International Journal of Agricultural Sciences
Volume **10** | Issue 2 | June, 2014 | 735-738
e ISSN-0976-5670 | Visit us | *www.researchjournal.co.in*

RESEARCH PAPER

Effect of integrated soil fertility management practices on production and productivity of wheat (*Triticum aestivum*) in alluvial soils of central plain zone of Uttar Pradesh

V.K. VERMA, SANJAI CHAUDHRY*, VIHSRAM SINGH, S.K. GUPTA **AND** HARVANSH KUMAR
Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, KANPUR (U.P.) INDIA
(Email : drsanjaychaudhry@hotmail.com)

Abstract : An investigation on integrated soil fertility management practices in wheat crop was conducted during *Rabi* season of 2011-12 at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur. The treatment consisted of seven super imposed doses of vermicompost @ 25.0 t/ha, farm yard manure @ 10.0 t/ha, *Azotobacter* and PSB as individual and in combination with recommended dose of fertilizer treatment (150 N : 60 P_2O_5 : 40 K_2O : 20 S : 20 Zn, kg/ha). The experiment was laidout in Randomized Block Design and treatments replicated three times. The soil of field was sandy loam in texture, deficient in nitrogen, medium in phosphorus and potash. The wheat variety Mahi (K-402) was sown on 12th December, 2011. The response of integrated soil fertility treatments was analysed on growth parameters, yield attributes and yield as well as economic parameters of wheat crop. All the super imposed fertility treatments responded well in terms of increase in yield of wheat crop to the tune of 6.93 per cent to 22.48 per cent compared to control treatments. The results revealed that the treatment consisted of recommended dose of fertilizers + vermicompost @ 5.0 t/ha + *Azotobacter* and PSB as seed treatment and sprayed at 1st and 2nd irrigation (T-8) registered highest grain yield (56.70 q/ha) of wheat followed by RDF + vermicompost @ 5.0 t/ha + *Azotobacter* and PSB as seed treatment ad sprayed under 1st irrigation (55.55 q/ha), RDF + FYM @ 10.0 t/ha + *Azotobacter* and PSB as seed treatment (55.32 q/ha) were significantly at par, RDF + vermicompost @ 5.0 t/ha + St. with *Azotobacter* and PSB (54.39 q/ha) differed significantly and lowest grain yield (46.29 q/ha) of wheat was recorded under only RDF treatment (control). The maximum gross income (Rs. 87443.00) and net income (Rs. 37000.00) was also recorded in treatment of RDF + vermicompost 5.0 t/ha + *Azotobacter* and PSB as seed treatment and sprayed at 1st and 2nd irrigation T-8).

Key Words : Wheat, Organic manure, Microbial inoculants, Recommended dose of fertilizers

View Point Article : Verma, V.K., Chaudhry, Sanjai, Singh, Vishram, Gupta, S.K. and Kumar, Harvansh (2014). Effect of integrated soil fertility management practices on production and productivity of wheat (*Triticum aestivum*) in alluvial soils of central plain zone of Uttar Pradesh. *Internat. J. agric. Sci.*, **10** (2): 735-738.

Article History : Received : 13.12.2013**; Revised :** 30.04.2014**; Accepted :** 12.05.2014

INTRODUCTION

Wheat is one of the most important food crop in the world, providing 20 per cent of humanity's dietary energy supply and serving as the main source of protein in developing nations. 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 per cent to the total food production. During 1964-65 wheat production was 12.3 Mt, which has gone upto 93.3 Mt during 2011-12 (economic Survey, 2011-12). 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

*** Author for correspondence**

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 nutrient particularly nitrogen and intensive cultivation of crops leads to create deficiency of all major as well as minor nutrients, lack of organic matter in soil also leads to create soil sickness. Integrated nutrient management or integrated soil fertility management by conjunctive use of all major nutrients in inorganic farm as well as organic source with microbial inoculants is the only option for sustaining in wheat production and productivity and improve soil health. During last one decade the practice of reducing inorganic fertilizer doses by 25-30 per cent, with complementary doses of organic manures did not achieve sustainability in wheat production. The integration of superimposed quantities of organic manure, microbial iniculants along with 100 per cent doses of inorganic fertilizers catching attention of scientific community, now a days. 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.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season of 2011-12, at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur, situated at $25^0$56‘ to $26^0$58‘ North and $79^0$31‘ to 80^0 34‘ 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 indogangetic alluvial origin, pH 7.75, EC 0.25 dsm^{-1}, well drained flat. Before sowing initial soil sample analysis was made to determine organic carbon, available N, P and K which was determined as 0.44 per cent, 170.0, 17.8 and 165.0 kg ha^{-1}, respectively.

Eight treatments of superimposed nutritional doses of organic manure, microbial inoculants over inorganic fertilizer doses were selected for experiment. The treatments consisted of RDF + vermicompost @ 5.0 t/ha, RDF + FYM @ 10.0 t/ha, RDF + St with *Azotobacter* and PSB, RDF + vermicompost @ 5.0 t/ha + St with *Azotobacter* and PSB, RDF + FYM @ 10.0 t/ha + St with *Azotobacter* and PSB and RDF + vermicompost 5.0 t/ha + St with *Azotobacter* and PSB and spraying at 1^{st} irrigation. RDF + vermicompost @ 5.0 t/ha + *Azotobacter* and PSB as seed treatment and spraying at 1^{st} and 2^{nd} irrigation were compared with only RDF treatment (150:60:40:20:20 kg NPKS and Zn per ha). The farm yard manure and vermicompost doses were mixed in soil before sowing and *Azotobacter* and PSB were used as seed treatment and sprayed after 1^{st} and 2^{nd} irrigation treatment wise. The treatments were replicated three times and studied under Randomized Block Design.

The wheat variety ‘Mahi’ (K-402) developed from C.S. Azad University during 2011, by the pedigree of K 8102 x K 68 was selected for experiment. The seed was inoculated with *Azotobacter* and PSB before sowing and sown at row spacing of 20 cm apart. The crop was irrigated with four irrigation. To provide weed free condition during critical growth period of crop, sulphosulfuran @ 33 g/ha was sprayed after first irrigation at 30 days after sowing. The crop was sown on December 12, 2011 and harvested on April 4, 2012.

In order to analyse the effect of different treatments, the crop growth characters like plant population, plant height (cm), number of tillers per plant, leaf area per plant (cm^2), yield attributing characters *viz.*, spike length (cm), grains per spike and test weight and finally data regarding biological and grain yield (q/ha) were studied. Economics of different treatment results were evaluated on the basis of investment made and output received. Five plants were randomly selected from each plot for taking observations regarding individual plant growth, yield attributes and yield data. All the data were statistically analysed separately. Critical difference was computed to determine statistically significant treatment difference.

$$CD = (\sqrt{2VEr^{-1}}) \times t5\%$$

where, VE is the error variance, r is number of replications, t5 per cent 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

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth characters :

The data pertaining to growth characters and yield attributes are summarized in Table 1. The results revealed that integrated soil fertility treatments did not affect initial plant population status, which was significantly at par. More or less similar results also obtained in case of plant population of the crop. The growth interms of number of tillers per plant at 45 DAS stage were significantly influenced by integrated soil fertility management treatments. The maximum tillers per plant at 45 DAS stage (5.26) were recorded under treatment T-8, while minimum tillers per plant (4.33) were obtained under control treatment (T-1). Plant leaf area recorded at 45 and 90 DAS stage was significantly influenced by super imposition of organic manure and microbial inoculants along with recommended fertilizer dose treatments. The maximum leaf area 529.11 cm^2, and 916.34 cm^2 at 45 and 90 DAS stage, respectively, was recorded under T-8 (RDF + vermicompost @ 5.0 t/ha + *Azotobacter* and PSB as seed treatment and spraying at 1^{st} and 2^{nd} irrigation), while lowest leaf area 439.53 cm^2 and 691.24 cm^2 at 45 and 90 DAS stage, respectively was recorded in treatment-1 (control).

Table 1: Effect of soil fertility management practices on growth characters and yield attributes of wheat

Treatments		Initial plant population per m^2	Plant height at maturity (cm)	Number of tillers per plant at 45 DAS	Plant leaf area (cm^2)		Spike length (cm)	No. of grains per spike	Test weight of grain (g)
					At 45 DAS	At 90 DAS			
T_1	Recommended fertilizer dose (RDF) (150:60:40:20"20 kg/ha NPKSZn)	158.10	83.53	4.33	439.53	691.24	7.52	53.53	38.13
T_2	RDF + vermicompost @ 5.0 t/ha	159.10	83..86	5.16	492.29	802.40	8.34	59.73	41.16
T_3	RDF + FYM @ 10.0 t/ha	157.13	83.86	4.80	468.51	767.46	8.25	58.13	41.76
T_4	RDF + ST with *Azotobacter* and PSB	158.34	83.93	5.06	485.91	806.22	8.32	59.33	41.98
T_5	RDF + vermicompost @ 5.0 t/ha + St. with *Azotobacter* and PSB	58.67	84.06	5.23	511.80	834.96	8.60	59.80	42.58
T_6	RDF + FYM @ 10.0 t/ha + St. with *Azotobacter* and PSB	157.67	84.53	5.36	519.66	841.90	8.75	59.93	42.77
T_7	RDF + vermicompost @ 5.0 t/ha + *Azotobacter* and PSB as St. and spraying at 1st irrigation	161.05	85.13	5.26	525.34	847.50	8.76	60.66	43.23
T_8	RDF + vermicompost @ 5.0 t/ha + *Azotobacter* and PSB as St. and spraying at 1st and 2nd irrigation	162.05	85.66	5.26	529.11	916.34	8.93	62.40	43.45
S.Ed. ±		1.13	0.26	0.28	15.33	39.09	0.29	1.64	1.43
C.D. (P=0.05)		2..46	0.57	0.62	3.78	84.65	0.64	3.56	3.11

VC- Vermicompost, FYM- Farm yard manure, St seed treatment, PSB-Phosphate solubilizing bacteria

Table 2: Effect of soil fertility managements on yield and economics of wheat

Treatments		Biological yield (q/ha)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Cost of cultivation (Rs./ha)	% increase over control	Gross return (Rs./ha)	Net return (Rs./ha)	% increase over control	B: C ratio
sw	Recommended fertilizer dose (RDF) (150:60:40:20"20 kg/ha NPKSZn)	108.79	46.29	62.51	42.56	42576.27	–	71980.65	29404.38	–	1.69
T_2	RDF + vermicompost @ 5.0 t/ha	121.52	53.00	68.52	43.64	48802.50	14.62	81809.00	33006.50	12.25	1.67
T_3	RDF+FYM @ 1.0 t/ha	120.36	51.61	68.75	42.89	48611.81	14.17	80068.85	31457.40	6.98	1.64
T_4	RDF + ST with *Azotobacter* and PSB	116.00	49.50	66.50	42.67	43237.77	1.53	76907.50	33669.73	12.60	1.77
T_5	RDF + vermicompost @ 5.0 t/ha + st with *Azotobacter* and PSB	126.15	54.39	71.76	43.16	49191.57	15.52	84243.15	35051.58	19.20	1.71
T_6	RDF + FYM @ 10.0 t/ha + st with *Azotobacter* and PSB	127.31	55.32	71.99	43.51	49327.78	15.85	85484.20	36156.42	22.96	1.73
T_7	RDF + vermicompost @ 5.0 t/ha + Azootobacter and PSB as ST and spraying at 1st irrigation	128.47	55.55	72.92	43.24	49832.03	17.00	85963.75	26131.72	22.87	1.72
T_8	RDF + vermicompost @ 5.0 t/ha + Azootobacter and PSB as ST and spraying at 1st and 2nd irrigation	129.62	56.70	72.92	43.75	50442.48	18.47	87443.50	37001.02	22.85	1.73
	S.Ed. ±	2.84	1.00	1.20	–	–	–	–	–	–	–
	C.D. (P=0.05)	6.15	2.16	2.60	–	–	–	–	–	–	–

Yield attributes :

Significant proliferation was obviously observed in yield attributes *viz.*, length of spike, number of grains per spike and test weight of grain (Table 1). The maximum spike length (8.93 cm) and number of grain per spike (62.40) were recorded under treatment-8 (RDF + vermicompost 5.0 t/ha + *Azotobacter* and PSB as seed treatment and sprayed at 1st and 2nd irrigation) and minimum spike length (7.52 cm), number of grains per spike (53.53) were observed in only RDF treatment (control). Other treatments were significantly at par among themselves. The conjunctive use of organic manure and microbial inoculants treatments recorded significant improvement in test weight of grain compared to control treatment but significantly at par among themselves. Similar findings were reported by Dahiya *et al.* (2008) and Rather and Sharma (2010).

Grain yield and economics :

The data regarding biological yield, grain yield, straw yield and economic analysis are summarized in Table 2. The super imposition of organic manure (FYM/vermicompost) and microbial inoculants (*Azotobacter* and PSB) over recommended dose of fertilizer (RDF) found more effective than imposition of only organic manure or only microbial inoculant with RDF interms of biological and grain yield of wheat. The augmentation on grain yield of wheat by super imposed nutritional doses varied upto 17.49 to 22.48 per cent compared to control treatment. The maximum biological yield, grain yield and straw yield (129.62 q/ha, 56.70 q/ha and 72.92 q/ha, respectively) were recorded under treatment-8, while minimum 108.79 q/ha biological yield, 46.29 q/ha grain yield and 62.51 q/ha straw yield was obvious in only RDF (Control treatment). Split dose of *Azotobacter* and PSB as seed treatment and sprayed at 1st and 2nd irrigation (treatment 7 and treatment 8) were significantly at par but superior over other treatments. Integration of only *Azotobacter* and PSB with RDF (T-4) showed least improvement in yield but significantly superior over control treatment (T-1).

The effectiveness of conjunctive use of organic manure + microbial inoculants with recommended dose of fertilizer on augmentation of grain and straw yield of wheat were reported by several scientists *viz.*, Singh *et al.* (2012), Dahiya *et al.* (2008) and Rather and Sharma (2009).

The total cost of cultivation (Table 2) was worked out minimum (Rs. 42576.27/ha) in T-1 having only recommended dose of fertilizer. The superimposition of microbial inoculants, organic manures, organic manure + different dose of microbial inoculants given in different treatments increased cost from 1.52 per cent to 18.47 per cent, while increased gross income by 6.40 to 21.48 per cent compared to control treatment. Integration of only *Azotobacter* and PSB and only compost/ vermicompost with RDF increased gross income upto Rs. 4927 to Rs. 9828 per hectare, while integration of compost/ vermicompost + *Azotobacter* and PSB + RDF, increased gross income up to Rs, 12263 to Rs. 13504 per /ha. Maximum gross income (Rs. 87443.50) by the increment of Rs. 15463 was received under treatment-8. The net income (Rs/ha) was evaluated minimum (Rs. 29404.38) in only RDF treatment (control) and maximum net income (Rs. 37001.02/ha) was recorded under T-8. The increment of net income in percentage varied upto 6.98 per cent to 25.85 per cent compared to control treatment. The benefit : cost ratio was evaluated minimum (1.64) in T-3 while maximum B:C ratio (1.77) was recorded under T-4. It was due to less cost involvement in the treatment. The economic viability of use of *Azotobacter* and PSB, FYM/ vermicompost along with recommended dose of fertilizers on boosting economic parameters of wheat were reported by Sharma *et al.* (2000) and Singh and Prasad (2011).

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