effect on succeeding crops (Tahiri *et al.* 2022) [13].

Keeping the above facts in view, the present study was designed to evaluvate effect of integrated nutrient management on growth, yield and economics of wheat.

Material and Methods

The current study, "Effect of integrated nutrient management on growth yield and economics of late sown wheat (*Triticum aestivum* L.)," was conducted during the Rabi season of 2022-2023 at the Department of Agriculture's experimental farm, MMDU Mullana Ambala. The experiment was laid out in randomized block design with three replications using wheat variety HD- 3086 and eight treatments. The eight treatments included combinations namely T_1 -control, T_2 -50% RDF+40 Kg Sulphur /ha, T_3 -50% RDF+25 Kg ZnSo4 /ha, T_4 -75% RDF, T_5 -75% RDF + 25 Kg ZnSo4 /ha + 40 Kg Sulphur /ha, T_6 -100% RDF, T_7 -75% RDF + 25% N through FYM + Azotobacter, and T8 -100% RDF + 25% N through vermicompost + 25 Kg ZnSo4 /ha. The HD3086 cultivar was sown at a seed rate of 100 kg ha-1 with a spacing of 22.5 cm. For wheat, fertilizer dosage recommendations are 150, 60, and 60 kg of N, P2O5, and K2O ha1, respectively. At the time of sowing, the entire dosage of P2O5, K2O, and 25% of N were applied. The remaining nitrogen dosages were administered in equivalent amounts (25%) at 4, 6, and 8 weeks, respectively, following seeding. Azotobacter and vermicompost, farm yard manure were applied in accordance with treatment levels. Obsevations were recorded on plant growth parameters like plant height, tiller number, dry matter aacumulation at 30, 60, 90 DAS and at harvest likewise observations recorded on grain yield parameters like number of spikes, spike length, no of grains per spike, test weight grain yield, syraw yield, biological yield and harvest index at the time of harvest. Mean data for all the character studied was subjected to Analysis of variance using statistical package opstat

Results and Discussion

Growth parameter

The information about growth parameters is presented in table 1. Among treatments, T8 (100% RDF + 25% N through Vermicompost +25 Kg $ZnSo_4$/ha) observed the highest plant height (101.7 cm), highest dry matter accumulation (1015.46 g), number of tillers per metre square (261) and the lowest growth parameters were observed in T_6 100% RDF. All the treatments were significantly superior to control. These results were similar to the findings of Yadav *et al*. (2023) [15].

Yield attributes and yield

The data regarding yield and yield attributes is presented in table 2. Among the treatments T8 (100%RDF + 25%N through Vermicompost +25 Kg $ZnSo_4$/ha) observed the highest number of spikes per metre square (245), length of spike (8.9), highest number of grains per spikes (46), highest test weight (43.4). These results were similar to the findings of Khan *et al*. (2020) [6]. Highest grain yield (48.82), straw yield (60.07), Biological yield (108.26), Harvest index (45.09%) was found in treatment T_8 whereas the lowest yield and yield attributs observed in control. Treatment T8 was also significantly superior to T_6 (RDF) all the treatments were significantly superior to control. These results were similar to the findings of Tiwari *et al*. (2023) [14].

Economics

The data reporting economics of wheat variety affected by treatments are reported in table 3. The treatment T_8 (100% RDF + 25% N through Vermicompost +25 Kg $ZnSo_4$/ha) observed the highest cost of cultivation (63443 Rs. /ha), gross return (145749 Rs./ha), net return (82306 Rs./ha) and benefit cost ratio (2:3) which were superior to T_6 (RDF). The lowest return were observed in control. These results were similar to the findings of Jain *et al*. (2021) [5].

Table 1: Effect of integrated nutrient management on Growth parameters

Treatment	Plant height (cm)				Dry Matter accumulation g/m^2				No. of Tillers per meter square			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
T_1	19	34.5	75.7	81.2	39.0	145.85	353.99	513.66	158.3	200	203.3	200.3
T_2	19.3	40.5	85.2	92.1	39.07	174.21	414.12	852.61	158.6	243	245.3	239
T_3	20.2	40.9	85.3	94.3	39.1	175.81	415.3	854.77	159.6	245.7	247.3	240.3
T_4	20.3	41.6	87.7	96.3	39.1	179.27	429.48	872.20	160	253.7	255.3	251.3
T_5	20.4	42.3	91.2	97.3	39.3	187	431.58	891.08	160	257.3	259	249.7
T_6	20.5	43	92.1	98.8	40.2	191.66	481.34	987.60	160.3	258	260.3	255.7
T_7	21.3	44	93.7	100.3	40.4	194.33	487.38	1008.87	160.6	261.7	263	260.3
T_8	21.6	46	95.3	101.7	40.5	197.3	493.22	1015.46	161	263	266	261
C.D.	NS	2.589	2.461	1.9	NS	2.5	9.96	9.89	NS	4.9	3.1	5.7
SE(m)	0.824	0.845	0.803	0.63	1.0	0.8	3.252	3.19	0.63	1.6	1.02	1.8
SE(d)	1.165	1.196	1.136	0.891	1.4	1.2	4.599	4.52	0.89	2.3	1.4	2.6

Treatment detail

T_1 Control T_2 50% RDF + 40 Kg Sulphur/ha
T_3 50% RDF +25 Kg $ZnSo_4$ /ha T_4 75% RDF
T_5 75%RDF + 25 Kg $ZnSo_4$/ha + 40 Kg Sulphur
T_6 100% RDF T_7 75% RDF +25% N through FYM + *Azotobacter*
T_8 100% RDF + 25% N through vermicompost + 25 Kg$ZnSo_4$/ha

Table 2: Effect of Integrated nutrient management on yield and yield attributes

Treatments	No. of spikes per meter square	Length of spike(cm)	No. of grain per spike	Test weight	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (q/ha)
T_1	197.7	6.1	33.3	36.5	24.22	36.04	61.12	39.63
T_2	232.3	7.2	35.3	40	32.30	44.42	76.47	42.28
T_3	233.7	7.8	36	40.3	33.37	45.65	78.62	42.45
T_4	238	8.1	42.3	41	41.80	54.57	96.30	43.40
T_5	240.7	8.3	43	41.6	43.03	55.56	98.77	43.56
T_6	242	8.4	43.7	42	44.74	56.41	101.11	44.26
T_7	244.3	8.7	44.7	42.3	46.96	58.39	105.45	44.53
T_8	245	8.9	46	43.4	48.82	60.07	108.26	45.09
C.D.	2.806	0.4	1.437	1.385	2.00	1.50	2.22	2.97
SE(m)	0.916	0.1	0.469	0.452	0.65	0.49	0.72	0.97
SE(d)	1.296	0.2	0.664	0.639	0.92	0.69	1.02	1.37

Treatment detail

T_1 Control T_2 50% RDF + 40 Kg Sulphur/ha
T_3 50% RDF +25 Kg $ZnSo_4$ /ha
T_4 75% RDF T_5 75%RDF + 25 Kg $ZnSo_4$/ha + 40 Kg Sulphur
T_6 100% RDF, T_7 75% RDF +25% N through FYM + *Azotobacter*
T_8 100% RDF + 25% N through vermicompost + 25 Kg$ZnSo_4$/ha

Table 3: Effect of Integrated nutrient management on economics

Treatment No.	Cost of cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	Benefit cost ratio
T_1	47300	76695.5	29395.5	1:62
T_2	52042.5	99731.5	47689	1:92
T_3	53342.5	102866.3	49523.75	1:93
T_4	57811.75	127024	69212.25	2:20
T_5	58799.75	130330.8	71531	2:22
T_6	59543	134559.5	75016.5	2:26
T_7	61683.75	140663	78979.25	2:28
T_8	63443	145749	82306	2:30

Treatment detail

T_1 Control T_2 50% RDF + 40 Kg Sulphur/ha
T_3 50% RDF +25 Kg $ZnSo_4$ /ha T_4 75% RDF
T_5 75%RDF + 25 Kg $ZnSo_4$/ha + 40 Kg Sulphur
T_6 100% RDF T_7 75% RDF +25% N through FYM + *Azotobacter*
T_8 100% RDF + 25% N through vermicompost + 25 Kg$ZnSo_4$/ha

Conclusion

Based on the data outlined above, it can be said that, under favorable conditions, the treatment T_8 100% RDF + 25% N through vermicompost + 25 kg ZnSo4/ha in wheat showed superior outcomes when considering the crop's growth and yield measurements and the lowest observed in T_1 control. In the treatment consisting of 100% RDF + 25% N through vermicompost + 25% kg ZnSo4 /ha, the greatest cost of cultivation, highest gross return, net return and highest benefit cost ratio was observed whereas the lowest economic parameter were recorded in T_1 control. Therefore, crop productivity rose as a result of integrated nutrient management. Kumar *et al*. (2017) [11] Yadav *et al*. (2023) [15].

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