Impact assessment of farmyard manures and microbial inoculants superimposed over inorganic fertilizers on the production and productivity of wheat (*Triticum aestivum* L.)

V.K. Verma, Vishram Singh, Ram Pyare, A.K. Srivastava, D. D. Yadav, Ramakant Yadav and Pyush Goyal

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ABSTRACT

An experiment was conducted during two consecutive winter seasons (Rabi) of 2011-12 and 2012-13 to assess the response of superimposed nutritional levels consisted vermicompost @ 5t/ha, FYM @ 10 t/ha, seed inoculation with Azotobacter and PSB, individually and in combination over recommended dose of fertilizers in wheat crop under irrigated condition. The response of fertility levels was analyzed on growth characters, yield attributes and yield as well as economic parameters of normally sown wheat variety PBW-502. Seven superimposed fertility levels compared with only recommended dose of fertilizer treatment (control) laid out in Randomized Block Design replicated three times. The soil of field was sandy loam in texture, deficient in nitrogen, medium in phosphorus and potash. The integration of vermicompost, FYM, Azotobacter & PSB along with inorganic fertilizers dose in different treatments exhibited significant response in terms of increasing grain yield of wheat from 12.66 to 18.36 percent and 16.21 to 27.90 percent compared to control treatment which recorded lowest 46.29 and 41.33 q/ha grain yield during 2011-12 and 2012-13, respectively. Treatment-8 (RDF + vermicompost 5.0 t/ha + Azotobacter and PSB as seed treatment and spraying at Ist and IInd irrigation) recorded maximum grain yield (56.70 and 57.33 q/ha), straw yield (72.92 and 88.67 q/ha), gross income (Rs. 87443.50 and Rs. 97127.50/ha) and net income (Rs. 37001 and Rs. 45462) during 2011-12 and 2012-13, respectively.

Key words: Irrigated wheat, vermicompost, FYM, Azotobacter & PSB, grain yield.

V.K. Verma Asso. Prof. (videshkumarverma@gmail.com),
Vishram Singh, Asst. prof,
Ram Pyare, Prof., (rampyare2012@rediffmail.com),
A.K. Srivastava Asso. Prof.,
D.D. Yadav, Prof.
Ramakant Yadav (Student)
Pyush Goyal (Student)
Department of Agronomy, C.S. Azad Univ. of Agric. & Tech., Kanpur

Introduction:

Wheat is one of the first cereal known to have been domesticated and it was a key factor enabling the emergence of city based societies at the start of civilization because it was the one of the first crop that could be easily cultivated on a large scale and had the additional advantage of yielding a harvest that provides long term storage of food. The global production of wheat is 647 mt. provides 20% of humanity's dietary energy supply and serving as the main source of protein in developing nations (Braun *et al.* 2010). The demand for wheat follows rapidly growing population and is expected to increase by 60% in the third world by 2050. India is the second largest wheat producing country in the world, contributing about 34% to the total food grain production. During 1964-65 wheat production was 12.3 mt. which has gone up to 92.46 mt. during 2012-13 (Economic Survey 2012-13). This production increase has come from a constant production area of around 29.9 mha.

A major driver for yield improvement of wheat, especially in intensive agricultural system in India is nitrogen fertilizer. Canopy growth requires nitrogen and it is canopy photosynthesis that ultimately drives yield. Indian soils are generally deficient in nutrients particularly nitrogen and intensive cultivation of crops in Indo-Gangetic Plains leads to create deficiency of all major as well as minor nutrients. Lack of organic matter in soil also leads to create soil sickness and low productivity. Conjunctive use of all major nutrients in inorganic form as well as organic source with microbial inoculants is the only option for sustaining wheat production and productivity. During last one and half decade the practice of reducing doses of inorganic fertilizers by 25-30 per cent, with complementary doses of organic manures did not achieve sustainability in wheat production. The superimposition of organic manures, microbial inoculants along with recommended doses of inorganic fertilizers catching attention of scientific community world over. Thus keeping above points in view the present investigation was formulated to increase production and productivity of wheat and to find out suitable soil fertility management package in alluvial soil of Uttar Pradesh.

Materials and methods:

The field experiments were conducted during two consecutive rabi season of 2011-12 and 2012-13 at Students instructional Farm of C.S. Azad University of Agriculture and

Technology, Kanpur, situated at 250 56` to 260 58` latitude north and 790 31` to 800 34` longitude East and 125 metre above mean sea level with semi-arid subtropical climate having dry hot summer and cold winter. The soil of experimental field was sandy loam (20.50% clay, 22.4% silt and 56.35% sand) of Indo Gang etic alluvial origin having pH 7.75, EC 0.25 dsm-1, well drained flat. Initial soil sample analysis determined organic carbon (0.44%), available nitrogen (170.0 kg/ha), P2O5 (17.8 kg/ha) and K2O (165.0 kg/ha) in experimental field.

Eight treatments of superimposed nutritional doses of organic manure, microbial inoculants over inorganic fertilizer doses were selected for the experiment. The treatments consisted RDF + vermicompost @ 5.0 t/ha (T2), RDF + FYM @ 10 t/ha (T3), RDF + seed treatment with azotobacter & PSB (T4), RDF + vermicompost @ 5.0 t/ha + seed treatment with azotobacter & PSB (T5), RDF + FYM @ 10 t/ha + seed treatment with Azotobacter & PSB (T6), RDF + vermicompost @ 5.0 t/ha + azotobacter & PSB as seed treatment and spraying at 1st irrigation (T7), RDF + vermicompost @ 5.0 t/ha +Azotobacter & PSB as seed treatment and spraying at 1st and 2nd irrigation (T8) were compared with only recommended dose of fertilizers (150 N : 60 P2O5 : 40 K2O : 20 S : 20 Zn kg/ha) treatment (T1). The farm yard manure and vermicompost doses were mixed in the soil before sowing and azotobacter & PSB were used as seed treatment as well as sprayed on soil after 1st and 2nd irrigation treatment wise. The treatments were replicated three times and evaluated under Randomized Block Design.

The wheat variety ‘PBW-502’ was selected for experiments. Prier to sowing seed was inoculated with Azotobacter and PSB and sown at the row spacing of 20 cm apart. The crop was irrigated with four irrigations at critical stages. To provide weed free condition during the critical growth period of the crop, sulphosulfuran was applied @ 33 g/ha and sprayed after 1st irrigation at 30 days after sowing.

In order to analyze the effect of different treatments four plants were randomly selected from each plot for taking observations regarding individual plant growth characters, yield attributes, and yield data. All the data were statistically analyzed separately. Critical difference and coefficient of variation were computed to determine statistically significant treatment difference.

$$CD = (\sqrt{2VEr^{-1}}) \times t\ 5\%$$

Where, VE is the error variance, r is the replications, t5% is the total value of t at 0.05 level of significance at error degree of freedom. MSTAT software (Freed *et al.*, 1991) was used for statistical analysis.

Results and discussion

Growth and yield attributes:

The data pertaining to growth characters and yield attributes were summarized in Table 1. The superimposed nutritional level treatments showed the response in terms of increasing plant height, the number of tillers/plant, spike length, the number of grains per spike and test weight of wheat grain compared to control treatment in both years. The maximum plant height (85.66 and 87.26 cm), number of tillers per plant (5.26 and 7.33), spike length (8.93 and 9.53 cm), number of grains per spike (62.40 and 60.00) and test weight of grains (43.45 and 43.68 g) were recorded during 2011-12 and 2012-13, respectively, in treatment eight (T8) having superimposed doses of vermicompost + split doses of Azotobacter and PSB over recommended dose of fertilizers, while, minimum plant height (83.53 and 84.13 cm), number of tillers per plant (4.33 and 4.86), spike length (7.52 and 7.93 cm), number of grains per spike (53.53 and 49.33) and test weight of grains (38.13 and 38.91 g) during 2011-12 and 2012-13, respectively, in control treatment (T1) having only recommended dose of fertilizers. The improvement in growth characters and yield attributes viz., plant height, number of tillers, spike length etc. by integrated use of organic manure, Azotobacter and PSB with recommended dose of fertilizers was reported by Singh et al. (2013), Singh and Prasad (2011) and Rather and Sharma (2010) etc.

Yield:

The minimum biological yield (108.79 and 116.66 q/ha in 2011-12 and 2012-13, respectively) was recorded in control treatment (T1) and maximum biological yield (129.62 and 146.00 q/ha in 2011-12 and 2012-13, respectively) recorded in treatment eight (T8) shows significantly superior over T1, T2, T3, and T4 while T5, T6, and T7 were significantly at par compared to T8. The maximum grain yield (56.70 and 57.33 q/ha during 2011-12 and 2012-13,

respectively) was recorded in treatment eight (T8), followed by T7, T6 and T5 were significantly at par with T8 but significantly superior over T2, T3 and T4, while, minimum grain yield (46.29 and 41.33 q/ha during 2011-12 and 2012-13 respectively) was recorded in control treatment (T1). The straw yield was also recorded in the similar trend. The harvest index was recorded minimum (42.55% and 35.43% during 2011-12 and 2012-13 respectively) in the control treatment (T1) while maximum harvest index (43.74% and 39.27% during 2011-12 and 2012-13, respectively) recorded under treatment-8. similar findings were reported by Nag and Roy (2008) and Bhatnagar and Kaurav (2007).

Economics:

The economic parameters of crop performance like the cost of cultivation, gross return and net return (Table 3) data revealed that superimposed fertility levels increased

not only the cost of cultivation but gross return and net return also increased. The minimum cost of cultivation (Rs. 42576.27 and 42581.47), gross return (71980.65 and 72855.50) and net return (Rs. 29404.38 and Rs. 30278.03) during 2011-12 and 2012-13, respectively, was recorded in control treatment (RDF only) and maximum cost of cultivation (Rs. 50442.48 and

Rs.51665.67), gross return (Rs. 87443.50 and Rs. 97127.50) and net return (Rs. 37001.02 and Rs. 45461.83) during 2011-12 and 2012-13, respectively, was computed in treatment-8. The super imposition of organic manure, microbial inoculants over recommended dose of fertilizer in treatment eight increases cost to the tune of 15.59% and 17.58%, but leads increment in gross return up to 17.68% and 24.98%, net return up to 20.53% and 33.40% during 2011-12 and 2012-13, respectively, compared to control treatment (T1). The benefit-cost ratio computed minimum (1.64 during 2011-12 and 2012-13) in treatment three (RDF + FYM) due to higher cost and low return. The maximum benefit-cost ratio 1.73 and 1.87 during 2011-12 and 2012-13, respectively, was computed in treatment eight Similar findings were reported by Yadav and Kumar (2009) and Mavi and Benbi (2008) etc.

Conclusion:

Based on the above results and supporting the view of different scientists, it can be concluded that superimposition of organic manure (vermicompost, FYM) and microbial

supplements (Azotobacter and PSB) in combination over recommended dose of fertilizers found more beneficial than individually. The most appropriate combination of superimposition of vermicompost @ 5 t/ha + Azotobacter and PSB as seed treatment and spraying at 1st and 2nd irrigation along with recommended dose of fertilizers in treatment-8 was found to be most productive in terms of maximum growth, yield attributes and yield q/ha, most profitable in terms of maximum gross and net income (Rs./ha) in wheat crop.

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Table 1: Effect of superimposed nutritional levels on growth characters and yield attributes of irrigated wheat

S. No.	Treatments (Nutritional levels)	Initial plant population/m²		Plant height at maturity (cm)		Number of tillers/plant at 45 DAS		Spike length (cm)		Number of grains per spike		Test weight of grains (g)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
1.	T_1- RDF (recommended dose of fertilizers) (150:60:40:20:20 NPK S Zn	158.10	157.43	83.53	84.13	4.33	4.86	7.52	7.93	53.53	49.33	38.13	38.91
2.	T_2- RDF + vermicompost @ 5.0 t/ha	159.10	158.90	83.86	85.36	5.16	5.93	8.34	9.00	59.73	57.33	41.16	41.21
3.	T_3- RDF + FYM @ 10.0 t/ha	157.13	158.23	83.66	84.56	4.80	5.40	8.25	9.00	58.13	57.33	41.76	38.34
4.	T_4- RDF + seed treatment with Azotobacter and PSB	158.34	158.85	83.93	84.70	5.06	5.26	8.32	8.83	59.33	52.00	41.38	38.64
5.	T_5- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB	158.67	159.10	84.06	85.86	5.23	5.86	8.60	8.16	59.80	57.33	42.58	40.09
6.	T_6- RDF + FYM @ 10.0 t/ha + seed treatment with Azotobacter and PSB	157.67	160.69	84.53	86.20	5.36	5.80	8.75	9.36	59.93	58.33	42.77	40.83
7.	T_7- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB & spraying at 1st irrigation	161.05	160.39	85.13	86.76	5.26	6.33	8.76	8.83	60.66	60.00	43.23	42.09
8.	T_8- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB & spraying at 1st & 2nd irrigation	162.05	160.82	85.66	87.28	5.26	7.33	8.93	9.53	62.40	60.00	43.45	43.68
9.	SE (d)	1.13	0.56	0.26	0.53	0.28	0.64	0.29	0.45	1.64	1.96	1.43	1.00
10.	CD at 5%	2.46	1.26	0.57	1.15	0.62	1.36	0.64	0.97	3.56	3.96	3.11	2.14

Table 2: Effect of superimposed nutritional levels on yield (q/ha) and harvest index (%)of irrigated wheat

S. No.	Treatments (Nutritional levels)	Biological yield (q/ha)		Grain yield (q/ha)		Straw yield (q/ha)		Harvest index (%)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
1.	T_1- RDF (recommended dose of fertilizers) (150:60:40:20:20 NPK S Zn	108.79	116.66	46.29	41.33	62.51	75.33	42.55	35.43
2.	T_2- RDF + vermicompost @ 5.0 t/ha	121.52	127.33	53.00	49.33	68.52	78.00	43.61	38.74
3.	T_3- RDF + FYM @ 10.0 t/ha	120.36	126.00	51.61	46.66	68.75	79.34	42.92	37.03
4.	T_4- RDF + seed treatment with Azotobacter and PSB	116.00	122.00	49.50	44.00	66.50	78.00	42.67	36.07
5.	T_5- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB	126.15	139.33	54.39	52.66	71.76	86.67	43.12	37.80
6.	T_6- RDF + FYM @ 10.0 t/ha + seed treatment with Azotobacter and PSB	127.31	134.00	55.32	53.06	71.99	80.94	43.45	39.60
7.	T_7- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB & spraying at 1st irrigation	128.47	140.66	55.55	54.40	72.92	86.26	43.24	38.67
8.	T_8- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB & spraying at 1st & 2nd irrigation	129.62	146.00	56.70	57.33	72.92	88.67	43.74	39.27
9.	SE (d)	2.86	5.28	1.00	3.46	1.20	3.79	-	-
10.	CD at 5%	6.15	11.33	2.16	7.43	2.60	8.15	-	-

Table 3: Effect of superimposed nutritional levels on cost of cultivation, gross return, net return and B:C ratio of irrigated wheat

S. No.	Treatments (Nutritional levels)	Cost of cultivation (Rs./ha)		Gross return (Rs./ha)		Net return (Rs./ha)		B.:C ratio	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
1.	T_1- RDF (recommended dose of fertilizers) (150:60:40:20:20 NPK S Zn	42576.27	42581.47	71980.65	72855.50	29404.38	30278.03	1.69	1.71
2.	T_2- RDF + vermicompost @ 5.0 t/ha	48802.50	49471.40	81809.00	84195.50	33006.50	36724.10	1.67	1.70
3.	T_3- RDF + FYM @ 10.0 t/ha	48611.81	49191.10	80068.85	80857.00	31457.40	31665.90	1.64	1.64
4.	T_4- RDF + seed treatment with Azotobacter and PSB	43237.77	43911.24	76907.50	77000.00	33669.73	33088.76	1.77	1.75
5.	T_5- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB	49191.57	50991.10	84243.15	90423.00	35051.58	39431.90	1.71	1.77
6.	T_6- RDF + FYM @ 10.0 t/ha + seed treatment with Azotobacter and PSB	49327.78	51050.34	85484.20	89817.00	36156.42	38766.66	1.73	1.76
7.	T_7- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB & spraying at 1st irrigation	49832.03	51250.68	85963.75	92692.00	36131.72	41441.32	1.72	1.80
8.	T_8- RDF + V.C. @ 5.0 t/ha + seed treatment with Azotobacter and PSB & spraying at 1st & 2nd irrigation	50442.48	51665.67	87443.50	97127.50	37001.02	45461.83	1.73	1.87