



Available online freely at [www.isin.org](http://www.isin.org)

# Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network



RESEARCH ARTICLE

BIOSCIENCE RESEARCH, 2021 18(3): 2355-2361.

OPEN ACCESS

## Integrated nutrients management for enhancing yield and nutrients uptake in wheat under water eroded land

Murad Ali<sup>1</sup>, Wiqar Ahmad<sup>2</sup>, Irfan Ullah Khan<sup>1</sup>, Fazal Said<sup>3</sup>, Ahmad Zubair<sup>1</sup>, Muhammad Saeed<sup>1</sup>, Rifat Ali<sup>1</sup>, Zeeshan Shahzad<sup>4</sup>, Obaid Ullah Shah<sup>5</sup>

<sup>1</sup>Cereal Crops Research Institute, Pirsabak, Nowshera, Khyber Pakhtunkhwa, **Pakistan**

<sup>2</sup>Department of Soil and Environmental Sciences, The University of Agriculture, AMK Campus Mardan, **Pakistan**

<sup>3</sup>Department of Entomology, Abdul Wali Khan University, Mardan, **Pakistan**

<sup>4</sup>Department of Biotechnology and Genetic Engineering, Hazara University, Mansehra, **Pakistan**

<sup>5</sup>Department of Biotechnology Abdul Wali Khan University Mardan KPK Pakistan

\*Correspondence: [dr.fazal@awkum.edu.pk](mailto:dr.fazal@awkum.edu.pk) Received 04-06-2021, Revised: 28-08-2021, Accepted: 30-08-2021 e-Published: 01-09-2021

Integrated nutrient management is a well-documented strategy for soil fertility restoration provided that it is within permissible economic limits and are synchronized with existing farming practices. In this experiment, to restore fertility of soil various formulated combinations via three nutrient sources were tested in eroded agricultural field in District Swabi (34.72° N, 72.11° E). The combinations included a percentage share of the NPK recommended dose (RD; 120-90-60 kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O ha<sup>-1</sup>), FYM (t ha<sup>-1</sup>) and poultry manure (PM, (t ha<sup>-1</sup>) on fresh weight basis. Fourteen combinations of %NPK: FYM t ha<sup>-1</sup> : PM t ha<sup>-1</sup> were prepared including 0:0:0 (T1, control), 100%:0:0, 0:20:0, 25%:15:0, 50%:10:0, 75%:5:0, 0:0:10, 25%:0:7.5, 50%:0:5, 75%:0:2.5, 0:5:2.5, 25%:5:2.5, 50%:5:2.5 and 75%:5:2.5 and applied to soil according to recommended procedures. Results from this study revealed that 50%:5:2.5 combination of the NPK:FYM:PM increased the uptake of NPK significantly (by 200, 281 and 177%, respectively) and wheat grain yield (by 90%) over the control. Maximum post-harvest available NPK in soil (54, 31 and 272 kg ha<sup>-1</sup>) was recorded in 0:0:10 combination of NPK: FYM: PM whilst 50%:5:2.5 combination of the NPK:FYM:PM was also statistically similar to the former. It was evident from the results that poultry manure at the rate of 10 t ha<sup>-1</sup> was required for soil the restoration of soil NPK level, however, with regard to nutrients availability, uptake and the resultant grain yield, the combination of 50%:5:2.5 combination of the recommended NPK: FYM: PM was superior amongst all treatments toward sustainable farming under eroded soil conditions.

**Keywords:** Erosion, Nutrients uptake, organic and inorganic, Wheat, yield

### INTRODUCTION

Sustainability and conservation of basic natural resources such as soil and water has become top priorities in modern agriculture for enhancing crop production and securing the environment. Sustainable food security is one of the hot debates amongst policy makers due to rising population and stress on natural resources

worldwide. Pakistan is no exception, where almost 70% population is dependent on agriculture and allied professions (Usman, 2016). In population, Pakistan range sixth in the world (FAO, 2011) with extremely meagre per capita land resources. Therefore, the practice of cultivating sloping and marginal lands with inadequate farming methods has increased due to the increasing food

requirements of the population, resulting in the deterioration of precious land resources (Ali et al. 2007). Khan et al. (2001) reported heavy soil loss (2 to 104 t ha<sup>-1</sup> year<sup>-1</sup>) in northern areas of Pakistan due to several factors like soil characteristic, amount of rainfall and inadequate soil management. Due to water erosion, heavy losses of soil P, N and OM (48, 24 and 18 kg ha<sup>-1</sup> year<sup>-1</sup>, respectively) (Bhatti et al. 1997) as well as the deficiency of macro nutrients P and K (2.68 and 48 ppm, respectively) coupled with low organic matter has been reported (Bhatti et al. 1998). Crops production in lands with severe water erosion problem can be improved through the application of adequate crop management strategies, conservation practices and supplementation of nutrient elements from different sources (Khan et al. 2007). To maintain improve soil conditions and obtain sustainable agriculture productivity via crop nutrition from integrated sources is of vital importance (Ramalakshmi et al. 2012). Ghosh et al. (2015) used 30 to 50% of nitrogen fertilizers and 45% of P fertilizers used for crop improvement. Crop nutrition from integrated sources can improve nutrients use efficiency (Kumar et al. 2014) whilst this can increase 20 to 30% wheat yield and other physiological traits for enhancing nutrients uptake (Mohanty et al. 2013; Yadav et al. 2013). Long term research trials conducted under various agro climatic conditions revealed that application of essential plant nutrients via chemical fertilizers had harmful effects on soil quality resulting in unsustainable crop production (Jaga, 2013). Consequently, an enhanced and efficient plant nutrient supplementation strategy is required in the form of nutrient management from integrated sources (Aulakh, 2010). Integrated nutrient management is a well-documented strategy for soil fertility restoration provided that they are within permissible economic limits and are synchronized with existing farming practices. In our agricultural areas, nutrients are managed mostly from NPK and farmyard manure and rarely from poultry manure without any formulation for soil fertility restoration. Furthermore, improper and unbalanced fertilizer application can result in decreasing fertilizer use efficiency which makes the use of fertilizer uneconomical and impose harmful effect on environment (Aulakh and Adhya, 2005) as well as water quality in aquifers (Aulakh et al. 2009) resulting in serious health and climate change issues. Depending on chemical fertilizer, overuse is unsafe for environment, therefore, the native and organic plant nutrient sources are

required to be investigated (Kumari et al. 2010) through specific formulation with fractions from inorganic NPK fertilizers. In this experiment, formulated combinations of three nutrient sources viz NPK, farmyard manure and poultry manure were tested for restoration of soil fertility, crops productivity and nutrient uptake by wheat crop under eroded soil conditions in District Swabi.

## MATERIALS AND METHODS

### Experimental site and climate

Experimental plot was located on water eroded agricultural field in District Swabi (34.72° N, 72.11° E), KP province-Pakistan. The average rainfall of the area varies from 450 to 750 mm and average temperature of the crop growth season was 18.85±3 °C. However maximum mean temperature was 25.7±3°C and minimum temperature was 9.2±3°C, with a relative humidity was 57.6% (Pakistan Metrological Department, Risalpur).

### Physic-chemical properties of soil

The experimental sites was classified as Pirsabak soil series having USDA classification of fine, mixed, hyperthermic, Typic Haplustalf regarding the basic principle as prescribed in Key for the Soil Taxonomy (USDA, 1998). Soil sample (0–15 cm depth) was obtained from of the selected site prior to sowing and were analysed for the assessment of soil properties (Table 1).

**Table1: Nutritional value of Farm Yard Manures (FYM) and Poultry manure (PM)**

| Parameters  | F.Y.M | P.M   |
|-------------|-------|-------|
| N (%)       | 0.75  | 1.83  |
| OC (%)      | 14.43 | 24.05 |
| C / N Ratio | 19.25 | 13.14 |
| P (%)       | 0.204 | 0.992 |
| K (%)       | 0.52  | 1.36  |

### Treatments structure and experimental design

The experimental trial was carried out in randomized complete block design (RCBD) replicated three times and plot size was 3 m x 5 m. The treatments were formulated from percentage usage of recommended N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O (120-90-60 kg ha<sup>-1</sup>), 20 t ha<sup>-1</sup> FYM and 10 t ha<sup>-1</sup> Poultry manures (PM) and as such the given 14 treatments were formed ; 0-0-0 (control), 100:0:0, 0:20:0, 25:75:0, 50:50:0, 75:25:0, 0:0:100, 25:0:75, 50:0:50, 75:0:25, 0:25:25, 25:25:25, 50:25:25 and 75:25:25. The chemical composition of farmyard manure and poultry manure has been

illustrated in Table 2. All the organic fertilizer doses were applied to respective plots 15 days before sowing. Wheat variety as was sown @ 120kg ha<sup>-1</sup>seed rate. As sources for NPK Urea, DAP as well as SOP were applied, respectively. Nitrogen was given in 2 separate doses vis half during sowing while the other half dose during tiller formation. However, at during sowing P and K doses were given to field followed by uniform agronomic practices.

**Table 2: Fertility status of the experimental site before conducting the experiment**

| Properties.                           | Concentration. |
|---------------------------------------|----------------|
| Texture                               | Silt loam      |
| pH (1:5)                              | 7.80           |
| EC (1:5) (dS m <sup>-1</sup> )        | 0.53           |
| OM (%)                                | 0.69           |
| N (mineral) (mg kg <sup>-1</sup> )    | 13.6           |
| Extractable P (mg kg <sup>-1</sup> )  | 2.43           |
| (Extractable K (mg kg <sup>-1</sup> ) | 65.8           |

#### Traits examined

Data were recorded on grain yield, N, P and K uptake and post-harvest nutrients contents for N, P and K. Grain yield was obtained on whole plot harvest and threshing.

#### Analysis of Nutrients (N, P and K) and their uptake in Wheat plant

In wheat grain and straw the total nitrogen was calculated using the standard protocol as mentioned by Bremner (1996). The total N uptake was calculated as N concentration in wheat grain and straw multiplied with their respective biomass. Standard procedure for determination of P and K in plant samples was adopted as mentioned by Kue (1996) using spectrophotometer for P and flame photometer for K determination. The P and K uptake were calculated from their respective P and K concentration in wheat grain and straw. Available nitrogen in soil samples was determined by the method mentioned by Mulvany (1996). Soltanpour and Schawab (1977) procedure was used for the determination of available P and K in soil sample.

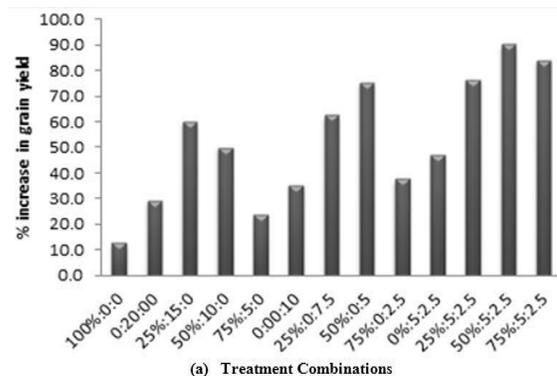
#### Statistical analysis

The data recorded on different parameters were subjected to analysis of variance (ANOVA) by using Statistics 8.1 software. Mean values were compared using least significant difference (LSD) test at the  $p \leq 5\%$  (Steel et al. 1997).

## RESULTS AND DISCUSSION

#### Grain yield

Soil supplementation with nutrients from different sources increased the grain yield significantly ( $p < 0.05$ ). The highest grain yield (4206 kg ha<sup>-1</sup>) was recorded in treatment receiving 50% of the recommended NPK, 25% (5 t ha<sup>-1</sup>) FYM and 25% (2.5 t ha<sup>-1</sup>) poultry manure (50:25:25 percentage of NPK: FYM: PM) (Table 3). The lowest grain yield (2211 kg ha<sup>-1</sup>) was recorded for control. The 50% NPK: 5 t ha<sup>-1</sup> FYM: 2.5 t ha<sup>-1</sup> PM enhanced the yield by 90% over the control treatment (Fig. 1 (a)). The use of organic manure might have improved soil nutrient holding capacity and boosted nutrients availability to crop. Application of mineral fertilizer might have enhanced crop yield and growth through supplementation of nutrients for immediate plant requirements whilst the decomposing organic manures might have served for plant food availability at the later growth stages of the crop resulting in higher grain yield from the treatment plots. The findings of this investigation are identical with result of Pooran et al. (2002), who concluded that statistically highest maximum grain yield was observed on treatment that were more fertile with proper water availability and better crop management.



**Figure 1 A: Per cent increase in (a) grain yield**

#### NPK uptake by wheat crop.

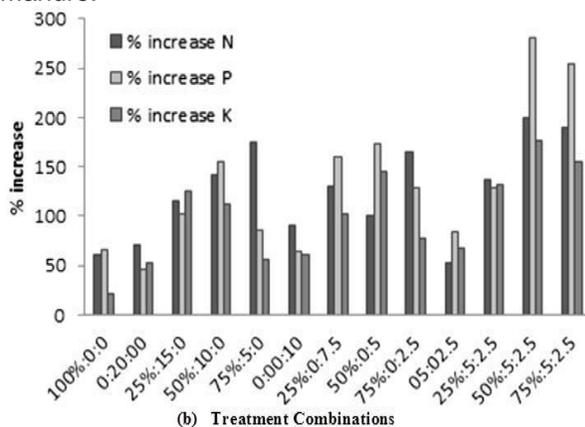
Integrated sources of macro nutrients have significantly ( $p \leq 0.05$ ) improved the uptake of N, P and K by wheat crop (Table 3). The maximum uptake for N, P and K were 94.66, 22.33 and 115.33 kg ha<sup>-1</sup>, recorded in treatment with 50%:25%:25% combination of NPK: FYM: PM (50% NPK with FYM 5 and PM 2.5 t ha<sup>-1</sup>) whereas the minimum uptake for N, P and K (31.33, 5.66 and 41.66 kg ha<sup>-1</sup>) was recorded in the control (Table 3).

**Table 3: Uptake values for N, P and K (kg ha<sup>-1</sup>) and wheat grain yield (kg ha<sup>-1</sup>)**

| Treatments.<br>(NPK%:FYM t ha <sup>-1</sup> :PM t ha <sup>-1</sup> ) | N         | P        | K        | Grain yield |
|--|-----------|----------|----------|-------------|
| 0:0:0  | 31.3 i    | 5.7f     | 41.7g    | 2211g       |
| 100%:0:0   | 50.7h     | 9.3def   | 50.3 fg  | 2493fg      |
| 0:20:0   | 54.0 gh   | 8.7ef    | 63.3 efg | 2855defg    |
| 25%:15:0   | 68.3 def  | 11.7cde  | 93.7abc  | 3544abcd    |
| 50%:10:0   | 76.3 bcd  | 14.7bc   | 88.3 bcd | 3311bcde    |
| 75%:5:0  | 87.0ab    | 10.7de   | 65.3ef   | 2738efg     |
| 0:0:10   | 60.3 fgh  | 9.3 def  | 66.7def  | 2991cdef    |
| 25%:0:7.5  | 72.7cde   | 15.0 bc  | 84.7bcde | 3597abc     |
| 50%:0:5  | 63.7efg   | 16.0 b   | 102.0 ab | 3878ab      |
| 75%:0:2.5  | 83.3 abc  | 13.0 bcd | 74.0 cde | 3042cdef    |
| 0:5:2.5  | 48.3h     | 10.7de   | 69.7def  | 3253bcde    |
| 25%:5:2.5  | 75.0 bcde | 13.0 bcd | 96.3 abc | 3900ab      |
| 50%:5:2.5  | 94.7a     | 22.3 a   | 115.3 a  | 4206a       |
| 75%:5:2.5  | 91.7a     | 20.3 a   | 106.0 ab | 4066a       |
| <b>LSD (P ≤ 0.05)</b>  | 12.06     | 3.67     | 22.93    | 739         |

NPK (per cent of the recommended dose (120-90-60 Kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O ha<sup>-1</sup>): FYM (t ha<sup>-1</sup>): Poultry manure (PM, (t ha<sup>-1</sup>); Mean values followed by same letter are not significantly different at the p<0.05.

However, results from 50%:25%:25% combination of NPK: FYM: PM for the N, P and K uptake were found statistically at par with 75%:25%:25% combination of NPK: FYM: PM. Application of 50%:50%:25% combination of NPK: FYM: PM increased nitrogen uptake by 199%, P uptake by 280% and K uptake by 177% (Fig. 1(b)) over the control. Ayeni et al. (2008) demonstrated that the availability of macro and micro nutrients is based on increased concentration of poultry manure.



**Figure 1b: N, P and K (b) N, P and K uptake of wheat crop as a result of combined used of N-P-K and organic nutrient sources over the control.**

The probable cause of higher N could be ascribed to higher N concentration in PM which resulted in its increased availability (Iqbal et al. 2008). Furthermore, higher N uptake by wheat crop with 50%:50%:25% combination of NPK:FYM:PM possibly is because of presence of

the N from non-organic fertilizers immediately after its application and from organic amendment at the delayed growth stages thus serving the plants with N availability throughout the plant growth cycle as compared to individual fertilizer, thus enhancing utilization of the applied nutrients (Kumar et al. 2014). Tatpurkar et al. (2014) concluded that integrated application of plant nutrients increased the uptake of macro and micronutrients. Kumar et al. (2011) demonstrated that co-applied organics with NPK increased nutrients availability and plant growth rate resulting in further enhanced absorption of P from soil. Although by application of several organic amendments will improve the organic contents which provide several vital nutrients through process of mineralization using organic acid as insoluble nutrients (Blair et al. 2006).

#### Post-harvest nutrients status in soil

Data revealed highly significant differences ( $p \leq 0.05$ ) for combined organic and mineral nutrient amendment on soil available N, P and K contents (Table 4). Data showed that maximum mineral N, P and K (54, 31 and 272 kg ha<sup>-1</sup>) was taken given plot treated with 0:0:100% (0:0:10 t ha<sup>-1</sup>) combination of NPK:FYM:PM which is statistically identical to plot received 50%:50%:25% (50%:10 t: 2.5 t) and 75%:50%:25% (75%:10 t:2.5t) combinations of NPK:FYM:PM, respectively. The current investigation exhibited that poultry manure if applied alone or combine form with other organic manures and mineral NPK fertilizers improved post-harvest available N and P in soil.

**Table 4: Post-harvest soil N, P and K (kg ha<sup>-1</sup>) content**

| Treatments (NPK%:FYM t ha <sup>-1</sup> :PM t ha <sup>-1</sup> ) | N      | P      | K      |
|--|--------|--------|--------|
| 0:0:0  | 22e    | 4f     | 127d   |
| 100%:0:0   | 30de   | 9ef    | 221abc |
| 0:20:0   | 36cde  | 27ab   | 203c   |
| 25%:15:0   | 44abcd | 16cde  | 227abc |
| 50%:10:0   | 39bcd  | 15cde  | 236abc |
| 75%:5:0  | 33cde  | 12def  | 232abc |
| 0:0:10   | 54a    | 31a    | 272a   |
| 25%:0:7.5  | 39bcd  | 28ab   | 263ab  |
| 50%:0:5  | 35cde  | 21abcd | 242abc |
| 75%:0:2.5  | 31cde  | 21bcd  | 240abc |
| 0:5:2.5  | 38cd   | 22abcd | 219abc |
| 25%:5:2.5  | 41abcd | 23abc  | 213bc  |
| 50%:5:2.5  | 44abc  | 24abc  | 259ab  |
| 75%:5:2.5  | 52ab   | 22abc  | 239abc |
| <b>LSD (P ≤ 0.05)</b>  | 14     | 10     | 54     |

NPK (per cent of the recommended dose (120-90-60 Kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O ha<sup>-1</sup>): FYM (t ha<sup>-1</sup>): Poultry manure (PM, (t ha<sup>-1</sup>); Mean values followed by same letter are not significantly different at the p<0.05.

The result of this experiment are highly correlated with the finding of Salako,(2008) who suggested that use of either organic manure surely will improve the status of soil micro nutrients. Ano and Agwu,(2006) stated that nutrients availability enhanced from organic manure might be due to better soil environment for microorganism to decompose it.

However, keeping the duration of availability as required for potential plant growth and yield, the sole application of poultry manure cannot be recommended because availability of these nutrients might be higher post-harvest but not for the current crop. Therefore, as evident from statistically similar available N and P contents from 50%:5:2.5 and 75%:5:2.5 combinations of NPK:FYM:PM with the maximum value, combined formulated application of inorganic and organic nutrients can be pick out due the immediate presence of these specific plant nutrients for early growth from the applied mineral NPK fertilizer portion and the availability of these nutrients form the organic portion of the formulation. The minimum post-harvest available soil N, P and K (22, 4 and 127 kg ha<sup>-1</sup>) were calculated in control. Our results are in close agreement to the findings of Ayeni and Adetunji, (2010) who observed that use of NPK with organic manure increased nutrients availability in soil. Application of inorganic sources alone reduced P availability

while in combination with organic manure enhanced soluble P in soil (Ibrahim *et al.* 2008).The present experiment results were also in line with the Ayeni and Adetunji (2010) who concluded that availability of K in soil statistically increased through joint uses of organic manures with NPK.

## CONCLUSION

Results from this experiment suggested that combined application of organic manure with mineral NPK statistically improved, the yield, NPK uptake and post-harvest soil available NPK status. Amongst different formulations for NPK, farmyard and poultry manure, the 50%:5:2.5 combination of NPK: FYM: PM stood eminent for enhanced grain yield, NPK uptake and post-harvest soil NPK status of water eroded land.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## ACKNOWLEDGEMENT

Gratitude to my worthy professors for reviews and improving the manuscript and thanks to the co-authors for their contributions throughout the process.

## AUTHOR CONTRIBUTIONS

Conceived and designed the experiments: Murad Ali, Wiqar Ahmad. Analyzed the data: Irfan Ullah Khan, Ahmad Zubair.

Contributed materials/ analysis/ tools: Muhammad Saeed and Fazal Said,

Wrote the paper: Rifat Ali<sup>1</sup>, Fazal Said, Ihtishamul Haq

## Copyrights: © 2021@ author (s).

This is an open access article distributed under the terms of the [Creative Commons Attribution License \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

## REFERENCES

- Ali, S., A.U. Bhatti., F. Khan and A. Ghani. 2007. Integrated plant nutrient management and cropping system for restoring crop

- productivity of an eroded land. *Soil & Environment*. 26(1): 48-58.
- Ano, A.O and J.A.Agwu. 2006. Effect of animal manures on selected soil properties: II. Nitrogen, potassium and phosphorus. *Nigerian Journal of Soil Science*. 16: 145- 150.
- Aulakh M.S., M.P.S. Khurana and D. Singh. 2009. Water pollution related to agricultural, industrial and urban activities, and its effects on food chain: Case studies from Punjab. *Journal of New Seeds*, 10: 112-137.
- Aulakh, M.S. 2010. Integrated nutrient management for sustainable crop production, improving crop quality and soil health, and minimizing environmental pollution. 19th World Congress of Soil Science, Soil Solutions for a Changing World, 1–6 August 2010, Brisbane, Australia.
- Aulakh, M.S., and T.K.Adhya. 2005. Impact of agricultural activities on emission of greenhouse gases – Indian perspective. In: *Proceedings of the International Conference on Soil, Water and Environmental Quality – Issues and Strategies*, Indian Society of Soil Science, New Delhi, pp. 319-335.
- Ayeni and Adetunji. 2010. Integrated application of poultry manure and mineral fertilizer on soil chemical properties, nutrient uptake, yield and growth components of maize, *Nature and Science*. 8 (1):60-67.
- Ayeni L.S., M.T.Adetunji. S.O. Ojeniyi, B.S.Ewulo, and A.J. Adeyemo. 2008. Comparative and Cumulative Effect of CocoaPod Husk Ash and Poultry Manure on Soil and Maize Nutrient Contents and Yield. *American – Eurasian Journal of Sustainable Agriculture*, 2(1) 92 – 97.
- Bhatti, A.U., M. Afzal and Farmanullah. 1997. Effect of slope position on soil properties and wheat yield. *Journal of Engineering and Applied Sciences*. 16(2):45-50.
- Bhatti, A.U., M. Khan, K.S. Khurshed and F. Khan. 1998. Site specific determination of N rates for rain-fed wheat using available soil moisture. *Pakistan Journal of Arid Agriculture*. 1(1):11-18.
- Blair, N., R.D. Faulkner, A.R. Till, and P. Poulten. 2006. Long-term management impacts on soil C, N and physical fertility. I. Broadbalk experiment. *Soil and Tillage Research*. 91, 30–38.
- Bremner, J.M. 1996. Nitrogen-total. In *Methods of Soil Analysis Part-3. Chemical methods* (D.L. Sparks, ed), SSSA, Inc., ASA, Inc., Madison, Wisconsin, USA. P: 1085-1122.
- FAO. 2011. AQUASTAT Country Profile – Pakistan. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy
- Ghosh, B.N., R.J. Singh and P.K. Mishra 2015. Soil and input management options for increasing nutrient use efficiency. In: *Nutrient Use Efficiency: from Basics to Advances*, (eds. A. Rakshit et al.) DOI 10.1007/978-81-322-2169-22, Springer, India.
- Ibrahim, M., A. Hassan., M. Iqbal, and E.E. Valeem. 2008. Response of wheat growth and yield to various levels of compost and organic manure. *Pakistan Journal of Botany*. 40 (5): 2135-2141, 2008.
- Iqbal, T., G. Jilani., A.N. Chaudhry and A. Zahid. 2008. Studies on the residual effect of poultry litter application under wheat-maize cropping system. Presentation of 12th Congress of Soil Sci Soc. of Pak. dated 20-23 October, at NWFP Agric. Univ. Peshawar. pp 88-99.
- Jaga, P.K., 2013. Effect of integrated nutrient management on wheat – a review. *Innovare Journal of Agricultural Sciences*, 1(1): 185-191.
- Khan, F., A.U. Bhatti and R.A. Khattak. 2001. Soil and nutrient losses through sediment and surface runoff under maize mono cropping and maize legume inter-cropping from upland sloping field. *Pakistan Journal of Soil Science*. 19:32-40.
- Khan, M.U., M. Qasim and I.U. Khan. 2007. Effect of integrated nutrient management on crop yields in rice-wheat cropping system. *Sarhad Journal of Agriculture*. 23(4):1019-1026.
- Kue, S. 1996. Phosphorus. In *Methods of Soil Analysis Part-3. Chemical methods* (D.L. Sparks, ed), SSSA, Inc., ASA, Inc., Madison, Wisconsin, USA. P: 869-919.
- Kumar A.B.M., N.C.N. Gowda, G.R. Shetty and M.N. Karthik. 2011. Effect of organic manures and inorganic fertilizers on available NPK, microbial density of the soil and nutrient uptake of brinjal. *Research Journal of Agricultural Sciences*. 2:304–307.
- Kumar, A., R.N. Meena, L. Yadav and Y.K. Gilotia. 2014. Effect of organic and inorganic sources of nutrient on yield, yield attributes and nutrient uptake of rice Cv. PRH-10. *The Bioscan*, 9(2): 595-597.
- Kumar, V., R.K. Prasad, S.N. Suman and S. Tiwari. 2011. Integrated nutrient management for better soil fertility and rice productivity. *Oryza*, 48(4): 335-338.
- Kumari, N., A.K. Singh, S.K. Pal and R. Thakur.

2010. Effect of organic nutrient management on yield, nutrient uptake and nutrient balance sheet in scented rice (*Oryzasativa*). *Indian Journal of Agronomy*, 55(3): 220-223.
- Mohanty, M., S.S. Nanda and A.K.Barik. 2013. Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of wet season rice (*Oryzasativa*) in Odisha. *Indian Journal of Agricultural Sciences*, 83(6): 599-604.
- Mulvaney, R.L. 1996. Nitrogen inorganic form. P 1123-11184. In: D.L. Sparks (ed). *Method of soil analysis part.3-chemical method*, SSSA book series No.5, Inc. ASA, inc. Madison, Wisconsin, USA.
- Pooran, C., P.K. Singh., M. Govardhan and P. Chand. 2002. Integrated management in rainfed castor (*Ricinuscommunis*). *Indian Progressive Agriculture*. 2: 122-124.
- Ramalakshmi, C.S., P.C. Rao, T. Sreelatha, M. Mahadevi, G. Padmaja, P.V. Rao and A. Sireesha.2012. Nitrogen use efficiency and production efficiency of rice under rice-pulse cropping system with integrated nutrient management. *Journal of Rice Research*, 5(1&2): 42-51.
- Salako, F.K. 2008. Effect of tillage, mucunapruiens and poultry manure on maize growth on physically degraded alfisols in Abeokuta, southwestern Nigeria. *Nigeria Journal of Soil Science*.18:10-21.
- Soltanpour, P.N. and A.P. Schwab. 1977. A new soil test for simultaneous extraction of macro and micro nutrients in alkaline soils. *Soil Science Plant Analysis*. 8: 195-207.
- Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. *Principles and Procedures of Statistics. A Biometrical Approach*, 3rd Ed. McGraw Hill Book Company, New York, 172-177.
- Tatpurkar, Sheetal, G., Pushpa, and V.V.Barange. 2014. Effect of integrated nutrient management on yield, quality, nutrient content and uptake of groundnut in shrink-swell soil. *International Journal of Agricultural Sciences*, 10(1): 291-293.
- Usman, M. 2016. Contribution of Agriculture Sector in the GDP Growth Rate of Pakistan. *J Glob Econ* 4: 184. doi:10.4172/2375-4389.1000184
- Yadav, G.S., M. Datta, S. Basu, C. Debnath and P.K. Sarkar.2013. Growth and productivity of lowland rice (*Oryzasativa*) as influenced by substitution of nitrogenous fertilizer by organic sources. *Indian Journal of Agricultural Sciences*, 83(10): 1038-1042.