Effect of Integrated Nutrients with liquid organic product TM AGRICULTURAL on Wheat

(Triticum aestivum)

Submitted by

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PROJECT SUMMARY REPORT

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PROJECT BACKGROUND

The present research project was designed and conducted as a part of Best Environmental Technologies Global Research Program. This project at Agricultural Research Institute, Durgapura, Jaipur was selected because of its strategic location and significant contribution to the farming community in semi arid eastern plains in **INDIA.**

The project was framed to study the efficacy of liquid organic product TM Agricultural on crop performance and wheat yield in semi arid eastern plain of Rajasthan, India where rain are scanty, summers are dry and very hot with mild winters with limited water resources.

Rajasthan Agricultural University was established on 1st August, 1987 by promulgation of an ordinance (#13 of 1987) which was later enacted by an Act (#39 of 1987). The University has undergone two major divisions through which the universities viz., MPUAT (Udaipur) and RAJUVAS (Bikaner) were carved out in 1999 and 2010 respectively. The SKRAU caters to the agricultural need of 21 districts out of 33 districts of Rajasthan. The University is committed to achieve excellence in the fields of education, research and extension in agriculture. Its multi-faceted activities are carried out through a network of six colleges, seven agricultural research stations and eight agricultural research sub-stations. Besides, there is a National Seed Project unit of ICAR functioning at Beechwal, with three seed farms at Beechwal, Khara and Rojari. The extension activities are carried out through 14 Krishi Vigyan Kendras and an Agricultural Technology Information Centre (ATIC).

Agricultural Research Station (ARS), Durgapura, Jaipur, comes under the S.K.

Rajasthan Agricultural University, Bikaner for the organization and management of research in all disciplines of agricultural sciences. This ARS since its inception in 1943 has come a long way, witnessing an era of state food deficits and poor farming systems to the present situation where we have enough food grain reserve.

AGRICULTURAL RESEARCH STATION
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ARS Jaipur is the biggest research center of S. K. Rajasthan Agricultural University, Bikaner., which was established on 74.1 hectare land with laboratories, experimental farm and a few residential accommodations for the staff. About 7 hectare of land is reserved for rain-fed agricultural research, and 2.5 ha land for organic farming, which is the need of the time in the state. This station is well equipped with modern laboratories and other infrastructure facilities to conduct research in the identified thrust areas. The various laboratories include Pesticide Residue Lab, White grub & other soil Arthropods Lab, Bio-agent production Lab, Seed Technology Research Lab, Crop Physiology Lab, Soil & Plant Elemental Analysis Lab, Wheat Quality Lab, Pathology Lab, Microbiology Lab, Vermi-compost Lab, Disease forecasting unit, Plant health clinic and Post Harvest Technology Lab. This station also has some general facilities like the CIMCA (Centre for Information Management and Computer Application), Kisan Call Centre, Library & Information Centre, Workshop, etc. As an important academic activity, Academy of Agriculture, Allied Sciences and Technology (AAAST) has been established with the objectives to organize symposia, seminars and publish the research highlights. More than 100 scientists and 200 administrative, supporting and auxiliary staff members are engaged in various research activities.

Through its Research Sub-stations in the zone-IIIa the research on development and production is taken care of on mustard, taramera, cotton, maize, sorghum, arid fruits, floriculture, etc.

To redress the existing constrains in agriculture, following disciplines, have been working through multidisciplinary approach:

Plant Breeding & Genetics	Horticulture
Agronomy	Seed Technology Research
Soil Science & Agricultural Chemistry	Breeder Seed Production
Plant Pathology	Agricultural Engineering
Entomology	Statistics
Nematology	Agricultural Economics
Physiology	Agro-meteorology
Biochemistry	

EXECUTIVE SUMMARY

A research project was under taken at S K Rajasthan Agricultural University Agricultural Research Institute (ARI) at Durgapura, Jaipur from November 2011 to April 2014 to study the efficacy of organic liquid product “TM AGRICULTURAL” on wheat crop performance manufactured at Best Environmental Technologies, Edmonton, Canada.

TM Agricultural is being used in different countries around the world since 1999 for enhancing soil quality and production of different crops. Therefore, the trials were set up to the study the efficacy on crops in semi arid eastern plain of Rajasthan, India where rains are scanty, summers are dry and hot and water is also limited for crops. Soils are poor in organic matter, low in organic carbon, nitrogen and medium in available phosphorus and potash. The location was taken as a benchmark to demonstrate and assess the product efficacy with an assumption that, if the product works in the scanty rainfall and dry climatic conditions, it could do well in other parts of the country also where these resources are not limited.

TM Agricultural is derived from natural and organic sources and manufactured according to USDA organic standards in Canada. The product is registered under USDA, National Organics Program (NOP) standards, by different states in USA and in other countries. It helps plants in increasing their nutrient uptake form soils and over all crop performance. It also helps in improving soil physical conditions and nutrient availability, movement and retention in soil while enhancing the soil quality.

The 3 years wheat crop trials data were analyzed and compiled using standard analytical methods and statistical tools to compare the differences among treatments treated with TM Agricultural product and control treatments with and without required amounts of fertilizers. Some of the findings are listed below:

Highlights of the findings:

- TM Agricultural application on wheat crop in combination with recommended doses of fertilizers significantly increased grain yield nearly by 10 % (462 kg/ha) over only fertilizer applied crops.

- Grain yield increase was more pronounced when the product is applied alone without any fertilizers added to the crop. The increase was over 40% on TM Agricultural applied crops over control without any fertilizers. This can be a potential benefit for organic wheat growers.

- Straw yield was significantly increased by 5.5% on TM application over control. TM and fertilizers applied crop gave about 325 kg/ha higher straw yield.

- Protein percent in the grain was increased by 1% in crops treated with TM Ag and fertilizers over crops grown with only fertilizers.

- Only TM Agricultural applied crops gave 2% higher protein content in grain than the corresponding crops without any TM AG and fertilizers.

- Soil Microbial Biomass Carbon (SMBC) in soil is increased nearly by 7.0% over the corresponding non-treated crop under same amounts of fertilizer application, where as the increase was more than 40% in crops grown with TM only and with no fertilizers.

- Higher tolerance to moisture stress was observed in TM Ag treated plants.

- TM Ag treated plots showed higher nutrients in soil at the end of each crop season compared to the soils from non-treated plots.

- Field scale TM Agricultural application recommendations: 100 ml/acre on soil at the time of sowing, and 2 sprays on crop as foliar application @ 200 ml per acre at 3-4 leaf stage and 3 weeks after 1st foliar spray.

1.0 INTRODUCTION

Research project entitled *" Effect of Integrated Nutrients with Liquid Natural Product 'TM Agricultural on Kharif and Rabi Crops in Semi-arid eastern plains of Rajasthan, INDIA"* was carried out at ARI, Durgapura, Jaipur to study the effect of TM Agricultural for enhancing production and quality of wheat crop. The research institute is located at important and strategic location to demonstrate advanced technologies in farming to communities in semi arid eastern plains of Rajasthan, India

The geographical setting is dominated with scanty rains and hot summers with dry and very hot weather. Water is the most limited resource in this area and soils are low in organic matter with lesser organic carbon and medium in available nutrients like nitrogen, phosphorus and potassium.

TM Agricultural product is manufactured according to USDA organic standards. It is registered under USDA, National Organics Program (NOP) standards in USA and in other countries. It helps plants in increasing their nutrient uptake form soils and improves over all crop performance by assisting the plants with higher nutrient absorption and better nutrient movement and retention in soil while enhancing the soil quality. TM Agricultural treated plants are expected to have a balance of nutrients in their tissues and grow healthier and stronger to yield better.

Being a drought prone state and having smallholdings less than 1 ha, the socio-economic status of farmers in Rajasthan state does not allow them to use advanced agricultural practices. So, TM Agricultural application may enhance the efficiency of applied fertilizers by increasing the nutrient availability, which in turn reflects the yield and better quality produce. Farmers can get higher prices for their produce by spending less money on agricultural inputs.

Organic farming system solely depend on the use of crop residues, animal manures, green manures, off farm organic waste, crop rotation, incorporating legumes and biological pest control to maintain soil productivity (Palaniappan and Annadurai 1999). The philosophy is to feed the soil rather than crops to maintain soil health and it is a means of giving back to the nature what has been taken out from it (Funtilana 1990). Therefore, the university has undertaken the project to test TM Agricultural, a certified liquid organic product. TM Agricultural is a dark brown colored liquid with a faint pungent smell of vinegar containing different amounts of macro and micro nutrients extracted into water from plant materials. It is non hazardous under USDA, safety and environmental regulations. This project was under taken to study the efficacy on wheat in 3 *Rabi* (winter) crop seasons.

OBJECTIVES

- To study the effect of TM Agricultural on plant growth, yield, and protein content in grain.
- Study the effect on soil nutrients status and soil microbial biomass.
- Transfer of technology to users for successful adoption.

2.0 MATERIALS AND METHODS

Field experiment was started in November 2011 on wheat crop with six treatments using with and without *Azotobacter* culture inoculation in split plot design with 3 replications at ARI, Jaipur. The research farm is located at 75' 25° East longitude and 26' 06° North longitude at 427 meter above m.a.s.l. in Rajasthan State, India. The climate in this region in typically semi-arid characterized by extremes temperature in both summer and winter. During the summers, temperature goes as high 48°c while in winter it may fall as low as to below 5°C. The average rainfall is about 45 cm during July to September. Data on temperature, relative humidity rainfall and evaporation recorded at the farm meteorological observatory during experimentation are presented in Table-1, Table 2 and 3 below.

Table 1: Meteorological Data for the Crop Season (Rabi/winter- 2011)

Month	Week No.	Date From – To	Temp° C Max. – Min.	R.H. (%)	Rainfall (mm)	Rat of evaporation (mm) U.S. open pan
November 2011	1.	12-18	31.1-16.9	38	0.0	3.9
	2.	19-25-	29.8-16.1	52	0.0	3.7
	3.	26 Nov -2 Dec.	26.9-13.1	42.5	0.0	2.9
December 2011	4.	3-9	30.4-15.5	48.0	0.0	2.9
	5.	10-16	23.9-7.4	55.0	0.0	2.3
	6.	17-23	23.6-9.5	53.0	0.0	2.1
	7.	24-31	22.2-7.9	64.0	0.0	2.2
January 2012	8.	1-7	20.3-10.3	77.5	0.0	1.5
	9.	8-14	19.4-5.7	58.0	0.0	2.0
	10.	15-21	20.5-5.8	57.5	0.0	2.3
	11.	22-28.	21.3-7.2	51.0	0.0	2.5
February 2012	12.	29 Jan-4 Feb.	21.9-7.6	50.5	0.0	2.6
	13.	5-11	21.1-7.9	43.0	0.0	3.7
	14.	12-18	23.4-11.2	40.0	0.0	4.3
	15.	19-25	28.3-12.7	45.0	0.0	4.7
March 2012	16.	26 Feb -4 Mar	28.6-14.8	37.5	0.0	5.5
	17.	5-11	28.8-12.3	31.0	0.0	6.7
	18.	12-18	30.0-15.0	29.5	0.0	6.1

Table 2: Meteorological Data for the Crop Season (Rabi/winter- 2012)

Month	Week No.	Date From – To	Temp° C Max. – Min.	R.H. (%)	Rainfall (mm)	Rat of evaporation (mm) U.S. open pan
November 2012	1.	12-18	39.4-12.8	45.5	0.0	3.4
	2.	19-25-	27.6-11.9	44.5	0.0	3.1
	3.	26 Nov-2 Dec.	26.4-10.3	47.5	0.0	2.9
December 2012	4.	3-9	27.3-10.4	54.5	0.0	3.2
	5.	10-16	25.7-13.6	65.0	0.0	2.9
	6.	17-23	24.2-9.0	52.0	0.0	2.8
	7.	24-31	22.5-7.5	63.0	0.0	2.7
January 2013	8.	1-7	19.5-3.6	62.5	0.0	1.7
	9.	8-14	23.3-8.3	56.0	0.0	3.1
	10.	15-21	21.0-8.7	68.5	0.0	2.6
	11.	22-28.	20.8-5.1	65.0	0.0	2.9
February 2013	12.	29 Jan -4 Feb.	24.3-9.9	59.5	0.0	3.6
	13.	5-11	22.4-10.9	65.0	11.6	3.7
	14.	12-18	23.4-10.4	70.5	14.0	3.4
	15.	19-25	24.6-13.7	64.5	0.0	4.5
March 2013	16.	26 Feb -4 Mar	27.1-12.3	50.0	0.0	4.9
	17.	5-11	32.8-16.1	41.5	0.0	6.1
	18.	12-18	31.9-17.6	44.0	0.0	6.4

Table 3: Meteorological Data for the Crop Season (Rabi/winter- 2013)

Month	Week No.	Date From – To	Temp° C Max. – Min.	R.H. (%)	Rainfall (mm)	Rat of evaporation (mm) U.S. open pan
November 2012	1	12-18	26.1-10.9	45.0	0.0	2.9
	2	19-25-	28.5-11.8	48.0	0.0	3.4
	3	26-2 Dec.	28.8-12.7	51.5	0.0	3.6
December 2012	4	3-9	26.7-10.3	56.5	0.0	3.2
	5	10-16	26.5-10.8	54.0	0.0	3.3
	6	17-23	22.6-11.0	70.0	0.0	2.5
	7	24-31	20.8-7.5	48.0	0.0	2.1
January 2013	8	1-7	18.9-6.4	65.0	0.0	1.8
	9	8-14	19.7-6.8	58.0	0.0	2.1
	10	15-21	18.8-7.8	74.0	5.6	1.5
	11	22-28.	19.6-10.0	75.5	8.2	1.2
February 2013	12	29-4 Feb.	24.0-10.1	64.0	0.0	2.2
	13	5-11	23.9-11.1	52.0	2.0	3.0
	14	12-18	22.2-7.6	51.0	0.0	3.0
	15	19-25	23.3-12.0	59.5	6.2	3.2
March 2013	16	26-4 March	23.1-11.6	63.0	33.0	2.8
	17	5-11	27.7-13.2	52.0	2.4	4.3
	18	12-18	30.1-16.2	38.5	0.0	4.4

Soil of experimental site was loamy sand. The initial sample was taken up to depth of 30 cm and analyzed for various chemical and physical properties using standard laboratory methods. Some important physic-chemical properties are given in table 4 below.

Table 4: Soil Physico- Chemical Characteristics of the test plots

pH	8.1
True density (g/cc)	2.55
Field capacity (%)	9.83
Hydraulic conductivity (cm/hr.)	6.80
Organic Carbon (%)	0.24
Wilting Point (%)	3.15
Available Nutrient (ppm)	
Nitrogen	145.27
P_2O_5	24.65
K_2O	188.69

2.1 Treatment combinations

T_1 : Recommended Dose of Fertilizer (RDF) without TM
T_2 : TM + 2/3 RDF
T_3 : TM + 1/3 RDF
T_4 : TM + Full RDF
T_5 : TM Agricultural only
T_6 : Control

These treatments were applied with & without *Azotobacter* culture with a total number of 12 treatments and replicated three times in split plot design by taking culture as main plot and doses of fertilizer in sub plot. Recommended does of NPK fertilizer i.e. 120-40-30 kg ha^{-1} of N-P-K, respectively was applied as basal (before seeding).

TM Agricultural was sprayed @ 0.5% (5 ml per liter water) on surface of moist soil as first application at the time of sowing and second application at 45 days after germination and third at 70 days after sowing (before flowering). Wheat CV. Raj-3765 was sown on November 21, 2011, November 24,2012 and November 19. 2013 and was harvested in the month of April every year. Yield and agronomic variables were collected every year and were sent to lab for nutrient analysis in soils and tissue. Root length and number of nodules were taken at 30 and 45 days of growth stage. Rhizosphere soil samples were also taken for analysis of soil microbial biomass of carbon, bacteria & fungi counts.

Laboratory analysis and statistical analysis was performed using standard analytical methods and statistical designs to test the differences among treatments using AVOVA. Soil and plant samples were taken for chemical analysis after harvest of wheat. Grain and plant samples were digested using nitric-perchloric (4:1) mixture for P & K determination and Sulphuric and perchloric (9:1) mixture was used to determine N by

colorimetric method using Nesseler's reagent (Jackson 1973). Phosphorus was estimated by vanadomolybdate yellow colour method (Jackson 1973) and potassium was estimated using flame photometer.

Soil microbial biomass carbon was estimated by using the method given by Jenkinson and Powlson (1976) and organic carbon was determined by Walklay and Black (1934). Bacteria and Fungi populations were counted by using Topping (1938) method.

3.0 RESULTS

3.1 Three years data and interpretation

Over all crop growth during the entire crop growing seasons was better in all the TM treated crops as compared to respective control crops.

Plant Height and Spike length

Three years results data on effect of TM Agricultural on wheat plant height and Spike length grown in loamy sand soil are presented in table 4. Results from three years pooled data revealed that TM Agricultural treated plants are significantly taller than non treated plants. Plant height in treatment T_4, TM Agricultural in combination with fertilizers was significantly higher (92.02 cm) over control (81.02 cm) and at par with T_2, and T_3 treatments. Spike length was also significantly higher (11.56) over all TM treated treatments and lowest in control (9.16 cm). TM Agricultural alone also gave significantly higher plant height and spike length (87.13 and 10.51 cm) respectively, over control.

Nitrogen (N) content in plant tissue at 40 and 80 days after sowing.

Three years pooled data (table 5) shows that application of full RDF with combination of TM gave significantly higher N content (1.41 and 1.17 % at 40 and 80 days, respectively in wheat plant tissue at both stages of growth over all treatments. Treatment T_5 also gave significantly higher N content over control and at par with other treatments. TM applied along with fertilizers gave the highest amount of N (1.31 and 1.09 % at 40 and 80 days) in plant tissue among all treatments.

Soil microbial bio mass carbon (SMBC): Significantly highest amount (124.24 mg g^{-1}) of soil microbial biomass carbon was found in the TM applied in combination of full dose of fertilizers (table 6), which was significantly higher over all the treatments. The lowest amount of SMBC was found in control (81.36 mg g^{-1}). Treatment T_5 i.e.TM Agricultural alone with out any fertilizers application also gave significantly higher soil microbial organic carbon (118.69 mg g^{-1}) over control that is nearly at par with T_1,T_2 and T_3.

Table 5: Effect of nutrient and liquid organic product TM Agriculture on plant height and spike length

Treatment	Plant Height (cm)				Spike Length (cm)			
	2012	**2013**	**2014**	**Pooled**	**2012**	**2013**	**2014**	**Pooled**
$T_{1:}$ RDF only	94.00	88.60	87.29	89.96	10.72	9.87	11.26	10.62
T_2 : TM + 2/3 RDF	94.33	89.23	88.53	90.70	11.02	10.0	11.72	10.99
T_3 : TM + 1/3 RDF	94.08	88.02	89.88	90.66	10.83	9.60	11.36	10.64
T_4 : TM + RDF	95.25	90.03	90.78	92.02	11.28	11.1	12.21	11.56
T_5 : TM Agricultural only	93.28	87.10	87.10	87.13	10.07	9.2	11,29	10.51
T_6 : Control	83.30	79.87	79.88	81.02	8.52	8.7	10.26	9.16
SEM ±	0.73	0.497	0.51	0.56	0.21	0.1	0.06	0.12
C.D. (P = 0.05)	2.16	1.467	1.49	1.68	0.63	0.40	0.16	0.37

Table 6: Effect of nutrient and liquid organic product TM Agricultural on plant height and spike length.

Treatment	Nitrogen content at 40 days growth stage (%)				Nitrogen content at 80 days growth stage (%)			
	2012	**2013**	**2014**	**Pooled**	**2012**	2013	**2014**	**Pooled**
T_1 : RDF only	1.29	1.28	1.30	1.29	1.08	1.08	1.09	1.08
T_2 : TM + 2/3 RDF	1.35	1.32	1.34	1.34	1.11	1.10	1.13	1.11
T_3 : TM + 1/3 RDF	1.31	1.32	1.32	1.32	1.07	1.08	1.11	1.09
T_4 : TM + RDF	1.41	1.39	1.42	1.41	1.17	1.13	1.14	1.17
T_5 : TM Agriculture only	1.32	1.30	1.31	1.31	1.08	1.09	1.10	1.09
$T_{6:}$ Control	1.18	1.18	1.17	1.18	0.94	0.93	0.95	0.94
SEM ±	0.01	0.01	0.005	0.014	0.02	0.02	0.01	0.02
C.D. (P = 0.05)	0.04	0.03	0.014	0.042	0.05	0.04	0.03	0.05

Table 7: Effect of TM Agricultural on Soil microbial Biomass Carbon (SMBC) and organic carbon

Treatments	SMBC mg/g soil				Organic carbon (%)			
	2012	**2013**	**2014**	**Pooled**	**2012**	**2013**	**2014**	**Mean**
T_1 : RDF only	113.67	116.17	118.68	116.17	1.95	2.15	2.24	2.11
T_2 : TM + 2/3 RDF	118.50	121.00	118.76	119.42	2.03	2.18	2.29	2.16
T_3 : TM + 1/3 RDF	117.67	120.17	119.82	119.22	1.96	2.16	2.24	2.12
T_4 : TM + RDF	122.00	124.50	126.23	124.24	2.10	2.20	2.33	2.21
T_5 ; TM Agriculture only	115,83	119.33	120.90	118.69	1.98	2.16	2.21	2.12
T_6 : Control	80.67	79.26	84.14	81.36	1.83	1.68	1.87	1.79
SEM ±	0.92	1.17	0.41	0.80	0.05	0.07	0.02	
C.D. (P = 0.05)	2.70	3.05	1.12	2.48	0.15	0.20	0.06	

Grain and Straw yield of Wheat

Three years pooled data (table 8) showed that all TM treated crop treatments gave significantly higher grain and straw yield over non-treated plots and control. The highest amount of grain yield (5542 kg/ha) was recorded in crop treated with TM and fertilizers (T4). Straw yield was also highest (6416 kg/ha) in the same treatment. These yields were significantly higher over other treatments in the order of T_1, T_3, T_5 and T_6 in grain and T_1,T_2, T_3, T_5 and T_6 in straw, respectively.

Table 8: Effect of TM Agricultural on wheat grain and straw yields

	Grain Yield (kg/ha)				Straw Yield (kg/ha)			
Treatment	**2012**	**2013**	**2014**	**Pooled**	**2012**	**2013**	**2014**	**Pooled**
T_1 : RDF only	5358	5158	4522	5080	6658	6216	5433	6091
T_2 : TM + 2/3 RDF	5988	5376	4630	5337	6804	6334	5592	6243
T_3 : TM + 1/3 RDF	5592	5150	4568	5103	6375	6088	5467	6010
T_4 : TM + RDF	6117	5571	4958	5542	7008	6486	5739	6416
T_5 : TM Agriculture only	5397	4840	4464	4900	6329	5756	5396	5860
$T_{6;}$ Control	3233	3400	3371	3335	5133	4292	3938	4440
SEM ±	1.21	0.368	0.39	1.10	1.65	0.750	0.82	0.54
C.D. (P = 0.05)	3.58	1.086	1.16	3.25	4.86	2.213	2.42	

Protein content in wheat grain

TM Agricultural application in wheat increased protein content in grain (Table 9). TM applied along with full rate of fertilizers increased grain protein content nearly by 1 % over non-treated crop on a three years average, which was statistically significant. Single year data and 3 years pooled data also showed that TM Agricultural in combination with different dose fertilizer gave significantly higher grain protein content over non-treated control crops. TM with full dose of fertilizer gave maximum protein content of 10.67 % as compared to other treatments and minimum was estimated in control 8.91%.

Table 9: Effect of TM Agricultural application on protein content in wheat grain

	Protein Content (%)			
Treatment	**2012**	**2013**	**2014**	**Pooled**
T_1 RDF only	9.93	9.94	10.00	9.96
T_2 TM + 2/3 RDF	10.18	10.18	10.23	10.20
T_3 TM + 1/3 RDF	10.13	10.08	10.08	10.10
T_4 TM + RDF	10.87	10.37	10.78	10.67
T_5 TM Agriculture only	10.62	10.16	10.27	10.35
T_6 Control	8.75	8.95	9.04	8.91
SEM ±	0.04	0.04	0,06	0.05
C.D. (P = 0.05)	0.14	0.13	0.19	0.14

Effect of TM Agricultural application on Soil Fungi and Bacteria: Three years pooled data (table 10) shows that all TM applied treatments gave significantly higher bacterial and fungi counts in soil over control. The highest Bacteria (48.24 cfu 10^{-4} g^{-1} soil) and fungi (46.50 cfu10^{-3} g^{-1}soil) counts were estimated in soils under treatment T4 i.e.TM Agricultural along with full rate of recommended fertilizers applied. These counts were significantly higher over other treatments viz. T_1, T_3, T_5 and T_6. Treatment T_5 (TM Agricultural alone with no fertilizer applications) also gave significantly higher bacteria and fungi 43.10 cfu 10^{-4} and 43.80 cfu$10^{-3}g^{-1}$ soil, respectively as compared to control.

Table 10: Effect of TM Agricultural on soil Bacteria and fungi grown under wheat

Treatments	Bacteria (cfu 10^4 /g soil)				Fungi (cfu 10^3 /g soil)			
	2012	**2013**	**2014**	**Pooled**	**2012**	**2013**	**2014**	**Pooled**
T_1 : RDF only	39.33	42.03	41.83	41.07	36.50	39.50	40.67	38.89
T_2 : TM + 2/3 RDF	45.83	47.83	44.83	46.16	45.17	48.18	44.17	45.84
T_3 : TM + 1/3 RDF	40.33	43.8o	42.00	42.04	41.17	44.27	42.67	42.70
T_4 : TM + RDF	47.37	50.23	47.17	48.24	46.50	49.00	47.33	46.50
T_5 : TM Agriculture only	42.17	45.29	41.83	43.10	43.83	47.07	40.50	43.80
T_6 : Control	31.50	30.50	33.00	31.67	22.67	23.96	27.67	24.60
SEM ±	0.87	1.17	0.52	0.86	0.98	1.28	008	0.87
C.D. (P =0.05)	2.56	3.28	1.15	2.56	2.88	3.67	1.14	2.64

Treatment results with *Azotobactor* inoculation were not included in this report, as the differences among treatments were not found significant.

REFERENCES

1. Palaniappan, S.P. and Annadurai, K. (1999). Organic farming theory and practice, scientific publisher (India), Jodhpur.

2. Funtilana, S. (1990). Safe, Inexpensive, Profitable and Sensible. International Agricultural Development, March-April 24.

3. Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

4. Jenkinson, D.S. and Powlson, D.S. (1967 a). The effect of biocidal treatment on metabolism in soil. 1. Fumigation with chloroform soil. Biochem. 8:167-177.

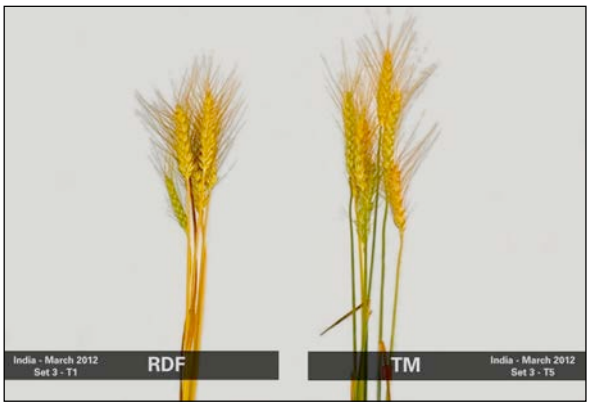
5. Walkley, A. and Black, C.A. (1934). An examination of different methods for determining soil organic matter and proposed modification of the chromic acid titration method. Soil science 37:29-38.

6. Topping, L.E. (1938). The predominant microorganisms in soil II. The relative abundance of the different type of organism obtained by plating and the relation of plate to total count. Zentrable Bakterol Abt. 298:193-201.

Field Photos


Fertilizer
Best & Fertilizer


T6 – CONTROL ONLY WITHOUT INOCULENT
T5 – TM AGRICULTURE WITHOUT INOCULENT


India - March 2012
Set 3 - T1
RDF
TM
India - March 2012
Set 3 - T5


WITHOUT
INOCULENT
T5 – TM AGRICULTURAL ONLY
T6 – CONTROL

ANOVA for pooled data on biomass/straw yield and test weight.

Grain yield			Straw yield		Test weight	
DF	MSS	VARIANCE	MSS	VARIANCE	MSS	VARIANCE
Rep. - 2	243.2210	181.57	376.6739	1205.31	10.6061	32.04
Culture (I) -1	10.122991	7.56	24.99998	13.42^{xx}	0.58268	<1
Error (a)-2	1.339546		-		-	
PE 6	-		-	-	-	
MPE 8	-		1.8622		0.8992	
Tr.-5	374.92315	51.57^{xx}	305.4946	172.75^{xx}	28.4041	72.27^{xx}
TxI -5	0.860248	0.12	0.68241	0.39	0.300252	0.76
Error(b) -20	7.270165		1.76842		0.39305	
PE 60	-	-	-	-	-	
MPE 80	-	-	-	-	-	

ANOVA for pooled data on number of grains per spike/head and nitrogen content in grain.

Number of grains per spike			Nitrogen content in grain	
DF	MSS	VARIANCE	MSS	VARIANCE
Rep. - 2	7.0897	6.48	0.00156	3.18
Culture (I) -1	0.22405	<1	0.oo711	0.45
Error (a)-2			-	
PE 6	-		-	-
MPE 8	-1.58876		0.000426	
Tr.-5	52.428530	59.29^{xx}	0.056964	58.81^{xx}
TxI -5	0.652952	0.91	0.000251	0.26
Error(b) -20	0.715567		0.000969	
PE 60	-	-	-	-
MPE 80	-	-	-	-