

EFFECT OF EM (EFFECTIVE MICROORGANISM) FERMENTED BASED IRRIGATION AND CHEMICAL FERTILIZER ON THE PHYSICO-CHEMICAL PROPERTIES OF SOIL AND YIELD OF WHEAT CROP AT FARMER'S FIELD IN PAKISTAN

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Abstract

Field experiments were conducted to study the effect of EM fermented based irrigation along with chemical fertilizer on the soil properties and yield of wheat crop during 1999-2001 at Dera Ismail Khan, Pakistan. Treatments were applied in a randomized complete block design that included: control (untreated), NPK alone, EM fermented based irrigation, and NPK+ EM fermented based irrigation. The study revealed that the application of EM fermented based irrigation was able to improve soil pH, EC, % organic matter and major inorganic nutrient contents of the soil. Significant increase in all the yield contributing components of wheat was found with different treatments as compared to control in both years of experiment. However, significantly higher results were obtained when EM fermented based irrigation was applied in combination with NPK fertilizers. The treatments followed the order: EM fermented based irrigation + NPK > NPK > EM fermented based irrigation > control. The study indicated that the EM fermented based irrigation along with NPK fertilizer can improve soil productivity and enhance economic yield of wheat.

Keywords: Chemical fertilizer, dry matter yield, EM, farmyard manure (FYM), fermented based irrigation, wheat.

INTRODUCTION

In Pakistan, farmers usually apply chemical fertilizer and pesticides in an effort to increase crop yield and improve crop quantity. While such goals

have often been achieved, the cost of these and other production inputs has made it difficult for many farmers to continue farming on a profitable basis. The government of Pakistan has, therefore, asked its scientists to explore effective and affordable alternatives to chemical based practices that would enhance the long-term sustainability of agriculture. Such alternatives are also needed to avoid the adverse effects of chemical fertilizers and pesticides on environmental quality, human and animal health, and food safety and quality.

One such alternative to conventional agriculture practices in Pakistan is the use of a microbial inoculants known as Effective Microorganisms (EM) within the context of nature farming and organic farming systems. The concept of EM was developed by Professor Teruo Higa, University of the Tyukyus, Okinawa, Japan. EM consist of mixed cultures of naturally-occurring beneficial microorganism applied as inoculants to increase the microbial diversity of soils and plants which, in turn, can improve soil quality and growth, yield and quality of crops [Higa and Wididana 1991, Higa and Kinjo 1991].

EM predominantly contains selected species of lactic acid bacteria, yeasts, Actinomycetes, photosynthetic bacteria, and other types of organisms. All of these organisms are mutually compatible and coexist in liquid cultures for extended periods [Higa 1991]. The initial work done on EM Technology by the WRRRI-NARC produced very promising results [Ahmad *et al.* 1997].

EM is not a substitute for good management practices. It is, however, an added dimension for optimizing our best soil and crop management practices such as crop rotation, use of organic amendments, conservation tillage, recycling of crop residues and animal manures, and bio control of pests. When used properly, EM has been shown to enhance the beneficial effects of these practices on crop growth and yield [Arakawa 1991, Higa and Kinjo 1991, Higa and Wididana 1991, Hussain *et al.* 1994, Minami and Higa 1994]. A number of beneficial effects of EM have been cited by these and other researchers including:

- a) increased decomposition of organic amendments and release of plant available nutrients;
- b) increased nutrient availability in the rhizosphere of plants;
- c) increased seed germination, emergence and seedling growth;
- d) increased biocontrol of plant diseases and pathogens through antagonism and antibiosis;
- e) increased plant growth from microbially synthesized hormones (e.g., Auxin) and growth factors;
- f) detoxification of residual phytotoxic substances and
- g) increased production of antioxidants that suppresses adverse effects of free radicals in plant metabolism.

Extensive field trials in Pakistan on nature farming using EM technology began in 1989. Results have shown that EM has consistently increased

crop yields while allowing some farmers to reduce their input of chemical fertilizers [Hussain *et. al.* 1993]. The present study was conducted to determine the effects of chemical fertilizers, EM + Farmyard manure mixture applied in irrigation on soil properties and yield of wheat crop in Pakistan.

MATERIALS AND METHODS

The experiment was conducted at the farmer's field in the year 1999-2000 and 2000-2001 in D.I. Khan (Pakistan). The soil of the experimental site was silt loam having pH 8.3, EC 4.1 to 4.2 dS cm⁻¹, organic matter and total N content low to moderate (1.30 to 1.10% and 0.05 to 0.04%, respectively). Whereas available P and K were moderate (6-6.5 ppm and 102-103 ppm, respectively).

The soil of the experimental site was thoroughly prepared. Wheat variety Inqalab-91 was grown with 30cm line to line spacing in the month of November each year. The seed rate was 100 Kg ha⁻¹. The experiment was laid out by following the Randomized Complete Block Design (RCBD), which were replicated three times with a plot size of 2 kanal (1000 m²) each.

The experiment comprised the following treatments.

- 1- Control (untreated, no amendments)
- 2- Recommended (NPK) N: P₂O₅ : K₂O fertilizer @ 120-90-60 kg ha⁻¹
- 3- EM treatments + FYM applied with the irrigation (EM-Fermenter Bio-fertigation)
- 4- NPK (N: P₂O₅ : K₂O fertilizer) and EM+FYM(EM-Fermenter Bio-fertigation).

Mineral fertilizers Urea, DAP and SOP were used as sources of N, P₂O₅ and K₂O, respectively. All P, K and half N was applied at the time of sowing while the remaining half N was applied with first irrigation.

The EM was prepared by mixing Basic EM + Molasses + Water at a ratio of 1:1:20, respectively on volume basis and allowed for three days in a drum to multiply and then applied in EM fermenter in which 1000 Kg of FYM was already added. The fermenter was applied to the plots with irrigation water. After each irrigation, the fermenter was prepared accordingly and applied to the plots with irrigation water. The quantity and interval of cultural practices, plant protection measures and irrigation was same for all the treatments and was made as when needed up to the harvest of the crop. At crop harvest (April each year), soil samples were collected at a depth of 0-30cm to determine the fertility status of the soil.

The growth and yield data were recorded on the following parameters:

- 1- Plant height (cm)
- 2- No of tiller per plant
- 3- 1000 grain weight (g)
- 4- Dry matter yield (kg ha⁻¹)
- 5- Grain yield (kg ha⁻¹)

Data recorded were analyzed statistically according to standard statistical procedures as described by Steel and Torrie [1980]. The treatment means were compared by Duncan's Multiple Range test at 5% probability level [Duncan 1961].

RESULTS AND DISCUSSION

Some promising results have been derived from the present investigation. The effect of EM fermenter irrigation and NPK alone and in combination on the yield and yield parameters of wheat during 1999-2000 and 2000-2001 are reported in Tables 1, 2, 3 and 4, respectively.

Table 1: Effect of EM fermenter irrigation and chemical fertilizer on the physico-chemical properties of soil (1999-2000).

Treatments	Soil properties						
	Textural class	O.M (%)	pH	EC dScm ⁻¹	N%	P (ppm)	K (ppm)
Control (untreated)	Silt loam	0.80	8.20	4.00	0.0400	6.0	102.0
NPK	Silt loam	0.98	8.10	4.50	0.0490	7.5	119.5
EM fermenter irrigation water	Silt loam	1.23	7.95	3.91	0.0615	6.8	112.8
EM fermenter irrigation water and NPK	Silt loam	1.10	8.00	4.10	0.0550	7.9	126.3

Table 2: Effect of EM fermented irrigation and chemical fertilizer on the physico-chemical properties of soil (2000-2001).

Treatments	Soil properties						
	Textural class	O.M (%)	pH	EC dScm ⁻¹	N (%)	P (ppm)	K (ppm)
Control (untreated)	Silt loam	0.80	8.2	4.00	0.04	6.00	103.0
NPK	Silt loam	0.98	8.0	4.50	0.08	7.5	120.5
EM fermenter irrigation water	Silt loam	1.63	7.69	3.81	0.07	6.8	112.
EM fermenter irrigation water and NPK	Silt loam	1.69	7.93	4.0	0.09	7.9	129.3

Table 3: Response of EM fermenter irrigation and chemical fertilizer to wheat crop during 1999/2000.

Treatments	Plant Height (cm)	No. of Tillers Plant ⁻¹	1000 grain yield (g)	D.M.Y Yield (Kg ha ⁻¹)	Grain yield (Kg ha ⁻¹)	% Increase grain yield
T1 Control	63.35 C	3.80 D	38.10 C	2400 A	1575 D	
T2 NPK	73 B	6.98 B	42.30 A	2890 B	2411 B	53.07
T3 EM fermenter irrigation water	66.21 C	5.667C	41.89 B	2798 B	1940 C	23.17
T4 EM fermenter irrigation water and NPK	82 A	8.12 A	43.12 A	3120 A	2648 A	68.12

Any two means not sharing a common letter(s) are significant at 5%.

Table 4: Response of EM fermenter irrigation and chemical fertilizer to wheat crop during 2000/2001.

Treatments	Plant Height (cm)	No. Of Tillers Plant ⁻¹	1000 grain yield (g)	DMY Yield (kg ha ⁻¹)	Grain yield (kg ha ⁻¹)	% Increase grain yield
T1 Control	62.27 D	2.67 C	39.40 C	2500 A	1580 D	
T2 NPK	76.56 B	6.93 B	41.93 B	2850 B	2300 B	45.56
T3 EM fermenter irrigation water	68.00 C	6.28 B	41.61 B	2715 B	1890 C	19.62
T4 EM fermenter irrigation water and NPK	89.20 A	9.83 A	42.28 A	3017 A	2571 A	62.72

Any two means not sharing a common letter(s) are significant at 5%.

Data concerning plant height, No. of tillers per plant, 1000 grain weight, dry matter yield and grain yield of wheat indicated an increase under all the treatments as compared to control. In statistical terms, significantly higher results were also obtained for all the different treatments in comparison with untreated plots.

In the 1st year, response of EM fermenter irrigation along with chemical fertilizer (NPK) was highest. It showed yield increase by 68% followed by chemical fertilizer applied singly 53% (Tables 3 and 4).

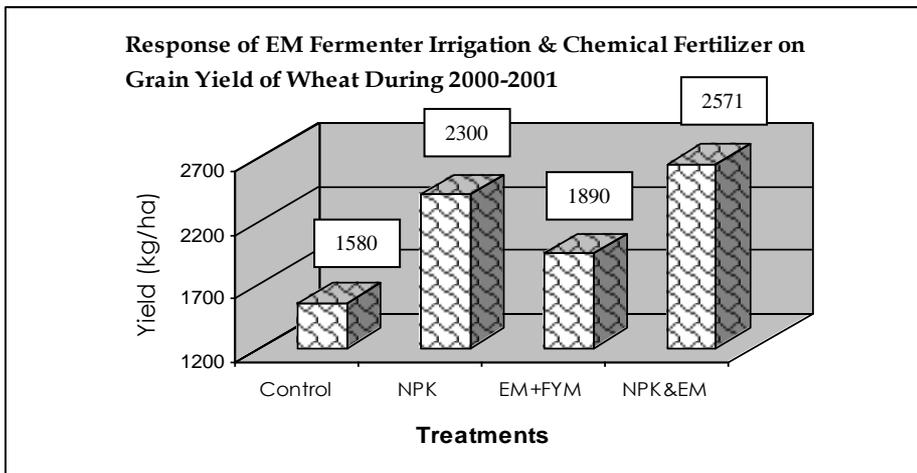


Fig. 1: Response of EM fermenter irrigation and chemical fertilizer on grain yield of wheat during 2000-2001.

In the 2nd year (2000-2001) (Table 4 and Fig. 1) the response was also fairly high. The trend of all the yield-attributing components was comparable with that of 1st year (1999-2000) (Table 3 and Fig. 2) but slightly higher than 1st year which is attributable to the continuous

application of EM fermenter irrigation, that ultimately created a better soil environment for the growth of wheat crop. The highest results were obtained from the treatments where EM fermenter irrigation + chemical fertilizer were applied and was followed by the NPK treatment. When the treatments were applied singly the yield and yield parameters of wheat during both years followed by the order of NPK > EM fermenter irrigation > Control. However, when the EM fermenter irrigation was applied in combination with recommended dose of chemical fertilizer(NPK), the yield and yield components of both years of wheat increased significantly over the individual treatments and were in the order EM fermenter irrigation +NPK > NPK> EM fermenter irrigation > control. The promising results obtained for both the years when EM fermenter irrigation was applied in combination with chemical fertilizer can be attributed the enhanced activities of the EM which is the presence of inorganic nutrients rapidly decomposed the organic manure (FYM) and released available nutrients for plant uptake.

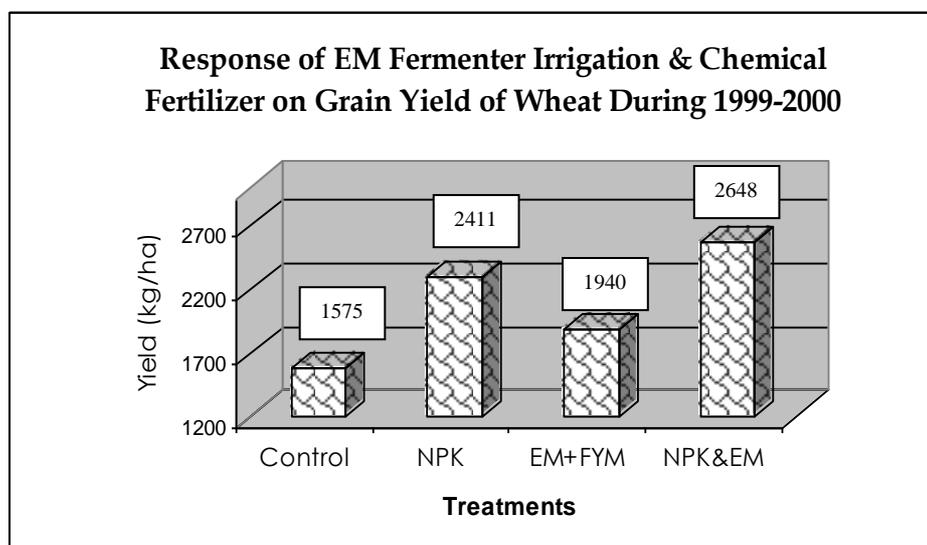


Fig. 2: Response of EM fermenter irrigation and chemical fertilizer on grain yield of wheat during 1999-2000.

Others have also reported similar results on the beneficial interaction of EM fermenter and chemical fertilizer [Karim *et al.* 1992, Ibrahim *et al.* 1993, Choudhary *et al.* 1994].

The data revealed that with the application of EM fermenter there was significant decrease in the soil pH as compared to control and other treatments. The trend towards decrease in pH will help for an efficient

availability of essential macro and micronutrients required for plant growth. The EC of the soil was also lowered with the EM fermenter from 4.0 to 3.81 dS cm⁻¹ Which shows that the total salts of EM fermenter are all organic based and thus don't add much towards salinity of soil.

All the treatments showed significant increase in the soil NPK levels over the control. The highest residual NPK level resulted from the application of EM fermenter in combination with chemical fertilizer followed by the chemical fertilizer applied singly (3120 kg ha⁻¹). However, the content of organic matter was higher in the treatment when EM fermenter was singly applied.

Others have also reported that biofertilization along with chemical fertilizer promoted the release of plant nutrients from the organic source that resulted in higher soil nutrient concentration [Lee 1993, Sharifuddin 1994].

CONCLUSIONS

The study reveals that the beneficial effects of EM fermenter along with chemical fertilizer are due to the enhanced microbial activities on the decomposition process of organic and inorganic nutrients, which brings about favorable changes in physical and chemical properties of soil. This ultimately increases the availability of soil nutrients and plant uptake.

Possible explanation of better response of wheat during 2000-2001 could be due to continuous application of EM Fermenter application.

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