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IMPACT OF ORGANIC FERTILIZER, HUMIC ACID AND SEA WEED EXTRACT ON WHEAT PRODUCTION IN POTHOWAR REGION OF PAKISTAN

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Wheat (*Triticum aestivum* L) crop production was evaluated under organic conditions during the year 2008-09 and 2009-2010 at National Agricultural Research Center (NARC), Pakistan Agricultural Research council (PARC) Islamabad. The study includes four treatments with four replications. The treatments includes; (1) Organic fertilizer 625 Kg ha^{-1}, (2) Organic fertilizer 625 and Humic Acid 10 Kg ha^{-1} (3) Humic Acid and Sea weed extract 625 ml ha^{-1} and (4) Control. Organic amendments were incorporated during land preparation and seaweed extract as foliar spray. The basal dose of organic fertilizer and humic acid (granule) were added at the time of sowing of wheat during 2008-2009 and 2009-2010.Humic acid solution 1% and sea weed extract were applied as foliar spray at 6 inches of wheat crop. The second foliar spray was done at tillering while third and forth sprays at heading and milking stage respectively. The crop conditions, color, shoot length and spike and yield parameters were recorded at different stages of the organic fertilizer application. The soils and crops managed organically are sustainable. Similarly, biological and chemical properties of soil also improved significantly. The compost enriched with different organic waste increased all physico-chemical and biological properties of the soil as well as yield of the crop. The wheat crop morphological and agronomical parameters also increase significantly. Moreover, nutrients supply and other soil properties like pH, CEC, ECe and plant nutrients including microbial community structure influence positively.
Keywords: Organic fertilizer, compost, humic acid and sea weed extract, wheat crop, rainfed condition

INTRODUCTION

Wheat (*Triticum aestivum* L) is one of the basic food requirements of human population. This is major grain crop which is being utilized for food and is cultivated on the maximum area of Pakistan. During Rabi season 2010-2011 wheat was cultivated on an area of about 9.045 million hectares (Anonymous, 2011) with an estimated yield of 25.20 million tonnes. This year (2011-2012) wheat crop area has reduced to 8.89 million hectares which was 9.045 million hectares in 2010-11. The decrease in area is mainly because of heavy rains in Sindh and Khyber Pakhtunkhwa (KPK). The demand of food grain is increasing with the rising population of Pakistan. The current population of Pakistan is 187 million which is increasing at the rate of 2.0 percent annually. They love to eat more wheat flour as compared to paddy, maize, Barley or any other staple food. Wheat grain keeps an eminent position in all food items consumed by human beings in Pakistan. Pakistan has 23 million hectares of arable land out of which 16 million hectares are irrigated while the rest of 6 to 7 million hectares are rainfed. Wheat is one of the major crop rotations in the cropping pattern of rainfed area of Pakistan. It adds 12% in the total wheat yield of the country (Rashid *et al.*, 2003). The better plant growth needs frequent and continuous supply of plant nutrients (Midmore *et al*., 1984) and (Reynolds *et al.* 1998); Hence, according to survey (Muhammad, 2010), 35 to 40% farmers in Pakistan are producing organic grains .From ancient times, farm yard manure is being used to enhance soil fertility along with better crop production and chemical properties i.e., CEC, Microbial biomass C, N and P (Blair *et al*., 2005; Kundu *et al.*, 2007; Lloveras *et al.*, 2001; Brown and Petrie, 2006). Due to severe financial constraints, the smallholders of the rainfed area cannot buy the expensive farm inputs and improve their livelihoods. It has been consistently analyzed that farmers do not commonly use phosphatic and nitrogenous fertilizers in Rainfed area or sometimes in a very limited quantity. In irrigated area, the farmers normally use NPK 208 $Kgha^{-1}$ and it is only 42 Kg ha^{-1} of NP in rainfed areas (Kisana *et al.,* 2006). The applied doses of N and P are very low ranging to 35 and 22.5 kg ha^{-1}.Wheat crop production is very low in Pakistan as 30 Mounds and 65 Maund ha^{-1} in rainfed and irrigated area (Kisana *et al.*, 2006). The organic fertilizer formulated at domestic and commercial level was compared with other organic substrates. These organic substrates include Bio-compost, Humic Acid, Sea Weed extract etc. This study will provide an alternate source of very effective and cheap nutrient for growing crops.

The main areas of study were alternative sustainable farming system, cheapest and eco-friendly plant nutrients and quality food by reducing hazardous chemicals in the food chain.

MATERIALS AND METHODS

The study was carried out during the year 2008-09 and 2009-2010 at National Agricultural Research Centre (NARC) Islamabad with the main purpose to evaluate the effects of different organic substrates on wheat crop production. Wheat crop was planted during the mid of November, 2008-2009 and 2009-2010 on big plots having area of about 2.5 hectare each. The crop was planted by using the drill having 25 cm apart line to line distance. The soil was well prepared before planting the crop by using the disk plough, cultivator followed by planking. The wheat seed was sown at the rate 125 kg ha^{-1}. The soil was analyzed before the planting of wheat crop and after the harvesting of crop for the different soil properties (Table 1&2). The four organic products such as organic fertilizer, compost, humic acid and sea weed extract were used for wheat production. The treatments includes: (1) Organic fertilizer 625 Kg ha^{-1} (2) Organic fertilizer 625 Kg ha^{-1} plus Humic Acid 10 kg ha^{-1} (3) Humic Acid 10 Kg ha^{-1} and Sea weed extract 625 ml ha^{-1} and (4) Control.

The organic fertilizer was formulated on domestic scale. Farm yard manure and poultry manure was enriched, fermented and decomposed with Rock phosphate(20% 0f total raw material), Mud Sulfur(5% of raw material), blood meal/fresh blood (1% of total raw material)and saw dust (2% of total raw material). Pakistan has plenty of natural reserves of Phosphorous in Distt. Haripur, Khyber Pakhtoon Kha (KPK). The quality of Rock Phosphate depending on P constituents varies from P_2O_5 from10% to 31% (Notholt *et al.,* 1989). The best quality Rock Phosphate 31% is enriched in Farm Yard manure, Poultry manure and vegetable waste to formulate organic fertilizer. The pH of the organic fertilizer is maintained by adding different organic fillers. The yeast and molasses were used as fermentation agents. The organic material and natural minerals were mixed in grinded form. The mixed and thoroughly incorporated organic material was fermented and decomposed for 28 days. The material was heaped in the windrow form and covered with 250 micron geo-membrane sheet. The decomposition was completed in 28 days; the material was passed through a hammer mill for converting organic fertilizer to fine powder.

Similarly, Bio-compost was prepared from poultry manure, farm yard manure and agricultural waste. All the organic wastes were incorporated and fermented for 28 days. The compost was fully mature and ready to use for the crop production. Similarly, humic Acid was prepared on domestic basis by using lignatic natural coal and treated with mines potassium hydroxide to convert it alkaline. The humic acid was utilized for soil fertility and foliar application.

The nutrient index in organic fertilizer is very high (Table 3) and versatile as well. It adds organic matter in the soil and enhances microbial activity. The quality of organic fertilizer is much better than chemical fertilizer because it continues adding microbes and organic matter in the soil. These two

Table 1. Chemical analysis of rock phosphate and organic fertilizer

	Nitrogen total (%)	Phosphorus total (%)	pH	ECe (dS m^{-1})	O.M (%)	K_2O (%)
Rock phosphate	0.16	13.60	7.72	0.54	7.24	0.46
Organic Fertilizer	3.50	9.88	5.76	9.98	28.49	5.10
Organic fertilizer (one year old)	2.85	8.09	5.88	8.20	27.49	4.72

Table 2. Physico-chemical properties of soil

Treatments	Clay (%)	Silt (%)	Sand (%)	$CaCO_3$ (%)	CEC (µmol C g^{-1})
Organic fertilizer	14	48	38	9.2	118
Organic fertilizer plus humic acid	16	65	09	8.8	124
Humic acid plus sea weed extract	16	61	25	6.8	133
Control	18	48	34	9.7	120

Table 3. Pre and post experiment Soil Microbial Biomass and its N and P contents

	Microbial Biomass C (µg g^{-1} soil)		Microbial biomass N (µg g^{-1} soil)		Microbial biomass P (µg g^{-1} soil)	
	Pre-soil analysis	Post-soil analysis	Pre-soil	Post-soil	Pre-soil	Post-soil
Organic fertilizer	90c	100c	17c	27c	13c	18c
Organic fertilizer plus humic acid	150b	195b	25b	60b	18b	35b
Humic acid plus sea weed extract	235a	350a	45a	101a	37a	70a
Control	80c	90c	11c	18c	08b	12c

components enhance water holding capacity, CEC and microbial biomass of the soil.

Table 4. Chemical composition of Potassium Humate (Humic Acid)

Ingredients	Percent (%)
C	56.00
N	3.20
COOH	0.36
OH	0.30
O	35.50
H	4.70

RESULTS AND DISCUSSION

The pre and post soil analyzed was dominated by the silt fraction with median 54% followed by clay fraction more than 20% and the sand fraction with a median of 16% (Table 2). The soil organic matter in the soil before addition of organic substrates was very low ranging from 0.69 to 1.42% (Table 5). The organic matter fraction was increased after adding wheat residue and organic amendment, the average increase was from 1.32 to 2.82% (Table 6). The pH and electrical conductivity of all the soils decreased significantly after organic amendment and addition of wheat residue on harvesting of wheat crop. The maximum decease in pH values was 7.10 in the treatment with organic amendments and the highest was 7.82 in control condition. Hence it showed maximum decrease with addition of organic fertilizer and wheat residue incorporation. The decrease in pH is due to addition of mud sulfur in organic fertilizer. The pH of organic fertilizer is about 5.76 which were safe for alkaline soils of Pakistan. Many scientists have also reported that soil pH and CEC can be managed with addition of elemental Sulfur. In present study mud sulfur which is organic source was added in the organic fertilizer formulation. This had reduced soil pH and some other hazardous salts in the soil. Similar results were observed by Bill, 2004. He also reported increase in soil organic matter with addition of organic substrates in any form. The same soil has pH ranging from an average of 7.85-8.32 before addition of organic fertilizers and amendments. Similarly, electrical conductivity decreased significantly from 0.34-0.68 dS m^{-1} to 0.13-0.21 dS m^{-1} (Table 6). The nutrients contents of organic fertilizer, Humic Acid and sea weed extract are enough to provide the essential macro and micronutrients for wheat crop. The P_2O_5 contents in Rock phosphate were more than 31% which ultimately remain up to 23% in organic fertilizer (Table 1). The nitrogen content was 3.2 % and after addition to organic fertilizer remained up to 3%. The organic Nitrogen constituents and its sources were blood, fish meal and coal. The organic fertilizer is a

Table 5. Pre- soil analysis

Treatments	AB-DTPA. Extract (mg Kg^{-1})			pH	ECe	O.M (%)
	NO_3-N	PO_4-P	K		(dS m^{-1})	
Organic fertilizer	0.62	1.30	88	7.85	0.37	1.31
Organic fertilizer plus humic acid	0.064	2.35	76	8.08	0.68	1.28
Humic acid plus sea weed extract	1.10	8.9	176	8.18	0.43	1.42
Control	0.37	4.32	124	8.32	0.34	0.69

Table 6. Post-experiment soil analysis

Treatments	ECe (dS m^{-1})	PH	P (µg/g)	K(µg/g)	OM (%)	CEC (µmol C g^{-1})
Organic fertilizer	0.18	7.25	3.00	60	1.86	180
Organic fertilizer plus humic acid	0.13	7.10	2.86	55	2.82	224
Humic acid plus sea weed extract	0.19	7.32	9.39	108	2.32	178
Control	0.21	7.82	2.87	72	1.32	148

Table 7. Growth and yield parameters of organic wheat

Treatments	Plant height (cm)	Spike length (cm)	Number of Spike lets spike	Tillers/ m^2	Biological yield (kg/ha)	1000 grain wt. (g)
Organic fertilizer	100.8 a	10.0 b	21.2 b	241 bc	9406 ab	39.3b
Organic fertilizer plus humic acid	106.0 a	11.4 a	26.1 a	277 a	11000 a	48.0a
Humic acid plus sea weed extract	99.5 a	9.8 b	19.7 b	213 ab	8719 ab	39.5b
Control	86.1 b	8.2 c	16.1 c	198 c	7731 b	30.5c
LSD	2.653	0.930	4.426	72.71	458.6	0.517

versatile source of organic nutrients which have the capability to release essential nutrients during crop growth. The results showed that there is better nutrient supply to crop when organic fertilizer, Humic Acid and bio-trace were applied (Table 5). Increase in soil organic matter (Table 6) reveals the same results as reported by Chang *et al.* (1991) who reported an increase in soil organic matter by the application of manure. Moreover, solubility of P increased in the soil solution due to increase in microbial activity and mycorrhizal growth in the soil. The soil reserves are even high in both P and K which is clear picture of improvement of soil chemical, biological properties and soils quality. Similarly, soil physical properties have also been improved by addition of organic substrates in the soil. Hence application of organic products proved better for soil as well as for the crop (Table 6 & 7). Farmyard manure application reduces the adverse effects of brackish water (Munir *et al*., 2012).

Significant difference was observed in plant biomass at heading stage by adding organic fertilizer 625 Kg ha^{-1} with humic acid 10 Kg ha^{-1} and alone. However maximum biomass was recorded in organic fertilizer and humic acid treatment.The increase in shoot and root emergence m^{-2} is due to sufficient supply and release NPK as reported by Ayoub *et al.* (1994) and Iqtidar *et al.* (2006). The minimum shoot and root biomass was recorded in the control treatment (Table 7). This shows that use of organic fertilizer in combination with humic acid and alone significantly ($P<0.05$) increases the crop growth (Table 6).

The grain formation during the grain development stages showed significant differences in the number of grains/spike and fresh weights/spike, similar significant differences in dry weights/spike were recorded at the later stages of grain growth as well (Table 6).The increase in the spike with different level of NPK and doses of organic fertilizers and other organic amendments. Actually they have released enough NPK in the rhizosphere with enhanced microbial activities which increase spike length and number of grains per spike. These results are in the line with many other researchers like Ayoub *et al.* (1994), Frederick and Camberato (1995), Iqtidar *et al.* (2006), Lloveras *et al.* (2001) and Mossedaq and Smith (1994).

Treatments 1, 2 and 3 showed promising plant height while reduction in height was observed in control (96.1 cm). It revealed that organic fertilizer and humic acid supported the plants in growth and height (Table 7) by giving maximum number of tillers (277 m^{-2}) and minimum number of tillers were recorded in control (198 m^{-2}). Application of organic fertilizer and humic acid produced maximum biological yield (11000kg ha^{-1}) while minimum biological yield (7731kg ha^{-1}) was recorded in the control treatment (Table 7) (Badaruddin *et al.*, 1994; Matsi *et al.*, 2003) . Similarly, significant differences in 1000 grains weights were recorded by applying the different treatments (Table 7).These results are due to application of organic fertilizers and other organic amendments which mobilized, solubilized, fixed and retained P in the soil. The better plant height, tillering and biological yield increase due to release of additional nutrients retained in soil. The addition of organic substrates, in the soil, increased grain yield (5555 kg ha^{-1}) while minimum grain yield (2255 kg ha^{-1}) was recorded in the control (Table 7)**.** Maximum increase in grain yield with an income of Rs. 90234 was observed in the treatment of organic fertilizer and humic acid followed by treatment of organic fertilizer, humic acid and sea weed extract (Organic matter 120 g/L, Sea weed extracted matter 20 g/L, N + P_2O_5 + K_2O-120 g/L, Micronutrients CU + Fe + Zn +B -5g/L). (Table 7). The results are similar to the findings of Negi and Mahajan (2000) and Mishra (2000) who reported significant reduction in grain yield when no FYM was added in comparison with the addition of FYM and inorganic fertilizers.

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