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Original Article

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ASSESSMENT OF COMBINED EFFECT OF HUMAN FECES COMPOST AND SINGLE SUPERPHOSPHATE ON THE BEHAVIOUR OF WHEAT PRODUCTION

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ABSTRACT. Application of organic fertilizers in improving soil fertility has become a major factor that has enabled the world to feed billions of people. However, the required quantities of organic material are enormous, so it becomes necessary to combine different types of fertilizers to feed plants. The effectiveness of human feces compost (HC) alone, as well as in combination with single super phosphate (SSP), was evaluated in the present study. A field experiment was conducted at farmer field located in district Swabi (Pakistan). A total of eight possible treatments combination were arranged in randomized complete block design (RCBD), replicated four times. Two levels of human feces compost (HC), including control (HC0: control and HC1: 7.5 t ha^{-1}) and four levels of P, as single superphosphate (SSP), including control (P0: control, P1:40 kg ha^{-1}, P2: 60 kg ha^{-1} and P3: 90 kg ha^{-1}) were utilized in the experiment. Results revealed that among all the treatments, combined application of SSP at 60 kg ha^{-1} along with 7.5t ha^{-1} HC significantly improved the growth, as well as the yield parameters of wheat crop. These results allow saving a half of usually made mineral fertilizer dose for the cultivation of wheat crop. Combined use of HC and SSP were strongly recommended for obtaining maximum wheat yield in the prevailing soil and environmental conditions.

Keywords: phosphorous; Swabi; calcareous soil; wheat.

INTRODUCTION

Continuous use of inorganic fertilizers and no use of organic fertilizers is becoming a serious threat to soil fertility in Pakistan, and that might be the big reason of low wheat production, as compared to the developing countries (Jamal and Fawad, 2018). In recent modern era, agricultural scientists have a keen interest to develop an agricultural system, which can lower production

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cost and conserve the natural resources. Therefore, recent interest in application of organic fertilizers has reemerged because of high prices of inorganic fertilizers and the importance of organic fertilizers that provide long term soil productivity, as well as provides almost all essential nutrients to crops and in return increased productivity (Abas *et al.*, 2012). Pakistani soils are generally low in organic matter content (< 1%) because of arid climate and addition of less organic matter to soils during cultivation (Jamal and Jamal 2018). Soil fertility can be increased with addition of organic matter and utilization of minerals (Azad *et al.,* 1982) and in combination render greater beneficial effects on plant growth and yield (Channabasanagowda *et al.,* 2008). The use of organic manures, like composts, animal manure, as well as human waste, may be a positive and significant step in improving soil fertility, as it restores of the exhausted nutrients from the soil (Jamal and Fawad, 2018). Organic materials not only improve soil health, but also play a key role in phyto-availability of the nutrients by increasing organic matter contents in the soil and improving the soil texture (Alam *et al*., 2003).

Human excreta can be used as fertilizer for growing crops because it contains many essential macro, as well as micro nutrients (Heinonen-Tanski and Van Wijk-Sijbesma, 2005). The beneficial effect of human excreta for crop growth has the subject of numerous researchers.

Schouw *et al. (*2002) reported that human excreta is the best and major source of macro as well as micro nutrients. Similarly, Guzha *et al.* (2005) studied human fecal matter as a fertilizer and reported an improvement in maize yield, as well as in soil fertility with application of human excreta. The developed countries, like China and Japan, frequently used human excreta as night soils, without any hesitation for agricultural productivity. However, poor handling of human excreta has been reported by Xu *et al.* (1995) and (Humphries *et al*., 1997).

It has been reported by many researchers that human excreta can be used as organic fertilizers because it provides appropriate amount of nitrogen (N), phosphorous (P), as well as potassium (K) for growing crops (Mnkeni and Austin, 2009; Kutu *et al.,* 2011), beside that human faeces also provide organic matter to the soil, which in turn improve soil structure (Jönsson *et al.,* 2004). Reuse of human excreta will reduce the pollution effects that result from unsafe excreta disposal and excess use of chemical fertilizers and protect surface and groundwater, as well as waterborne enteric microbiological diseases (Heinonen-Tanski and Wijk-Sijbesma, 2005).

Before using human waste as a fertilizer, they must be composted, as the number of enteric bacteria, viruses, protozoa and helminthes eggs in faeces can be high. Keeping in view the importance of human fecal compost for agricultural crops, the present study was organized on calcareous soil of Swabi (Pakistan) to evaluate the effect of human feces compost in combination with single super phosphate (SSP) on wheat crop yield.

MATERIAL AND METHODS

Experimental site description

The present study was conducted at farmer field at village Yar Hussain (Swabi), located at 34°10'19"N and 72°16'19 E of Khyber PakhtunKhwa, Pakistan, with an elevation of 295 m above the sea level, during 2017-18.

Human fecal source and composting process

Human fecal used to prepare the compost were collected from camp area, an informal settlement in experimental area Swabi. The fecal were collected in biodegradable bags that are single use toilets and used once by one person. Fecal compost was prepared by using pit method (Mengistu*et al.*, 2017 and Violet, 2015). A total of four pits were prepared for composting purpose, each measuring 2 m long by 2 m wide and 0.5 m deep. Biodegradable bags containing human feces were then laid in two layers and covered by a thin layer of soil. After three weeks, the contents were then transferred into another pit and to the third pit where it was allowed to cure for a month after which it was uncovered and packed in big bags ready for use.

Experimental design and treatments

Two levels of human fecal compost (HC), including control (HC0: control and HC1: 7.5 t ha^{-1}) and four levels of P as single super phosphate (SSP), including control (P0: control, P1:40 kg ha^{-1}, P2: 60 kg ha^{-1} and P3: 90 kg ha^{-1}) were utilized in the experiment. Eight possible treatments combination were arranged in RCBD, replicated four times. Each plot size was kept to 20 m^2; all the treatments were applied before seed sowing. Wheat variety Pirsabak 2013 was used as test crop and was sown with seed rate of 120 kg seed ha^{-1} and maintained row to row distance of 25 cm. All the agronomic and cultural practices were maintained during the experiment. At maturity, the growth parameters, like plant height and spike length (cm), were recorded, while yield parameters, like 1000-grain weight, grain yield and biological yield (t ha^{-1}), were recorded after crop harvest.

Following treatments combination was utilized during the study: Treatment 1 - P0HC0; Treatment 2 - P0HC1; Treatment 3 - P1HC0; Treatment 4 - P1HC1; Treatment 5 - P2HC0; Treatment 6 - P2HC1; Treatment 7 - P3HC0; Treatment 8 - P3HC1.

Physico-chemical properties of soil

A composite soil sample was taken (0-20 cm depth) from the field before treatments application and was analyzed for various physical and chemical properties, like pH, EC (Richards, 1954), soil texture (Gee and Bauder 1986), lime content (U.S. Salinity Laboratory Staff. 1954), and organic matter (OM) (Nelson and Sommer, 1982). The soil was also analyzed for total N (Bremner, 1996), AB-DTPA-extractable P and K (Soltanpour, 1985). The soil under study was found highly calcareous in nature, alkaline in reaction with pH value (8.0), EC (1.5), low in organic matter content (0.59) and silty clay loam in texture. The available total N 0.04%, available P 3.9 mg kg^{-1} and exchangeable K 130 mg kg^{-1} were recorded, respectively (*Table 1*). Soil of district Swabi was found low in OM content, as reported by Jamal and Jamal (2018).

Table 1 - Physico-chemical properties of under study soil (0-20 cm depth)

Property	Value
Clay (%)	19
Silt (%)	62
Sand (%)	19
Textural class	Silty clay loam (SCL)
pH (1:5; Soil: Water)	8.0
Organic matter (%)	0.59
EC (dsm^{-1})	1.5
Lime ($CaCO_3$) (%)	16.8
AB-DTPA P (mg kg^{-1})	3.9
Total N (%)	0.04
AB-DTPA K (mg kg^{-1})	130

Statistical analysis

Using Statistix, 2000 package and Least Significant Difference (LSD) test, the collected data were analyzed statistically for any significant difference among the treatments (Steel and Torri, 1981).

RESULTS AND DISCUSSION

Plant height (cm)

The overall result of different treatments on wheat plant height was found non-significant at $p < 0.05$ (*Table 2*). Many researchers reported significant increase in wheat plant height with application of P, as well as organic fertilizers in the prevailing soil and environmental conditions (Jamal and Fawad 2018, Naseer and Muhammad, 2014). The non-significant effect might be due to marginal AB-DTPA extractable P (3.9 mg kg^{-1}), in addition the P is known to more contribute in yielding components, like flower, seed formation and ripening rather than crop growth.

Spike length

Application of human fecal compost alone and in combination with single superphosphate significantly increased the wheat spike length, as compared with control treatment (*Table 2*). The maximum spike length of 8.62 cm was recorded at T6, where P was applied at 60 kg ha^{-1} in combination with human fecal compost at 7.5 t ha^{-1} (*Table 2*). However, the values of spike length at T6, T7 and T8 were found statistically similar with each other, indicated that possibly 60 kg ha^{-1} in combination with human fecal compost at 7.5 t ha^{-1} could be the optimum level under the given soil and climatic conditions. Our results were in lined with Jamal and Fawad (2018) and Ahmad *et al*. (2013); they also reported an increased in wheat spike length with the application of organic and inorganic fertilizers.

1000-grain weight

Application of different treatments significantly increased wheat 1000-grain weight. The maximum 1000-grain weight of 45 g was recorded at T8, where P was applied at rate of 90 kg ha^{-1} with HC at rate of 7.5t ha^{-1} (*Table 2*). However, this highest 1000-grain weight was statistically similar and closely followed by T6 with value of 44.7 g, where P was applied in combination with HC at 60 kg ha^{-1} and 7.5 t ha^{-1}, respectively.

Our results were in agreement with Ahmad *et al*. (2013), Jamal and Fawad (2018), Akhtar *et al*. (2000) and Jamal *et al*. (2019); they reported that organic fertilizers in combination with chemical fertilizers significantly improved yield contributing factors in wheat crop, as compared with chemical fertilizers applied alone.

Biological yield

The data on biological yield of wheat responded significantly to different applied treatments. Biological yield of wheat was significantly increased from 4.65 at T1 (control) to 13.2 t ha^{-1}at T6, where P was applied in combination with HC at 60 kg ha^{-1} and 7.5 t ha^{-1}, respectively (*Table 2*). These values suggested that 60 kg ha^{-1} P along with HC at 7.5 t ha^{-1}could be the optimum levels to avoid the luxury consumption by crop and extra input by farmers. Our result was also in lined with the findings of Ghosh *et al.* (2004) and Sarwar *et al.* (2007). The significant effect of organic and chemical fertilizers in combination for wheat crop was also reported by Jamal and Fawad (2018) and Jamal *et al.* (2019) for the same soil and environmental conditions.

Grain yield

Wheat grain yield was significantly increased with the application of SSP and HC, either applied alone or in combination, as compared with the control treatment. The maximum grain yield of 4.82 t ha^{-1} was recorded in T6, where P was applied in combination with HC at 60 kg ha^{-1} and 7.5 t ha^{-1}, respectively (*Table 2*). The increase in grain yield is in consistency of many research reports. Ahmad *et al.* (2013) revealed that yield in high lime was low, which gradually increased with P application along with organic fertilizers. Similarly, Patil *et al.* (2000) reported maximum grain yield with application of organic fertilizers. Our results were also in lined with the findings of Abbas *et al.* (2012), Jamal *et al.* (2019) and Jamal and Fawad (2018).

Table 2 - Effect of different levels of SSP alone and in combination with HC on plant height, spike length, 1000-grain weight, grain yield and biological yield of wheat

Treatments	Plant height (cm)	Spike length (cm)	1000-grain weight (g)	Biological yield (t ha^{-1})	Grain yield (t ha^{-1})
T1 = *P0HC0	75.250a	7.9450d	32.250g	4.650e	**2.1325e
T2 = P0HC1	75.250a	8.0500cd	34.000f	5.350e	2.9000d
T3 = P1HC0	76.250a	8.1250cd	36.000e	6.325d	3.1000d
T4 = P1HC1	75.000a	8.2500bc	37.750d	8.475c	3.6750c
T5 = P2HC0	75.500a	8.3250bc	39.500c	9.175c	3.7750c
T6 = P2HC1	76.250a	8.6250a	44.750a	13.200a	4.8250a
T7 = P3HC0	75.250a	8.6250a	42.000b	11.500b	3.9500c
T8 = P3HC1	76.000a	8.6250a	45.000a	12.500a	4.3250b
LSD $_{(0.05)}$	**NS**	**0.2891**	**1.3767**	**0.7967**	**0.3495**

*P (P0, P1, P2 and P3): P_2O_5 levels (control, 40, 60 and 90 kg ha^{-1}) and HC (HC0 and HC1): Human fecal compost levels (control and 7.5 t ha^{-1}); **Means with different letter (s) in columns are significantly different at $p< 0.05$.

CONCLUSIONS

It was concluded from the results that the effect of HC on wheat yield is more pronounced at low level of SSP, as compared to higher levels. Furthermore, it was concluded that 60 kg ha^{-1} P along with 7.5 t ha^{-1} HC was more effective and could be the optimum level for wheat crop in the prevailing soil and environmental conditions. Further researches were strongly recommended for widespread recommendations.

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