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PRODUCTION AND ECONOMICS OF IRRIGATED WHEAT (*TRITICUM AESTIVUM*) AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

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Abstract

An experiment was conducted on wheat during 2011-12 at C.S. Azad University of Agriculture and Technology, Kanpur (U.P.) to evaluate the effect of integrated nutrient management (INM) on crop productivity and economics. Recommended dose of 75% and 50% were integrated with vermicompost, $ZnSO_4$ and /or biofertilizers. The results revealed that 100% RDF (150 kg N+60 kg P_2O_5 + 40 kg K_2O ha^{-1}) produced highest grain yield (51.73 q ha^{-1}) and straw yield (63.75 qha^{-1}) alongwith significantly maximum net return of Rs. 71493 ha^{-1}. it was followed by the treatment 75% RDF + vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + seed treatment with *Azotobacter* and PSB inoculation; 75% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter* and PSB; and 75% RDF + vermicomposat @ 2.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} with 49.40, 48.30 and 48.00 qha^{-1} grain yield; 63.75, 62.40 and 57.63 q ha^{-1} straw yield and Rs. 66418, 64105 and 59256 ha^{-1} net return, respectively. All integrated nutrient treatments with 50% RDF yielded lesser and earned lesser net returns than respective integrated nutrient treatments with 75% RDF. Effect of $ZnSO_4$ and biofertilizers integration was more pronounced with 50% RDF compared to 75% RDF treatments. The control treatment (no fertilizer etc.) produced significantly lowest grain yield (23.25 q ha^{-1}), straw yield (31.00 q ha^{-1}) and earned minimum of Rs. 18718 ha^{-1} net return.

Key words: Wheat, fertilizers, vermicompost, biofertilizer, yield, economics.

Introduction

The dwarf wheat varieties of wheat have great potential but due to exhaustive nature they require heavy amount of nutrients, which are mat mainly by chemical fertilizers. It posed a great threat to long-term sustainability of crop production. Although the balanced use of N, P and K fertilizer could maintain wheat productivity, in practices it has sown a declining trend in yield response. This deteriorating yield response was found associated with degrading of soil physical and biological qualities besides imbalance in secondary and micronutrients. The integrated nutrient management which involves integrated use of chemical fertilizers along with biofertilizers in addition to organic manures. Organic manuring improves soil physical and biological characteristics and when applied in conjunction with biofertilizers, it supplies energy to beneficial microorganism including *Azotobacter* and PSB. Biofertilizers like *Azotobacter* and PSB offer a low cost, low capital intensive and ecofriendly route to lowest the crop productivity depending upon their activity of mobilizing different nutrients. They also play an important role in increasing the availability of N, P and K whether applied or native. Keeping it in view, the present study was under taken to find out the effect of integrated nutrient management (INM) on productivity and economics of wheat crop.

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Materials and Methods

An experiment was conducted during winter (*rabi*) season of 2011-12 and Student's Instructional Farm of C.S. Azad University of Agriculture and Technology,

Kanpur (Uttar Pradesh), India. The soil was sandy loam in texture and slightly alkaline in nature (pH 7.5). It was low in organic carbon (0.44%), available nitrogen (170 kg ha^{-1}), medium in phosphorus (17.8 kg ha^{-1}) and low in potassium (165 kg ha^{-1}). The treatments consisted 12 practices of nutrient management *viz.*, $\mathbf{T_1}$–control, $\mathbf{T_2}$-RDF, $\mathbf{T_3}$- 75% RDF, $\mathbf{T_4}$– 50% RDF, $\mathbf{T_5}$–75% RDF + 2.5 t ha^{-1} vermicompost, $\mathbf{T_6}$– $\mathbf{T_5}$ + 25 kg ha^{-1} $ZnSO_4$), $\mathbf{T_7}$– $\mathbf{T_5}$ + biofertilizers, $\mathbf{T_8}$–$\mathbf{T_6}$+biofertilizers, $\mathbf{T_9}$- 50% RDF + 5 t ha^{-1} vermicompost, $\mathbf{T_{10}}$–$\mathbf{T_9}$ + 25 kg ha^{-1} $ZnSO_4$, $\mathbf{T_{11}}$-$\mathbf{T_9}$ + biofertilizers and $\mathbf{T_{12}}$–$\mathbf{T_{10}}$ + biofertilizers. The RDF in biofertilizers *Azotobacter* and phosphate solubilizing bacteria (PSB) were applied through seed treatment. All 12 treatments were tested in randomized block design replicated thrice. Vermicompost as per treatment was broadcasted and mixed with soil plot wise 20 days prior to seed sowing. Fertilizers as per treatment were applied by using recommended practice. Variety PBW-343 was used in the experiment. Before sowing required seed quantity was treated with *Azotobacter* and PSB cultures @ 5 g inoculum per kg seed. Uniform costing of both cultures was done as per standard procedure. The sowing of seed was done in furrows behind plough at 20 cm row spacing using uniform seed rate of 100 kg ha^{-1} in all treatment plots. Sowing was done on December 1, 2011 and harvested at full maturity on 11th April, 2012. Other than treatments, the crop was raised with recommended package of practices under irrigated condition. The data obtained from different observations were analyzed statistically as per standard procedure suggested by Pause and Sukhatme (2000).

Results and Discussion

Productivity

Wheat productivity with 100% RDF ($\mathbf{T_2}$) in form of total biomass production, grain and straw yield was recorded highest of 113.35, 51.73 and 63.75 q ha^{-1}, respectively while significantly lowest of 54.25 q ha^{-1} total biomass, 23.25 q ha^{-1} grain and 31.00 q ha^{-1} straw was produced under control treatment (table 1). Reduction in RDF from 100% to 75% and 50% RDF reduced biological yield by 11.45 and 20.90 q ha^{-1} or 10.1 and 18.4%, grain yield by 7.28 and 11.38 qha^{-1} or 14.11 and 22.07% and straw yield by 6.30 and 11.65 q ha^{-1} or 9.9 and 18.3%, respectively. It shows that effect of fertilizers was more pronounced on grain yield compared to straw production. Among integrated nutrient treatments, T_8 produced highest grain yield closely followed by T_7 and T_6 treatments. Though, their yield level was in between 95.5 and 92.8% of yield with 100% RDF ($\mathbf{T_2}$). In general, all integrated nutrient treatments of 50% RDF ($\mathbf{T_9}$-$\mathbf{T_{12}}$) and $\mathbf{T_5}$ of 75% RDF caused remarkable reduction in grain yield compared with 100% RDF ($\mathbf{T_2}$) by 6.58 to 16.54 q ha^{-1} or 12.7 to 32.0%. It may also be seen from grain yield increase margins over control (table 1) that 100% RDF ($\mathbf{T_2}$) showed 122.5% increase followed by $\mathbf{T_8}$, $\mathbf{T_7}$ and $\mathbf{T_6}$ with 112.5, 107.7 and 106.5% increase in grain yield over control, respectively.

All other integrated nutrient treatments could increase grain yield over control by the margins from 51.4 to 94.2%. These results have an indications that with integration of vermicompost @ 2.5 t ha^{-1} + 25 kg ha^{-1} $ZnSO_4$ or seed treatment with biofertilizers may give almost at par grain production with 100% RDF alone. Thus the 25% dose of N,P,K fertilizers may be reduced by integrated use of vermicompost + $ZnSO_4$ or biofertilizers without any reduction in grain yield. The higher yield response to 100% RDF might be attributed to poor fertility of experimental soil where chemical fertilizers at recommended dose provided sufficient nutrients to crop in readily available form while integration of vermicompost could not substitute 25% reduction in RDF. However, application of $ZnSO_4$ and / or biofertilizers alongwith vermicompost could substitute 25% RDF upto some extent and yielded near about 100% RDF. It might be due to increased nutrients availability in soil with the application of biofertilizers, $ZnSO_4$ and vermicompost thus yield improved. These results are in agreement to the findings of Kumar and Singh (2010) and Rather and Sharma (2009).

Economics

The total cost of cultivation in general was higher in integrated nutrient treatments of 50% RDF followed by those of 75% RDF and by inorganic NPK treatments (table 2). These differences are attributed mainly to the cost of vermicompost application. However, control treatment required lowest cost for wheat cultivation. Gross income was worked out highest of Rs. 99808 ha^{-1} with 100% RDF which being at par with $\mathbf{T_7}$ and $\mathbf{T_8}$ was found significantly higher then all other treatments. Though, treatment $\mathbf{T_6}$ yielded at par with $\mathbf{T_7}$ and $\mathbf{T_8}$, it could not compete in gross income with them because of higher additional cost of $ZnSO_4$. Net return was computed significantly maximum of Rs. 71493 ha^{-1} under 100% RDF ($\mathbf{T_2}$) and minimum of Rs. 18718 ha^{-1} under control treatments ($\mathbf{T_1}$). It might be attributed to higher gross income and lower cost of cultivation of 100% RDF ($\mathbf{T_2}$) than all the treatments of integrated nutrient management ($\mathbf{T_5}$-$\mathbf{T_{12}}$). Among all integrated nutrient treatments, $\mathbf{T_8}$ and $\mathbf{T_7}$ being at par with each other earned significantly higher net return then other treatments. It might be

Table 1 : Effect of integrated nutrient management on the yields and harvest index of wheat.

Treatments	Biological yield (q/ha^{-1})	Grain yield (q/ha^{-1})	Increase in grain yield over control		Straw yield (q/ha^{-1})	Harvest index (%)
			(q ha^{-1})	(%)		
T_1- Control	54.25	23.25	-	-	31.00	42.86
T_2- 100% RDF	113.35	51.73	28.48	122.5	63.75	44.80
T_3- 75% RDF	101.90	44.45	21.20	91.2	57.45	43.62
T_4- 50% RDF	92.45	40.35	17.10	73.5	52.10	43.64
T_5- 75% RDF + Vermicompost	103.49	45.15	21.90	94.2	58.34	43.63
T_6- 75% RDF + Vermicompost + $ZnSO_4$	105.63	48.00	24.75	106.5	57.63	45.44
T_7- 75% RDF + Vermicompost + biofertilizer	110.75	48.30	25.05	107.7	62.40	43.61
T_8- 75% RDF + Vermicompost + $ZnSO_4$ + biofertilizer	113.15	49.40	26.15	112.5	63.75	43.66
T_9- 50% RDF + Vermicompost	80.75	35.19	11.94	51.4	45.55	43.58
T_{10}- 50% RDF + Vermicompost + $ZnSO_4$	95.30	41.60	18.35	78.9	53.80	43.64
T_{11}- 50% RDF + Vermicompost + biofertilizer	97.65	42.60	19.35	83.2	55.05	43.63
T_{12}- 50% RDF + Vermicompost + $ZnSO_4$ + biofertilizer	103.20	45.05	21.80	93.8	58.20	43.63
S. Ed. ±	4.70	4.18	-	-	4.43	1.32
CD (P = 0.05)	10.99	9.61	-	-	10.19	3.03

RDF - Recommended dose of fertilizers *i.e.* 150 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}.
Verm - Vermicompost @ 2.5 t ha^{-1} with 75% RDF and @ 5.0 t ha^{-1} with 50% RDF fertilizer treatments.
$ZnSO_4$ - @ 25 kg ha^{-1} as per treatment.
Biofert. - Seed treatment with *Azotobacter* and phosphate solubilizing bacterium (PSB) cultures.

Table 2 : Effect of integrated nutrient management on economics of wheat cultivation (Rs./ha).

Treatments	Total cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Increased in net return over control		Benefit : cost ratio
				(Rs. ha^{-1})	(%)	
T_1- Control	24899	43617	18718	-	-	0.75
T_2- 100% RDF	28315	99808	71493	52775	281.9	2.52
T_3- 75% RDF	27225	84688	57463	38745	207.0	2.11
T_4- 50% RDF	26250	77387	51137	32419	173.2	1.95
T_5- 75% RDF + Vermicompost	30145	87906	57761	39043	208.6	1.92
T_6- 75% RDF + Vermicompost + $ZnSO_4$	30780	90036	59256	40538	216.6	1.93
T_7- 75% RDF + Vermicompost + biofertilizer	30250	94355	64105	45387	242.5	2.12
T_8- 75% RDF + Vermicompost + $ZnSO_4$ + biofertilizer	31090	97508	66418	47.700	254.8	2.14
T_9- 50% RDF + Vermicompost	31895	68814	36919	18201	97.2	1.16
T_{10}- 50% RDF + Vermicompost + $ZnSO_4$	32750	81208	48458	29740	158.9	1.48
T_{11}- 50% RDF + Vermicompost + biofertilizer	32145	83026	50881	32163	171.8	1.58
T_{12}- 50% RDF + Vermicompost + $ZnSO_4$ + biofertilizer	33050	88567	55517	36799	196.6	1.68
S. Ed. ±	-	2449	1469	-	-	0.12
CD (P = 0.05)	-	5633	3379	-	-	0.27

RDF - Recommended dose of fertilizers i.e. 150 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}
Verm - Vermicompost @ 2.5 t ha^{-1} with 75% RDF and @ 5.0 t ha^{-1} with 50% RDF fertilizer treatments
$ZnSO_4$ - @ 25 kg ha^{-1} as per treatment
Biofert. - Seed treatment with *Azotobacter* and phosphate solubilizing bacterium (PSB) cultures.

attributed to beneficial effect of biofertilizers, which with minimum cost could improve the yield and these by more net return. The integrated nutrient treatment of 50% RDF ($\mathbf{T_9}$-$\mathbf{T_{12}}$) gave significantly lower net return than the respective treatments of 75% RDF. Biofertilizers and $ZnSO_4$ were found more profitable with 50% RDF compared to 75% RDF perhaps due to low availability of NPK nutrients from 50% RDF application. Gross as well as net returns might be attributed to grain and straw yields of wheat under different treatments. Benefit: Cost ratio was found significantly highest of 2.52 under 100% RDF ($\mathbf{T_2}$) treatment followed by $\mathbf{T_8}$, $\mathbf{T_7}$ and $\mathbf{T_3}$ treatments. It might be attributed to higher net returns and comparatively lower cost of cultivation. These results corroborate with the findings of Rathore and Sharma (2009).

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