

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL FERTILITY AND PRODUCTIVITY ON WHEAT CROP

ABSTRACT

A field experiment was conducted during *Rabi* season 2013-14 and 2014-15 on sandy loam soil to study on crop research Centre Chirori of Sardar Vallabhbhai Patel University of Agriculture and Technology; Meerut (U.P.). The results revealed that application of 120% RDF of NPK were significantly higher plant height at different stages, number of spikelets spike⁻¹, Number of grains spike⁻¹, Test weight (g) than the other treatments during both the years. Application of 125% RDF recorded significantly highest grain yield 49.73 to 47.75 q ha⁻¹ during 2013-14 & 2014-15, respectively. Among the various treatments where 125% NPK was applied proved to be superior and it statistically at par with T₂ and T₁₁ in terms of growth, yield attributes and yields during first & second years. Moreover the application of organic in integration with inorganic fertilizers could also maintain the soil fertility which is much important for sustainable crop production. The organic carbon and available NPK in soil after harvest increase with the combined application of organic and inorganic with Biofertilizer. Integration of 75% NPK with VC @ 2.5 t ha⁻¹ + PSB + *Azotobacter* was found better by improving the residual soil fertility status after the harvest of wheat crop.

Keywords: *Nutrient Management, FYM, Pressmud, Vermicompost, Azotobacter, PSB, Growth, Yield and Yield Attributes.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important food crop of the world in terms of area, production and nutrition which contribute 20 per cent of total food requirement of the world population. It provides more than 19 % calories and 21 % of the protein (FAO, 2013), besides is a major source of dietary fiber in human nutrition since decades. The area under wheat increased from 12.8 M ha in 1966-67 to 29.65 M ha⁻¹ in 2013-14. While, production has also increased from 11.4 to 93.50 Mt and the productivity increased from 0.887 to 3.153 t ha⁻¹ of the (FAO, 2013). Moreover, Productivity of wheat is very low in India in comparison to major wheat producing country viz., UK (7.9 t ha⁻¹), Germany (7.8 t ha⁻¹), France (7.5 t ha⁻¹) China (4.7 t ha⁻¹)

etc. The INM refers “a system which aim to improving and maintaining soil fertility for sustaining crop productivity, and involves the use of chemical fertilizers in conjunction with organic manure rice rich input through biological process”. Incorporation of organic sources i.e. farm yard manure (FYM), vermicompost, pressmud , Biofertilizer, phosphate solubilizing bacteria (PSB) and *Azotobactor* along with chemical fertilizers is effective in increasing the nutrient availability in soil, improving physical properties of soil and its organic carbon status. On account of continuing world energy crisis and spiraling price of chemical fertilizer the use of organic manure as a renewable source of plant nutrients is assuming importance. In this endeavor proper balance of organic and inorganic fertilizer is important not only for increasing yield but also for sustaining soil health (Weber *et al.*, 2007). The integrated nutrient management favorably affects the physical, chemical and biological environment of soils. Integrated nutrient supply involving conjunctive use of inorganic fertilizers and organic sources of nutrients assumes greater significance. Farmyard manure improves the physical condition of soil by increasing water holding capacity for maximum utilization of water. It also improves the chemical and biological condition of soil by increasing cation exchange capacity and providing various hormones and organic acids which are very important for soil aggregation and for beneficial micro-organism involved in various biochemical processes and release of nutrients. The combination of organic and inorganic N sources resulted in comparable rice yield to the application of inorganic N alone. Inorganic N application increased rice yield by 45.8 % over unfertilized control. The increase in yield was due to an increase in the number of panicle per plant and panicle weight (**Rao *et al.*, 1996**).

MATERIALS AND METHODS

Field experiments were conducted during winter season 2013-14 and 2014-15 at CRC Farm Chirrori, Sardar Vallabhbhai Patel Agriculture University Meerut. The soil was sandy loam having organic carbon 0.56 and 0.54% with pH 8.25 and 8.10, available N 241 kg ha⁻¹ and 240 kg ha⁻¹, available P₂O₅ 13.60 and 13.33 kg ha⁻¹ and available K₂O 208.6 kg ha⁻¹ and 206.25 kg ha⁻¹ at the start of the experiment in 0 to 30 cm soil layer during 2013-14 and 2014-15 respectively. The experiment consists of thirteen treatments *viz.*, T₁ (Control), T₂ (100 % NPK) , T₃ (75% NPK + FYM @ 7.5 t ha⁻¹) , T₄ (75 % NPK + vermicompost @ 2.5 t ha⁻¹), T₅ (75 % NPK + Press mud 3.0

$t\ ha^{-1}$), T_6 (75 % NPK + Press mud @ $1.5\ t\ ha^{-1}$ + FYM @ $3.75\ t\ ha^{-1}$), T_7 (75 % NPK + vermicompost @ $1.25\ t\ ha^{-1}$ + Press mud @ $1.50\ t\ ha^{-1}$), T_8 (75 % NPK + vermicompost @ $1.25\ t\ ha^{-1}$ + FYM @ $3.75\ t\ ha^{-1}$), T_9 (75 % NPK + *Azotobacter* + PSB), T_{10} (75 % NPK + FYM @ $7.5\ t\ ha^{-1}$ + PSB + *Azotobacter*), T_{11} (75 % NPK + vermicompost @ $2.5\ t\ ha^{-1}$ + PSB + *Azotobacter*), T_{12} (75 % NPK + press mud @ $3.0\ t\ ha^{-1}$ + PSB + *Azotobacter*), T_{13} (125% NPK). The experiment was laid out in Randomized Block Design with three replications. Vermicompost was applied 15 days before sowing as per treatment. Wheat cultivar PBW-550 was sown in rows 20 cm apart on 12 Nov. in 2013-14 and 14 Nov. in 2014-15 and harvested on 15 March in 2013-14 and 12 March in 2014-15 respectively. Half of nitrogen and full dose of phosphorus and potash were applied at the time of sowing as per treatment combination. The remaining nitrogen as per treatment was top dressed after first irrigation. N, P, and K were applied through urea, single super phosphate and muriate of potash respectively. The seeds were inoculated with phosphate solubilizing bacteria (PSB) i.e. *Pseudomonas strata* before sowing as per treatments. The crop received three uniform irrigations (at Crown Root Initiation, flowering and milking stages). Postharvest soil samples were drawn and analyzed for organic carbon by wet digestion method (Walkley and Black 1934), available N by alkaline permanganate method (Subbiah and Asija 1956), available phosphorus (P) by 0.5 M $NaHCO_3$ Extractable Olsen's Colorimetric method (Olsen's 1965) and available potassium (K) by neutral normal ammonium acetate method (Jackson, 1973) The treatment comparisons were made using t-test at 5% level of significance. The economics was calculated on the basis of prevailing local market price of wheat grains and cost of inputs.

RESULTS AND DISCUSSION

Plant height increased at a faster rate between 60-90 DAS as affected significantly by different nutrient treatments. The plant height was significantly affected at 30, 60, 90 DAS and at harvest in different treatments (Table 1). The Application of 125% NPK produced maximum plant height which was at par 75% NPK with Vermicompost @ $2.5\ t\ ha^{-1}$ + PSB + *Azotobacter*. Control plots produced shorter plant at all the growth stages. The higher plant height with the application of 125% NPK and 75% NPK + vermicompost @ $2.5\ t\ ha^{-1}$ + PSB + *Azotobacter*, can be associated with sufficient nutrient supply at the active growth stage. Similar results of increased plant height with increasing nutrient level were also reported by Singh *et al.* (2008)

reported that the treatments consisted of FYM, vermicompost, green manure, *Azotobacter*, phosphate solubilizing bacteria (PSB) and NPK fertilizers.

Yield attributes:

Significantly higher number of spikelet per spike, number of grains per spike and test weight recorded with the application of 125% NPK which was at par with 75% NPK with vermicompost @ 2.5 t ha⁻¹ + PSB + *Azotobacter* (Table 2). It might be due to stimulated vegetative growth of wheat on account of adequate and prolonged supply of essential nutrients. Afzal *et al.* (2005) also reported that PSB along with organic manures or with other combinations significantly increased the number of tillers m⁻². These results are in line with the findings of Kumar *et al.* (1999) who reported significant increase in number of plants per metre row by inoculation of *Azotobacter chroococcum*. Integrated nutrient management had beneficial effect on yield attributes, the maximum value of all yield attributes of rice and wheat were recorded under treatment receiving 100% NPK + 5 t FYM ha⁻¹ followed by 75% NPK + 5 t FYM ha⁻¹ as compared to 100% NPK. The better crop growth with combined use of nutrient may be attributed to improvement in physico-chemical and biological properties of soil which maintained continuous supply of nutrient to crop. Similar higher values of yield attributes with combined use of inorganic + organic source of nutrients was reported by Davari and Sharma (2012).

Yield (q ha⁻¹):

The grain yield of wheat which ranged from 26.52 to 49.73 and 24.57 to 47.75 q ha⁻¹ during 2013-14 and 2014-15, respectively was influenced significantly by different treatments (Table 2). The maximum grain yield 47.75 to 49.73 q ha⁻¹ during first and second year, respectively recorded with the application was 125% NPK was found statistically at par with treatment T₂, T₁₁ during both the years. The minimum yield of wheat 24.57 to 26.52 q ha⁻¹ was recorded from the treatment under control. The effect of FYM, vermicompost and presumed application with 75% NPK was not similar and the grain yield in 75% NPK + vermicompost 2.5 t ha⁻¹ was significantly higher than 75% NPK + FYM or pressmud. Grain yield was statistically similar in the treatments receiving 100% NPK and 75% NPK + vermicompost. The effect of

121 biofertilizers inclusion with 75 % NPK was not appreciable but when biofertilizers were applied
 122 with vermicompost it yielded statistically at par to T₁₃ during both the years. This might be due to
 123 immediate and quick supply of plant nutrients through chemicals for crop growth and steady
 124 supply of plant nutrient by organics throughout growing period. The FYM released nutrients
 125 following decomposition and mineralization that would have increased the availability of plant
 126 nutrients at later stage and brought improvement in physical, chemical and biological properties
 127 of soil. As a result the fertility status of soil might have increased and thus increasing the
 128 absorption of plant nutrients.

129 **EFFECT ON SOIL NUTRIENT STATUS**

130 The application of 75 % NPK +Vermicompost @ 2.5 t ha⁻¹ + PSB + *Azotobacter* significantly
 131 increase the Organic carbon, available nitrogen, phosphorus and potash status of the soil (Table
 132 3). which was found at par with 75% NPK with vermicompost @ 2.5 t ha⁻¹. Available NPK of soil
 133 after the harvest of wheat were found to be maximum with the application of 75 % NPK
 134 +Vermicompost @ 2.5 t ha⁻¹ + PSB + and the lowest from Control. It might be due to the
 135 application of vermicompost and PSB which enhances the activity of some microbial populations
 136 and there was a high level of total N in experimental plot. Pandey *et al.*, (2009) also reported that
 137 addition of organic manure (FYM) with fertilizer levels significantly increased the nutrient uptake
 138 by wheat, improved the organic carbon content N, P and K status as compare to chemical
 139 fertilizer alone.

140 **Economics:**

141 The highest cost of cultivation 37374 and 38675 Rs ha⁻¹ was found in T₁₁ where 75%
 142 NPK with vermicompost @ 2.5 t ha⁻¹+PSB + *Azotobacter* was applied which was minimum cost
 143 of cultivation than the rest of the treatments Rs. 24558 and Rs. 24558 Rs. ha⁻¹during 2013-14 and
 144 2014-15, respectively was found recorded control (Table 4). The highest gross return Rs. 90591
 145 and Rs. 920228 ha⁻¹, Net return Rs. 60025 and Rs. 62924 ha⁻¹ and benefit: cost ratio 2.03 and 2.09
 146 was found in T₁₁ (75 % NPK +Vermicompost @ 2.5 t ha⁻¹ + PSB + *Azotobacter*) while minimum
 147 gross return Rs. 52188 and Rs. 51563 ha⁻¹, net return Rs. 27630 and Rs. 27005 ha⁻¹ and benefit

cost ratio 1.13 and 1.10 during 2013-14 and 2014-15, respectively. The observation is in conformity with those reported by Pandey *et al* (1999) and Singh and Singh (2001) who also reported a higher benefit ratio while using INM. Suthar (2006) reported that integrated application of NPK fertilizers along with vermicompost in field crops not only influences growth and production of plant but at the same time also reduces the production budget.

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Table: 1 Effect of integrated nutrient management on plant height (cm) of wheat at various stages.

Treatment	30 DAS		60 DAS		90 DAS		At harvest	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Control	13.84	13.20	43.11	42.45	65.83	63.83	68.17	66.50
100 % Recommended dose of NPK	17.19	16.22	59.13	58.47	84.48	83.46	86.80	86.10
75% NPK + FYM @ 7.5 t ha ⁻¹	16.43	16.29	58.86	58.2	83.58	82.58	85.9	85.23
75 % NPK + Vermicompost @ 2.5 t ha ⁻¹	17.07	16.20	59.70	59.03	85.32	84.32	87.65	86.98
75 % NPK + Press mud 3.0 t ha ⁻¹	16.07	15.25	56.17	55.52	80.70	76.37	83.03	78.70
75 % NPK + Press mud @ 1.5 t ha ⁻¹ + FYM @ 3.75 t ha ⁻¹	16.27	16.07	57.08	56.41	80.00	78.90	85.57	81.57
75 % NPK + Vermicompost @ 1.25 t ha ⁻¹ + Press mud @ 1.50 t ha ⁻¹	16.76	16.39	57.37	56.72	81.97	80.97	84.3	83.63
75 % NPK + Vermicompost @ 1.25 t ha ⁻¹ + FYM @ 3.75 t ha ⁻¹	16.97	16.80	58.53	57.88	82.63	81.63	84.95	84.28
75 % NPK+ <i>Azotobacter</i> + PSB	15.73	15.52	55.25	54.58	76.50	75.50	82.17	78.17
75 % NPK+ FYM @ 7.5 t ha ⁻¹ + PSB+ <i>Azotobacter</i>	16.97	16.27	61.47	60.8	86.05	85.06	88.33	87.36
75 % NPK + vermicompost @ 2.5 t ha ⁻¹ + PSB + <i>Azotobacter</i>	17.27	17.12	62.01	61.34	87.32	86.32	89.65	88.98
75 % NPK + press mud @ 3.0 t ha ⁻¹ + PSB+ <i>Azotobacter</i>	16.22	15.92	56.62	55.96	79.12	78.12	81.43	80.77
125% Recommended dose of NPK	18.47	17.41	63.10	62.43	89.37	88.39	91.73	90.37
SEm(±)	0.39	0.59	0.83	0.91	1.42	0.86	1.59	1.04
C.D. (P=0.05)	1.66	1.75	2.44	2.69	4.17	2.54	4.69	3.06

Table: 2 Effect of integrated nutrient management on yield attributes and yield of wheat crop

Treatment	Grain Yield (q ha ⁻¹)		Spike length (cm)		No of spikelets/spike		No. of grains/spike		Test weight (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Control	26.52	24.57	6.65	6.43	8.33	8.23	28.80	27.65	31.18	30.85
100 % RDF of NPK	47.12	46.02	10.75	10.65	13.85	13.52	45.97	45.58	45.84	45.62
75% NPK + FYM @ 7.5 t ha ⁻¹	40.54	38.60	10.32	10.30	13.50	13.28	42.97	42.50	45.18	44.56
75 % NPK + VC @ 2.5 t ha ⁻¹	44.40	42.61	10.19	9.88	12.45	12.20	40.40	39.75	43.58	42.84
75 % NPK + PM 3.0 t ha ⁻¹	37.47	36.73	8.93	8.85	11.25	10.78	38.00	37.56	40.77	40.60
75 % NPK + PM @ 1.5 t ha ⁻¹ + FYM @ 3.75 t ha ⁻¹	39.32	37.73	9.73	9.68	11.56	11.20	39.23	38.10	42.94	42.75
75 % NPK + VC @ 1.25 t ha ⁻¹ + PM @ 1.50 t ha ⁻¹	41.62	39.70	10.00	9.90	12.51	12.30	41.30	40.85	43.89	43.50
75 % NPK + VC @ 1.25 t ha ⁻¹ + FYM @ 3.75 t ha ⁻¹	45.08	43.68	10.58	10.48	13.68	13.45	45.60	45.12	45.28	44.26
75 % NPK+ <i>Azotobacter</i> + PSB	36.63	35.73	8.67	8.47	10.85	10.50	37.90	36.83	40.65	40.28
75 % NPK+ FYM @ 7.5 t ha ⁻¹ + PSB+ <i>Azotobacter</i>	42.34	40.55	9.94	10.12	12.58	11.95	42.07	41.21	45.10	44.37
75 % NPK + VC @ 2.5 t ha ⁻¹ + PSB + <i>Azotobacter</i>	47.82	45.68	11.12	11.10	14.23	13.80	46.43	45.30	45.99	45.65
75 % NPK + PM @ 3.0 t ha ⁻¹ + PSB + <i>Azotobacter</i>	38.80	37.08	9.53	9.48	11.43	11.10	38.30	37.10	42.33	41.64
125% RDF of NPK	49.73	47.75	11.38	11.27	14.56	13.86	49.27	47.42	48.47	47.78
SEm(±)	0.99	0.78	0.44	0.43	0.53	0.52	0.61	0.58	1.67	1.65
C.D. (P=0.05)	2.92	2.30	1.29	1.28	1.57	1.53	4.73	4.65	4.91	4.85

198 **Table: 3 Effect of integrated nutrient management on soil nutrient status after harvest of wheat crop**

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Treatment	OC %		Available N kg ha ⁻¹		Available P ₂ O ₅ kg ha ⁻¹		Available K ₂ O kg ha ⁻¹	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Control	0.43	0.42	140.17	135.47	7.45	6.85	125.73	124.35
100 % RDF of NPK	0.58	0.57	189.43	188.67	15.45	15.10	208.33	207.13
75% NPK + FYM @ 7.5 t ha ⁻¹	0.65	0.65	184.87	183.80	14.65	14.25	198.73	197.5
75 % NPK + VC @ 2.5 t ha ⁻¹	0.74	0.74	183.03	183.03	12.45	12.20	201.22	200.35
75 % NPK + PM 3.0 t ha ⁻¹	0.73	0.73	172.43	171.80	10.80	10.50	190.40	189.27
75 % NPK + PM @ 1.5 t ha ⁻¹ +FYM @ 3.75 t ha ⁻¹	0.64	0.64	175.90	175.27	12.10	11.75	193.53	192.85
75 % NPK + VC @ 1.25 t ha ⁻¹ + PM @1.50t ha ⁻¹	0.67	0.66	181.87	181.13	12.83	12.25	198.90	197.42
75 % NPK + VC @ 1.25 t ha ⁻¹ + FYM @3.75 t ha ⁻¹	0.70	0.70	186.23	185.50	14.72	14.42	204.30	202.90
75 % NPK+ <i>Azotobacter</i> + PSB	0.69	0.69	170.60	170.13	10.45	10.25	189.60	188.77
75 % NPK+ FYM @ 7.5 t ha ⁻¹ + PSB+ <i>Azotobacter</i>	0.67	0.67	177.17	176.53	13.55	13.10	196.90	195.37
75 % NPK + VC @ 2.5 t ha ⁻¹ + PSB + <i>Azotobacter</i>	0.74	0.74	188.43	187.87	15.85	15.45	210.12	208.83
75 % NPK + PM @ 3.0 t ha ⁻¹ +PSB+ <i>Azotobacter</i>	0.64	0.62	174.23	173.47	11.54	11.07	194.70	193.63
125% RDF of NPK	0.61	0.60	191	190.4	16.5	15.72	212.43	210.23
SEm(±)	0.013	0.011	1.68	1.67	0.49	0.48	1.39	1.34
C.D. (P=0.05)	0.039	0.035	4.94	4.91	1.45	1.41	4.09	3.94

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203 **Table: 4 Effect of integrated nutrient management on Cost of cultivation, Gross return, Net returns and B: C**
204 **ratio of wheat.**

Treatment	Cost of Cultivation (Rs ha ⁻¹)		Gross Returns (Rs ha ⁻¹)		Net returns (Rs ha ⁻¹)		B:C ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Control	24558	24558	52188	51563	27630	27005	1.13	1.10
100 % RDF of NPK	29516	30098	89541	93022	60025	62924	2.03	2.09
75% NPK + FYM @ 7.5 t ha ⁻¹	30150	30525	78033	79312	47883	48787	1.59	1.60
75 % NPK + VC @ 2.5 t ha ⁻¹	37025	38275	84890	86703	47865	48428	1.29	1.27
75 % NPK + PM 3.0 t ha ⁻¹	30975	31275	72864	76103	41889	44828	1.35	1.43
75 % NPK + PM @ 1.5 t ha ⁻¹ +FYM @ 3.75 t ha ⁻¹	30562	30900	76191	77875	45629	46975	1.49	1.52
75 % NPK + VC @ 1.25 t ha ⁻¹ + PM @1.50t ha ⁻¹	34000	34775	80303	81362	46303	46587	1.36	1.34
75 % NPK + VC @ 1.25 t ha ⁻¹ + FYM @3.75 t ha ⁻¹	33587	34425	85883	88520	52296	54095	1.56	1.57
75 % NPK+ <i>Azotobacter</i> + PSB	28625	28675	71405	74319	42780	45644	1.49	1.59
75 % NPK+ FYM @ 7.5 t ha ⁻¹ + PSB+ <i>Azotobacter</i>	30500	30925	81851	82733	51351	51808	1.68	1.68
75 % NPK + VC @ 2.5 t ha ⁻¹ + PSB + <i>Azotobacter</i>	37374	38675	90591	92028	53217	53353	1.42	1.38
75 % NPK + PM @ 3.0 t ha ⁻¹ +PSB+ <i>Azotobacter</i>	31325	31675	75318	76680	43993	45005	1.40	1.42
125% RDF of NPK	30750	31483	93515	95437	62765	63954	2.02	2.03