Effect of Organic Manure and Mineral Fertilizers on Wheat Growth and Soil Properties

Naila Khatoon Phullan[1], Mehrunisa Memon[1*], Javaid Ahmed Shah[2], Muhammad Yousuf Memon[2], Tanveer Ali Sial[3], Naheed Akhtar Talpur[1]and Ghulam Mujtaba Khushk[4]

[1]*Department of Soil Science, Sindh Agriculture University, Tandojam, Pakistan*

[2]*Nuclear Institute of Agriculture (NIA) Tandojam, Sindh, Pakistan*

[3]*College of Resources & Environment, Northwest A & F University, Yangling, Shaanxi, 712100, China*

[4]*Department of Rural Sociology, Sindh Agriculture University, Tandojam, Pakistan*

Abstract: Sustainable crop management relies on the combined use of organic and inorganic sources of nutrients. The experiment was laid out in a split plot design with manures (control, farmyard manure, sesbania and cluster bean) as main split and mineral fertilizer rates (control, 40-30, 60-45, 80-60, 90-70 and 120-90 kg N-P_2O_5 ha^{-1}) as sub-split. The manures significantly influenced shoot dry weight, N, P and K uptake and soil properties. Conversely, the rates of mineral fertilizers did not have any effect on soil properties, however, significantly enhanced the shoot dry weight and N, P and K uptake. The combined use of manures and mineral fertilizers had a significant effect on shoot P uptake. Farmyard manure was the best manure amendment with 13% reduction in bulk density and 51% increase in organic matter content over control. Incorporation of farmyard manure increased the shoot dry weight and N, P and K uptake, respectively by 8, 14, 11 and 8% over control. Among rates of mineral fertilizers, recommended rate of mineral fertilizer (120-90 kg N-P_2O_5 ha^{-1}) was the best treatment with corresponding increase of 26, 81, 56 and 55% in shoot dry weight, N, P and K uptake over control. Integration of farmyard manure with recommended rate of mineral fertilizer enhanced shoot P uptake by 17% as compared to solo application of mineral fertilizers. Through this study, it was concluded that farmyard manure at 6 tons ha^{-1} coupled with mineral fertilizer rate of 120-90 kg N-P_2O_5 ha^{-1} was the best source for sustainable soil health and wheat production.

Keywords: Cluster bean, farmyard manure, green manure, organic, sesbania, wheat.

INTRODUCTION

Soils of Pakistan are generally high in pH, calcareous in nature, low in organic matter content and deficient in essential plant nutrients [1]. The prevailing conditions reduce the efficacy of mineral fertilizers and ultimately affect the productivity of crop [2]. Wheat is an important cereal crop of Pakistan cultivated on large area of 9.18 m ha with production of 25.5 m tons [3]. Average crop yield is lower than the other wheat growing countries of the world. Besides, imbalanced fertilization is one of the major yield limiting factors. It not only affects the crop quality, but hampers the crop yield potential in many countries of the world [4]. In Pakistan, mostly growers are managing deficiencies of primary macro nutrients like nitrogen (N) and phosphorus (P) and to some extent potassium (K) by applying mineral fertilizers. However, management of some secondary macro and micronutrients is completely ignored. Intensive cultivation of high yielding crop varieties without proper nutrient management is not only depleting limited nutrient reservoirs of soil, but also reducing the nutrient use efficiency. Moreover, mineral fertilizer requirement cannot be completely fulfilled by the fertilizer industry due to wide margin between production capacity and crop demand. A large quantity of mineral fertilizers, especially micronutrients is currently being imported. The high cost of mineral fertilizers, low use efficiency and less availability makes it difficult to manage crop production [5]. Integrated plant nutrition management (IPNM) can be the best alternate approach for better crop production and sustainable soil health. Under IPNM, different nutrient sources are collectively used in a sustainable manner. Incorporation of organic manures along with mineral fertilizers can help in improving soil properties and reduce nutrient leaching, thereby increase the efficacy of mineral fertilizers [6, 7, 8]. Farmyard manure contains 0.05-1.50% N, 0.40-0.80% P_2O_5, and 0.50-1.90% K_2O [9]. Application of farmyard manure enhanced water holding capacity of soil, cation exchange capacity, soil aeration, seed germination and plant growth [10]. Similarly, green manure crops like sesbania (*Sesbania aculeate*) and cluster bean (*Cyamopsis tetragonoloba*) increased soil organic matter content, nutrient availability, soil fertility by improving soil physico-chemical and biological properties and also reduced nutrient losses [11, 12]. Cluster bean may contribute about 220 kg N ha^{-1} in terms of N fixation by nodules [13]. Plowing of sesbania

*Address correspondence to this author at the Department of Soil Science, Sindh Agriculture University, Tandojam, Pakistan;
E-mail: nisamemon@gmail.com

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as green manure significantly enhanced the paddy yield [14]. Moreover, integration of farmyard manure and green manures with mineral fertilizers in wheat-rice-wheat cropping pattern enhanced yield of both crops [15]. Similarly, another study reported significant increase in wheat harvest with the integration of farmyard manure and mineral fertilizers [16]. Healthy plants actually produce the highest yield, which is not possible without healthy soil and balanced fertilization. Farmyard manure application is relatively a common practice over green manures. The soil nutrient dynamics may vary with the type of organic source as well as the rate of mineral fertilizer. The main aim of this study was to establish the effective IPNM system for wheat-cotton-wheat cropping pattern.

MATERIALS AND METHODS

The experiment was carried out under semi-arid subtropical environment located at a altitude of 14 m of marine level in Sindh province of, Pakistan. Temperature varied between 10-36°C during the growth period (October to December) of crop. The experiment was laid out in a split plot design with four organic manures (control, farmyard manure, sesbania and cluster bean) as main split and mineral fertilizer rates (control, 40-30, 60-45, 80-60, 90-70 and 120-90 kg $N\text{-}P_2O_5$ ha^{-1}) as sub-split replicated four times. Farmyard manure was applied at 6 tons ha^{-1}, sesbania and cluster bean were sown and plowed into the experimental field at flowering stage before the sowing of wheat crop. In addition, all the treatments received a basal rate of K (60 kg K_2O ha^{-1}). One composite sample from each organic manure treatment was analyzed for N, P and K contents following the standard procedures [17]. Addition of nutrients in soil via organic manures was calculated on the basis of nutrient content in the dried matter. The incorporation of farmyard manure, cluster bean and sesbania added 112, 158 and 146 kg N ha^{-1}, 27, 13 and 15 kg P ha^{-1} and 105, 147 and 142 kg K ha^{-1}, respectively. Mineral fertilizer application was carried out as per treatment requirement. All of P_2O_5 (DAP), K_2O (SOP) and half of N (urea) were applied as basal rate and the leftover N at 1st irrigation. Wheat variety NIA-Sarang was sown by drilling method at 30 cm row to row distance. All the cultural practices were performed as per requirement of the crop. Fifteen plant shoots were randomly harvested after 45 days of sowing and the data regarding growth traits was recorded. The harvested material was washed with deionized water and dried at 70°C till its constant weight and ground in Willey's mill. Nitrogen in the plant material was determined by using modified Kjeldahl's method [18]. For P and K determination, plant material was digested in 5:1 acid mixture (HNO_3:$HClO_4$). The digests were separately used to determine P by developing blue coloured complex using spectrophotometer (UV-1800, Shimadzu-Japan) and K directly by emission spectrophotometry using flame photometer (Jenway-PFP 7, Essex-England) [17]. The nutrient content determined was used to calculate the uptake [19]. The composite soil samples collected from each experimental unit at the time of plant harvest were air-dried, ground in a wooden pestle mortar, passed through 2 mm sieve and analyzed for $pH_{1:2.5}$, bulk and particle density and organic matter content following the standard procedures [17]. The data obtained was statistically analyzed for analysis of variance test using computer software Statistix 8.1 [20]. The significant parameters were followed by Tukey's honestly significance difference (HSD) test for separation of means at alpha 0.05 probability level.

RESULTS

Organic manures significantly ($p<0.05$) influenced biomass production, nutrient contents, all soil properties, except soil porosity and pH (Table **1**). Mineral fertilizers also had a significant ($p<0.05$) effect on shoot dry matter yield and nutrient (N, P and K) content with exception to bulk density, soil porosity, organic matter and pH. The interaction of organic manures and mineral fertilizers had non-significant effect on all soil properties except shoot P uptake.

Shoot Dry Weight Per Plant

Shoot dry weight was significantly influenced with the incorporation of organic manures and rates of mineral fertilizers (Table **1** and Figure **1a** and **b**). In case of organic manures, maximum shoot dry weight of 0.263 g $plant^{-1}$ (8% over mineral fertilizer) was noted in plots fertilized with farmyard manure. However, plowing of sesbania and cluster bean into the soil could not significantly increase the shoot dry weight. The rates of mineral fertilizers produced capricious effects on shoot dry weight. The heaviest shoot dry weight of 0.278 g $plant^{-1}$ (26% over control) was noted in plots fertilized with recommended rate of mineral fertilizer (120-90 kg $N\text{-}P_2O_5$ ha^{-1}). In case of interactive effects of organic manures and mineral fertilizer, the highest shoot dry weight of 0.288 g $plant^{-1}$ (4.3% over recommended rate of mineral fertilizer and 38% over control) was noticed, where farmyard manure was integrated with recommended rate of mineral fertilizer.

Table 1: Mean of Squares from Analysis of Variance Table Showing Significance Level for Various Parameters under Organic Manures and Mineral Fertilizer Application

Parameter	Organic Manures	Mineral fertilizer	Organic manures × Mineral fertilizer
Bulk density	0.5498***	0.0011 ^{NS}	0.00105^{NS}
Soil Porosity	46.4585^{NS}	2.0624 ^{NS}	3.9212^{NS}
Soil organic matter	0.4915***	0.0062 ^{NS}	0.0019^{NS}
Soil pH	0.01756^{NS}	0.5579 ^{NS}	0.09957^{NS}
Shoot dry matter yield	0.00139*	0.00484***	0.00006^{NS}
Shoot N uptake	11.124***	59.138***	0.7980^{NS}
Shoot P uptake	0.0345***	0.0702***	0.0010***
Shoot K uptake	3.5357*	52.2848***	0.3888^{NS}

NS - non-significant, * and ***significant at HSD level of 0.05 and 0.001, respectively.

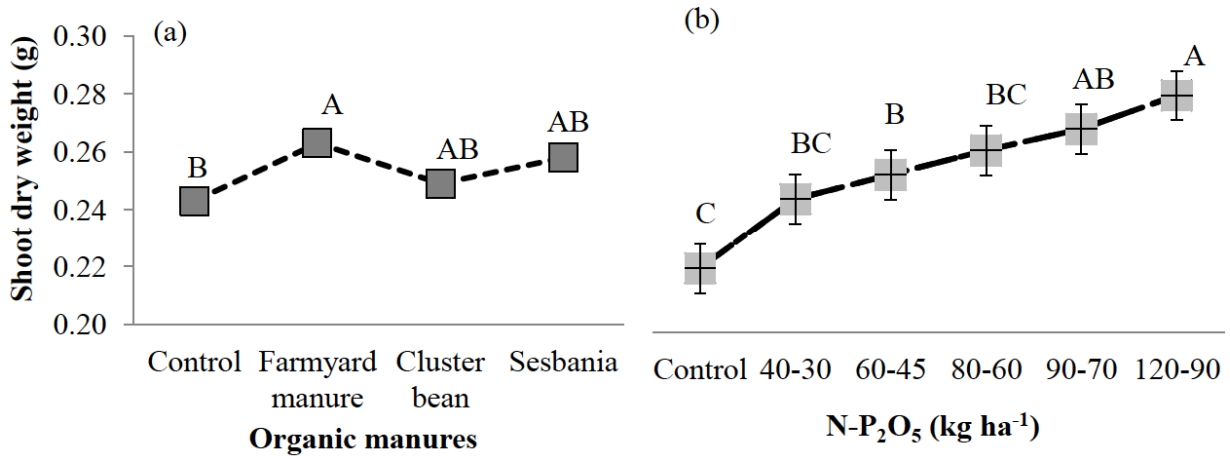

Figure 1: Effect of organic manures (**a**) and mineral fertilizer application (**b**) on shoot dry weight.

Nitrogen Uptake in Shoot

Application of organic manures and mineral fertilizers significantly influenced the N uptake of shoot (Table **1** and Figure **2**). In contrast to organic manures, the maximum N uptake of 12.7 kg ha^{-1} (14% over control) was recorded in plots fertilized with farmyard manure (Figure **2a**). Considering the rates of mineral fertilizers, the highest N uptake of 14.1 kg ha^{-1} (81% over control) was noticed in plots fertilized with recommended rate of mineral fertilizer (Figure **2b**). As for interactive effects of organic and mineral fertilizers, the highest N uptake of 14.7 kg ha^{-1} (7% over recommended rate of mineral fertilizer and more than twofold over control) was obtained where farmyard manure was integrated with recommended rate of mineral fertilizer with no significant differences.

Potassium Uptake in Shoot

Potassium uptake of shoot was also significantly influenced with application of organic manures and mineral fertilizers alone (Table **1** and Figure **2**). Highest K uptake of 13.4 kg ha^{-1} (8% over control) was recorded with the application farmyard manure (Figure **2a**). Considering mineral fertilizer rates, maximum shoot K uptake of 15.1 kg ha^{-1} (66% over control) was noticed at recommended rate of mineral fertilizer (Figure **2b**). In contrast to solo application of each organic manures and mineral fertilizers, the interaction of the two (although non-significant) gave the highest K uptake of 16.2 kg ha^{-1} (8% over recommended rate of mineral fertilizer and 95% over control).

Phosphorus Uptake in Shoot

Shoot P uptake was significantly influenced with the incorporation of organic manures, mineral fertilizers and the combination of the two (Table **1** and Figure **3**). Farmyard manure was found to be the most effective among organic manures having highest shoot P uptake of 0.55 kg ha^{-1} (11% over control). Among rates of mineral fertilizers, recommended rate was the most effective with 56% increase in shoot P uptake over

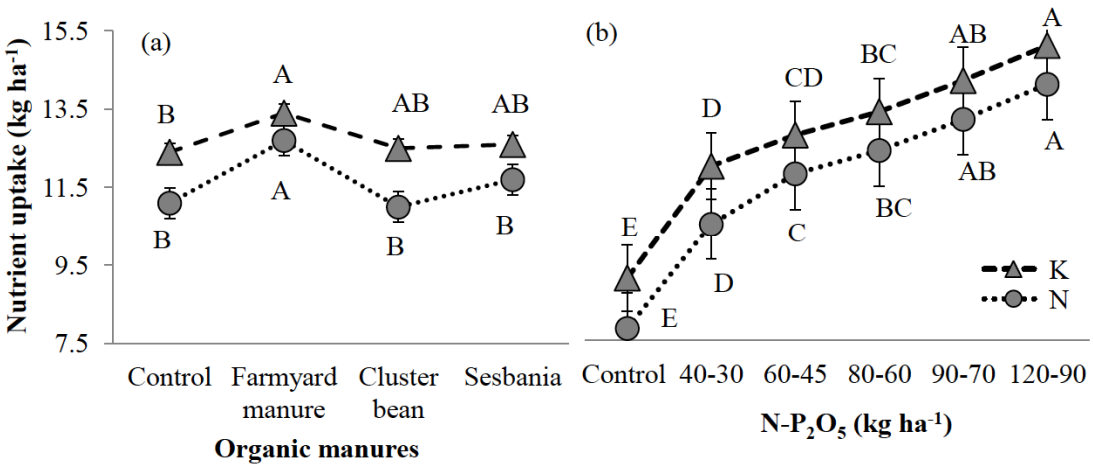

Figure 2: Effect of organic manures (**a**) and mineral fertilizer application (**b**) on N and K uptake.

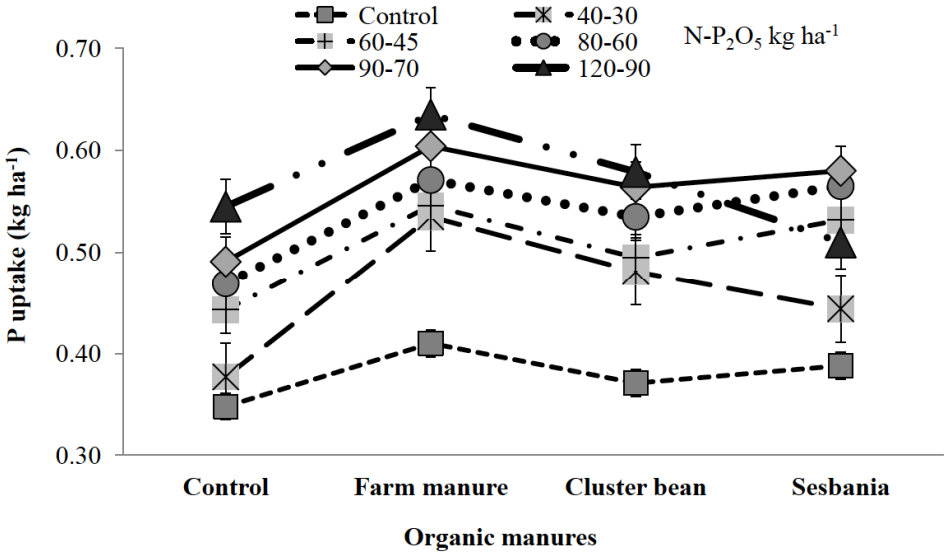

Figure 3: Effect of organic manures and mineral fertilizer application on P uptake.

control. In case of interaction, the highest shoot P uptake of 0.635 kg ha^{-1} (17% over recommended rate of mineral fertilizer and 82% over control) was recorded, where farmyard manure was incorporated with recommended rate of mineral fertilizers.

Soil Properties

Application of organic manures produced variable effects on soil properties (Table **2**). Soil bulk density was significantly influenced with application of organic and green manures. Application of organic manures reduced the bulk density of soil. Plots fertilized with farmyard manure reduced bulk density by 13%, compared to the plots fertilized with mineral fertilizers (Table **3**). Both green manure crops i.e. sesbania and cluster bean produced almost equal effects on soil bulk density and reduced it by 5% over mineral fertilizer. Rates of mineral fertilizers alone and in combination with organic manures did not have any significant effect on soil bulk density. Organic matter content of soil increased significantly with the application of farmyard manure and cluster bean (Table **2**). Incorporation of farmyard manure and plowing of sesbania enhanced the soil organic matter content, respectively by 51 and 31% over control. The data presented in Table **3** revealed that application of organic manures (farmyard manure, sesbania and cluster bean) and rates of mineral fertilizers could not significantly influence the soil pH and porosity.

DISCUSSION

The current scenario of Pakistani soils with regard to poor soil fertility status, low organic matter content and nutrient application rates, not only hampers the

Table 2: Effect of Organic Manures on Soil Properties

Organic manures	Bulk density (g cm^{-3})	Soil porosity (%)	Soil organic matter (%)	Soil pH
Control	1.190 A	7.8 A	0.780 C	50.1 A
Farmyard manure	1.056 C	7.7 A	1.181 A	53.7 A
Cluster bean	1.132 B	7.7 A	0.970 B	51.5 A
Sesbania	1.133 B	7.8 A	1.022 AB	52.9 A

Means followed by different letters are significantly different from each other @ 5% probability level.

Table 3: Effect of Mineral Fertilizer Rates on Soil Properties

Fertilizer treatments N-P_2O_5 (kg ha^{-1})	Bulk density (g cm^{-3})	Soil porosity (%)	Soil organic matter (%)	Soil pH
Control	1.143 A	52.3 A	0.972 A	7.7 A
40-30	1.127 A	51.8 A	0.966 A	7.6 A
60-45	1.122 A	52.2 A	1.002 A	7.8 A
80-60	1.116 A	51.8 A	1.028 A	7.7 A
90-70	1.123 A	52.6 A	0.978 A	7.7 A
120-90	1.134 A	51.5 A	0.982 A	7.7 A

Means followed by different letters are significantly different from each other @ 5% probability level.

yield targets but also adversely affect the properties of soil [21]. Under this study, the soil was amended with farmyard manure, cluster bean and sesbania with and without different mineral fertilizer rates using IPNM approach. The basic concept behind was that the crop growth and properties of soil will improve. The improvement in water use efficiency, eventually increases the biomass production [22]. Incorporation of organic manures and rate of mineral fertilizers significantly influenced shoot dry matter yield of wheat [23]. Increase in fresh weight of wheat with the incorporation of organic fertilizers have also been reported [24]. Increase in shoot dry matter yield at recommended rate of mineral fertilizer is due to the availability of nutrients. These studies reported highest N (154.7 kg ha^{-1}) and P (20.5 kg ha^{-1}) uptake at 150-75 kg N-P_2O_5 ha^{-1}. Improvement in crop yields under balanced fertilizer application has been reported by number of scientists [25, 16]. Application of organic and mineral fertilizers also affected the nutrient uptake of shoot. Farmyard manure and recommended rate of mineral fertilizers were found to have maximum NPK uptake in shoot. Incorporation of farmyard manure provided ideal conditions to plant by increasing P mobilization and improving microbial activities [26, 27]. Incorporation of organic manures alone and along with mineral fertilizers increased N and P uptake in plant [28]. Moreover, significant increase in N and P uptake has been reported at higher rates of N and P fertilizer. Organic manures actually provide supplement nutrients to plant and increase growth parameters of wheat crop [29]. Incorporation of farmyard manure, cluster bean and sesbania produced positive effects on soil properties and significantly reduced soil bulk density. Farmyard manure was found as best organic manure treatment for reduction of bulk density and enhancement of organic matter in soil, followed by green manures (sesbania and cluster bean). Among three organic manures, the superiority of farmyard manure in advancement of soil properties may be due to its large quantity (6 tons ha^{-1} $year^{-1}$). The studies [30] also supported this and reported that incorporation of farmyard manure at 6 tons ha^{-1} produced higher paddy yield and improvement in soil properties compared to lower rates. The research reports [8] regarding farmyard manure use were also in line with our studies. Soil porosity and pH were however, not significantly influenced by farmyard manure or even other two manures. This might be due to the high environmental temperature and buffering capacity of soil. Increase in global warming eventually deceases soil organic carbon stocks [31]. Application of poultry manure at different rats did not change pH of Calcisols due its hypo-buffering capacity [32]. A slight increase in porosity was noted with application of farmyard manure. Application of mineral fertilizer with and without organic manures produced a non-significant effect on almost all soil properties, unlike solo

application of organic manures with special reference to farmyard manure. Research reports [12] are in accordance with the results, where organic manures enhanced soil organic matter content and physical properties. Improved soil properties and growth of maize plants by using organic manures has also been reported elsewhere [33, 34, 35]. Soils amended constantly with organic manures give fruitful results.

CONCLUSION

Application of organic manures in conjunction with mineral fertilizers can improve soil properties, wheat growth and nutrient uptake. It can be concluded from the results of this study that application of farmyard manure was the best among three organic manures followed by similar performance of both sesbania and cluster bean. Farmyard manure (6 tons ha^{-1}) coupled with recommended mineral fertilizer rate (120-90 kg N-P_2O_5 ha^{-1}) improved dry shoot weight and nutrient uptake at early growth stage of wheat crop. Long term application of these manures can further improve the wheat growth and soil properties in a sustainable manner.

REFERENCES

[1] Abbas G, Khattak JZK, Mir A, Ishaque M, Hussain M, Wahedi HM, Ahmed MS and Ullah A. Effect of organic manures with recommended dose of NPK on the performance of wheat (*Triticum aestivum L.*). J Anim Plant Sci 2012; 22: 683-687.

[2] Rashid A. Boron deficiency in soils and crops of Pakistan: Diagnosis and Management. Islamabad: PARC; 2006.

[3] GOP (Government of Pakistan). Ministry of Food and Agriculture (Economic Wing), Agricultural Statistics of Pakistan, Islamabad; 2015.

[4] Ghaffar A, Mahmood A, Yasir A, Muhammad N, Mahmood T, Munir MK and Sattar A. Optimizing seed rate and row spacing for different wheat cultivars. Crop Environ 2013; 4: 11-18.

[5] NFDC. Annual fertilizer review 2007-08. National Fertilizer Development Centre, Planning and Development Division, Islamabad, Pakistan; 2008.

[6] Lamps S. Principles of integrated plant nutrition management system. In: Proc. Symp. Integrated plant nutrition management. (Nov. 8-10, 1999), NDFC, Planning and Development Division, Govt. of Pakistan. 2000; p 3-7.

[7] Bodruzzaman B, Meisner CA, Sadat MA and Hossain MI. Long term effects of applied organic manures and inorganic fertilizers on yield and soil fertility in a wheat-rice cropping pattern. World Congress of Soil Science, Australia. 2010; p 142-145.

[8] Tadesse T, Dechassa N, Bayu W and Gebeyehu S. Effects of farmyard manure and inorganic fertilizer application on soil physic-chemical properties and nutrient balance in rain-fed lowland rice ecosystem. Am J Plant Sci 2013; 4: 309-316. https://doi.org/10.4236/ajps.2013.42041

[9] Mukund J and Prabhakarasetty TK. Sustainability through organic farming. Delhi: Xpress Graphics; 2006.

[10] Sultani MI, Gill MA, Anwar MM and Athar M. Evaluation of soil physical properties as influenced by various green manuring legumes and phosphorus fertilization under rain fed conditions. Int J Environ Sci Technol 2007; 4: 109-118. https://doi.org/10.1007/BF03325968

[11] Akhtar N, Ali A, Ali Z and Iqbal J. Effect of integrated use of organic manures and inorganic fertilizers on grain yield of wheat. J Agric Res 2011; 49: 181-186.

[12] Naeem M, Khan MMA, Moinuddin K and Siddiqui MH. Triacontanol stimulates nitrogen-fixation, enzyme activities, photosynthesis, crop productivity and quality of hyacinth bean (*Lablab purpureus L.*). Sci Hortic 2009; 121: 389-396. https://doi.org/10.1016/j.scienta.2009.02.030

[13] Sanderson KW. Guar (*Cyamopsis tetragonoloba*) in the Rhodes ianlowveld. Rhodesia Agric J 1974; 71: 17-21.

[14] Mann RA and Ashraf M. Reduction of chemical fertilizers through organic matter supplement for rice production. Pak J Agri Res 2000; 16: 20-23.

[15] Ibrahim M, Rashid M, Nadeem MY and Mahmood K. Integrated use of green manuring, FYM, wheat straw and inorganic nutrients in rice-wheat crop rotation. In: Ahmad N and Hamid A, editors. Proceedings of Symposium Integrated Plant Nutrition Management; Nov.8-10, 1999, p 186-195. NFDC, Islamabad, Pakistan; 2000.

[16] Shah JA, Depar N, Memon MY, Aslam M and Sial NA. Integration of organic and mineral nutrient sources enhances wheat production. Pak J Agri Agril Engg Vet Sci 2013; 29: 106-113.

[17] Estefan G, Sommer R and Ryan J. Manual for the West Asia and North Africa region. 3rd edition. ICARDA. Aleppo, Syria; 2013.

[18] Bremner JM. Total nitrogen. In: Black CA *et al.* editors. Methods of soil analysis. Part 2. 1st ed. ASA, Madison, WI 1965; p. 1149-1178.

[19] Zhang Z, Tain X, Duan L, Wang B, He Z and Li Z. Differential responses of conventional and Bt-transgenic cotton to K deficiency. J Plant Nutr 2007; 30: 659-670. https://doi.org/10.1080/01904160701289206

[20] Steel RGD and Torrie JH. Principles and Procedures of Statistics. 2nd ed. New York: McGraw Hill Inc Book Co; 1980.

[21] Ahmad S, Naz SY and Raja MR. Effect of farm yard manure, crop residues and mineral fertilizers on wheat yield under rain fed conditions. Pak J Soil Sci 1998; 14: 111-113.

[22] Ahmad R, Naveed M, Aslam M, Zahir ZA and Arshad M. Economizing the use of nitrogen fertilizer in wheat production through enriched compost. Renew Agr Food Syst 2008; 23: 244-249. https://doi.org/10.1017/S1742170508002299

[23] Nyangani ET. Effect of combined application of organic manure and chemical fertilizers on soil properties and crop yields. Nigerian J Sci, Technol Environ Ed 2010; 3: 28-32.

[24] Sarwar G, Naseem AR and Mujeeb F. Efficacy of various organic materials for improving chemical characteristics of normal soil. Int J Agric Appl Sci 2009; 1: 97-101.

[25] Abbas M, Shah JA, Irfan M and Memon MY. Growth and yield performance of candidate wheat variety 'BWQ-4' under different nitrogen and phosphorus levels. Am Eurasian J Agric Environ Sci 2016; 16: 952-959.

[26] Muneshwar S, Singh VP, Reddy KS and Singh M. Effect of integrated use of fertilizer nitrogen and farm manure or green manure on transformation of N, K and S and productivity of rice-wheat system on a Vertisol. J Indian Soc Soil Sci 2001; 49: 430-435.

[27] Nevens F and Reheul D. The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: nitrogen availability and use. Eur J Agron 2003; 19: 189-203. https://doi.org/10.1016/S1161-0301(02)00036-9

[28] Salim M, Muhammad S. and Hassan M. Studies on synergistic effect of organic manure and mineral fertilizers on wheat yield and NP content of straw. Annual Report. 1980-87. Land Resource Section. NARC, Islamabad; 1986.

[29] Khan P, Imtiaz M, Memon MY, Aslam M, Shah JA and Sial N. Response of wheat genotype NIA Sundar to varying levels of nitrogen and phosphorus. Sarhad J Agric 2014; 30: 325-331.

[30] Siavoshi M. Effect of organic fertilizer on growth and yield components in rice (*Oryza sativa L*.). J Agric Sci 2011; 3: 217-224. https://doi.org/10.5539/jas.v3n3p217

[31] Kirschbaum MUF. The temperature dependence of soil organic matter decomposition and the effect of global warming on soil organic C storage. Soil Biol Biochem 1995; 27: 753-760. https://doi.org/10.1016/0038-0717(94)00242-S

[32] Dikinya O. and Mufwanzala N. Chicken manure-enhanced soil fertility and productivity: Effects of application rates. J Soil Sci Environ Manage 2010; 1:46-54.

[33] Memon M, Memon KS, Mirani S and Jamro GM. Comparative evaluation of organic wastes for improving maize growth and NPK content. Afr J Biotechnol 2012; 11: 9343-9349. https://doi.org/10.5897/AJB12.004

[34] Mashori NM, Memon M, Memon KS and Kakar H. Maize dry matter yield and P uptake as influenced by rock phosphate and single super phosphate treated with farm manure. Soil Environ 2013; 32: 130-134.

[35] Moe K, Mg KW, Win KK and Yamakawa T. Combined effect of organic manures and inorganic fertilizers on the growth and yield of hybrid rice (Palethwe-1). Am J Plant Sci 2017; 8: 1022-1042. https://doi.org/10.4236/ajps.2017.85068

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