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FOOD QUALITY ATTRIBUTES OF *Triticum aestivum* L. AS INFLUENCED BY SCHEDULES OF ORGANIC AND INORGANIC SOURCES OF NUTRIENTS

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ABSTRACT

Soil degradation is one of the major contributors of declining crop productivity. Soil fertility management is most important component for sustained crop production. Investigations were carried out in this context to study the effect of different sources of nutrients on yield and quality of wheat. The experiment was laid out in Randomized Complete Block Design with four replications at research farm of College of Agriculture, University of Sargodha, Sargodha. Good quality seed of wheat variety named "Sehar-2006" was utilized for sowing purpose. There were five treatments which were compared for their effect on wheat yield and quality in four replicates. Treatments include (T_1) recommended dose of mineral NPK, (T_2) recommended dose of farm yard manure, (T_3) 25% recommended dose of FYM+75% recommended dose of mineral NPK (T_4) 50 % recommended dose of FYM+50% recommended dose of NPK,(T_5) 75% recommended dose of FYM+25% recommended dose of mineral NPK. Data regarding different yield components and quality traits was collected and analyzed statistically. The collected data revealed that plant emergence m^{-2}, total number of tillers m^{-2}, plant height at maturity, spike length, number of spikelets $spike^{-1}$, number of grains $spike^{-1}$,1000 grain weight, biological yield, grain yield, straw yield and harvest index of wheat was significantly affected by different combinations of different doses of farm-yard manure and mineral NPK. Maximum grain yield (4700 kg ha^{-1}) and biological yield (14470 kg ha^{-1}) was observed in treatment where Farm-Yard manure was applied at rate of 25 % of its recommended dose along with 75 % recommended dose of mineral NPK. Maximum benefit cost ratio as well as crude protein contents of wheat were recorded in same treatment. However, maximum straw yield (10300 kg ha^{-1}) was recorded in treatment where full recommended dose of NPK was applied alone.

Keywords: *Triticum aestivum* L., farm yard manure, mineral NPK, yield, protein, Pakistan.

INTRODUCTION

Food security is major issue in many parts of the world including Asia and Africa (Aziz *et al*. 2015). Increasing trend of agricultural productivity as observed in last number of decades has become stagnant now (Cassman *et al*. 2010). However, Human population growth rate is increasing at alarming rate (Bommarco *et al.* 2013). One of the major factor for maintaining this increasing trend in yield level is management of declining soil fertility in order to make the system sustainable (Sosibo *et al*. 2017; Demelash *et al.* 2014). Resource conservation as well as its rehabilitation is one of the best strategies in this context (Singh, 2012). Moreover, yield gap in case of major field crops is considerably more in rain-fed agriculture (Affholder *et al*. 2013).

Triticum aestivum L. is second most cultivated crop and important cereal grain with diverse anatomical adaptation, contributing one-fifth of total calorific intake of human population throughout the globe (Chnapek *et al*., 2015; Valluru *et al*. 2015). Nutritionally, wheat contain lot of carbohydrates along with other valued components such as proteins, minerals including phosphorus, magnesium, iron, copper and zinc, vitamin including niacin, riboflavin, thiamine and vitamin E (Ikhtiar and Alam, 2007). The bran is source of dietary fiber, potassium, calcium, phosphorus, magnesium and niacin in trace amounts (Kumar *et al.,* 2011). Land degradation is one of the major threat towards food security of 9.5 billion population projected till 2050 (Lal, 2015).Nearly about one third of land area is severely affected by some degree of degradation (Bini, 2009). This has resulted into decline in crop productivity. Different form of land degradation include, soil salinization, soil erosion, soil acidification, poor soil fertility and nutritional imbalance are as a result of inappropriate farming practices, which are needed to be worked out for soil security. (Van Lynden, 1997; Lal, 2015). Soil organic carbon is universally accepted indicator of soil security (Koch *et al*., 2013).

One of the most attractive strategies is the use of organic manure and inorganic fertilizer in integrated manner, in order to improve soil organic carbon reserves gradually and thus increase in overall productivity (Bharali *et al*. 2017). Crops are benefited in terms of more nutrient availability (Hu *et al*. 2014). Continuous use of inorganic fertilizers alone resulted into pollution of the environment along with high nutrient losses (Oad *et al*., 2004). Mineral fertilizers can be easily handled with quick results in terms of increased yield of crop but their non-judicious use effects human health with increase in environmental problems and at the same time increase in cost of production. Although there are reports that application of farm yard manure alone to soil had been practiced a long ago that improved the soil structure with improvement in soil fertility, organic matter status, microbial activities of

soil and crop yield to some extent (Blaire *et al*. 2006, Kundu *et al.,* 2007). Use of organic or inorganic sources alone cannot serve the purpose, integrated use of both is more beneficial (Ibrahim *et al.* 2008). For sustainable agriculture, it is imperative to find the economically viable and environmental friendly solution of problem.

Proper combination of both organic and inorganic fertilizers has better effects on crop development, growth and yield components of wheat than alone (Badaruddin *et al.,* 1999; Manna *et al.,* 2005). The combination of FYM and NPK increased soil total N, organic matter, P and ammonium acetate and exchangeable K by 31 %, 47 %, 13 % and 73 % respectively as compared to the use of mineral NPK fertilizers (Bhattacharyya *et al.,* 2008). Therefore; there is a need to improve nutrient supply system in terms of integrated nutrient management involving the use of chemical fertilizers in conjunction with organic manures coupled with input through biological processes. Therefore, the present study was carried out to optimize the doses of the combined use of farm yard manure and inorganic fertilizers to have better effect on yield, yield components and quality of wheat.

MATERIALS AND METHODS

The present study pertaining to the yield and quality of wheat as influenced by different sources of nutrients was conducted at experimental farm of University College of Agriculture, University of Sargodha, Sargodha. The experiment was laid out in Randomized Complete Block Design with four replications. Various treatments which were tested are as under.

T_1: Recommended dose of mineral NPK
T_2: Recommended dose of FYM
T_3: 25% recommended dose of FYM+75% recommended dose of NPK
T_4: 50% recommended dose of FYM+50% recommended dose of NPK
T_5: 75% recommended dose of FYM+25% recommended dose of NPK

Sowing of wheat crop was done manually on 2nd December, 2011 with the help of single row hand drill with 22.5 cm row to row distance. Seed rate of 150 kg $ha^{-1}$was used. Full dose of phosphorus and potash were applied at sowing time in the form of single super phosphate and sulphate of potash, while half dose of urea as source of nitrogen was applied at the time of sowing and remaining half was applied at the time of first irrigation. Full dose of farm yard manure was applied at the time of sowing. Hand weeding was done in order to keep the crop free from weeds. First irrigation was applied 25 days after sowing and subsequent as per need of the crop, keeping in view soil and environmental conditions. Total 5 irrigations were applied. The crop was harvested by sickle on 5th May 2012. All other agronomic practices were kept normal for all the treatments.

Standard procedures were adopted for recording various yield and yield components. The data on various yield and yield components of wheat was subjected to Fisher's analysis of variance technique and the treatment means were compared by the least significant difference test (LSD) at 0.05 %level of probability (Steel *et al*., 1997).

RESULTS AND DISCUSSIONS

Data indicated that plant population was affected significantly by application of farm yard manure and mineral NPK in different doses (Table-1). Maximum plant population (246.25) was observed in T_3(25% recommended dose of FYM+75% recommended dose of NPK). Minimum number of plants (238.5) was observed in plots receiving recommended dose of FYM (T_2). Seedling survival might be due to availability of macro and micro nutrients from both sources and in quantity required by wheat. These results are not different from the results reported by Akhtar *et al.,* (2011).

Total numbers of tillers m^{-2} vary considerably with different management practices in wheat and are important yield contributory component. The treatment means indicated that all the treatments were statistically different regarding number of tillers m^{-2}. Maximum response of farm yard manure and mineral NPK was observed in treatment $T_3$where 25% recommended dose of FYM was applied along with 75% recommended dose of NPK by producing maximum number of tillers m^{-2} (345.5). More number of productive tillers m^{-2} in T_3 may be due to balanced availability of nutrients both through organic and inorganic sources with the improvement of nutrient holding capacity of soil. Minimum number of tillers m^{-2} was recorded in T_2 (Recommended dose of FYM). These results are in harmony with results reported by Singh (1999) that significant effect of combined application of farm yard manure and mineral NPK on number of tillers m^{-2}. Comparison of various treatment means indicated that plant height responded differentially to various doses of NPK and FYM. Tallest plants were observed in T_1 (recommended dose of NPK) by achieving 105.50 cm plant height. Increase in plant height in T_1may be due to efficient utilization of nutrients. The lowest (97.75 cm) plant height was observed in T_2 (Recommended dose of FYM). These are different from results reported by Singh (1999) as he recorded tallest plants in treatment where combination of farm yard manure and mineral NPK was applied.

Data regarding spike length is presented in Table-1. Different treatments affected spike length in different manner. Maximum Spike length was observed in T_3 (25% recommended dose ofFYM+75% recommended dose of NPK). Maximum spike length can be attributed efficient portioning of assimilates as a result of balance availability of nutrients. Minimum spike length was recorded in T_5 (75% recommended dose of FYM+25% recommended dose of NPK). These results are similar to the findings of Shaaban *et al.,* (2009) as they also reported that combined application of FYM and mineral fertilizer produce more spike length. Number of spikelets $spike^{-1}$ is closely associated with number of grains $spike^{-1}$ and thus determine yield to largest extent. The combined effects of farm yard manure with inorganic nutrient sources affected

the number of spikelets spike^{-1} significantly (Table-1). Maximum no of spikelets spike^{-1}(19.5) were recorded in treatment T_3 (25% recommended dose of FYM+75% recommended dose of mineral NPK) and it was found statistically different from all other treatments. The increase in number of spikelets spike^{-1} in T_3 (25% recommended dose of FYM + 75 % recommended dose of NPK) can be correlated with efficient utilization of nutrients.

Table-1. Yield and yield components of *Triticum aestivum* L. as influenced by combination of different sources of nutrients.

Treatments	Plant emergence m^{-2}	Total number of tillers m^{-2}	Plant height at maturity (cm)	Spike length (cm)	Number of spikelets spike^{-1}	Number of grains spike^{-1}	1000 grain weight	Biological yield (kg ha$^{-1)}$
T_1 (Recommended dose of NPK)	244.25 a	332 b	105.50 a	10.03 b	18.825 b	45.05 b	41.2 d	14300 a
T_2 (Recommended dose of FYM)	238.5 b	288.75 e	97.75 e	9.17 d	16.875 d	35.45 d	43.73 c	11450 c
T_3 (25% recommended dose of FYM+75% recommended dose of NPK)	246.25 a	345.50 a	104.25b	10.67 a	19.5 a	46.42 a	49.25 a	14470 a
T_4 (50% recommended dose of FYM+50% recommended dose of NPK)	242.75 ab	318 c	102.75 c	9.96 bc	18 c	41.62 c	46.71 b	13600 ab
T_5 (75% recommended dose of FYM+25% recommended dose of NPK)	244 a	303.25 d	100.25 d	9.5 cd	17.5 c	40.85 c	44.03 c	12200 bc

Table-2. Quality and yield components of *Triticum aestivum* L. as influenced by combination of different sources of nutrients.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index	Grain Nitrogen contents (%)	Grain Phosphorus contents (%)	Grain Potassium contents (%)	Grain crude protein contents (%)	Crude Fibre Contents (%)
T_1 (Recommended dose of NPK)	4000 b	10300 a	27.95 b	2.96 ab	0.296 b	0.719 a	18.5 ab	2.64 b
T_2 (Recommended dose of FYM)	3400 d	8050 c	29.72 ab	1.74 d	0.272 c	0.672 d	10.87 d	1.96 c
T_3 (25% recommended dose of FYM+75% recommended dose of NPK)	4700 a	9770 ab	32.54 a	3.11 a	0.328 a	0.714 ab	19.43 a	3.00 a
T_4 (50% recommended dose of FYM+50% recommended dose of NPK)	3850 bc	9750 ab	28.53 b	2.69 b	0.285 b	0.705 b	16.81 b	2.77 b
T_5 (75% recommended dose of FYM+25% recommended dose of NPK)	3600 cd	8600 bc	29.615 ab	2.14 c	0.268 c	0.681 c	13.37 c	2.07 c

Minimum (16.87) number of spikelets spike^{-1} were observed in T_2 (Recommended dose of FYM) These results are in agreement with results reported by Verma and Parasad (2003). Number of grains spike^{-1} was significantly affected in response to combined use of farm yard manure and inorganic fertilizers (Table-2). Maximum number of grains spike^{-1} (46.42) were achieved in treatment T_3.Minimum number of grains spike^{-1} (35.45) was recorded in T_2 where only recommended dose of FYM was applied. These results are not similar to the results reported by Patra *et al* (1998).

1000 grain weight is a key factor in producing final grain yield. The integrated application of organic and inorganic nutrient sources affected 1000 grain weight significantly (Table-2). Results indicated that maximum thousand grain weight 49.25 g was achieved in T_3(25% recommended dose of FYM+75% recommended dose of NPK) and minimum thousand grain weight(41.2 g) was

recorded in T_1 (Recommended dose of NPK). The reason of higher 1000 grain weight of 49.25 g in T_3 (25% recommended dose of FYM+75% recommended dose of NPK) can be ascribed to more partitioning of assimilates in grains because of combined application of manure and mineral NPK. Shah e*t al.,*(2010) also reported similar results.

Biological yield is highly responsive to different fertilizer management strategies. Statistical analysis of different treatment means revealed that biological yield was significantly affected by combined application of farm yard manure and mineral NPK (Table-2). Maximum biological yield (14470 kg ha^{-1}) was achieved in T_3 (25% recommended dose of FYM+75% recommended dose of NPK). Results indicated that minimum biological yield (11450kg ha^{-1}) was recorded in T_2 (recommended dose of FYM). These results are similar to the results of Rehman *et al.,* (2008) who also reported increase in biological yield by the combined application of organic and inorganic fertilizer.

Grain yield was differentially affected by integrated application of organic and inorganic nutrient sources. Data illustrated that highest grain yield (4700 kg ha^{-1}) was achieved in T_3 (25% recommended dose of FYM+75% recommended dose of NPK). Minimum (3400 kg ha^{-1}) grain yield was obtained in T_2 where only farm yard manure was applied (Table-2). These results are in harmony with result reported by Rehman *et al.,* (2008).

Integrated effect of farm yard manure and mineral fertilizer influenced straw yield significantly. Maximum straw yield (10300 kg ha^{-1}) was achieved in T_1 where only recommended dose of NPK was applied. Minimum straw yield (8050 kg ha^{-1}) was obtained in T_2 (Recommended dose of FYM). These findings do not match with the results of Nehra *et al.,* (2000). Statistical analysis of various treatment means showed that application of farm yard manure and inorganic nutrient sources significantly affected harvest index.

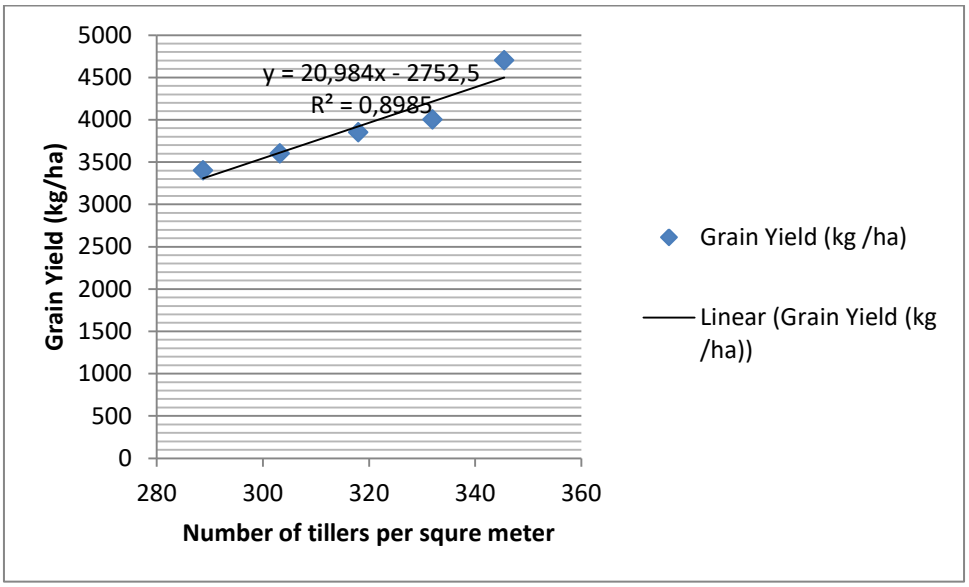

Figure-1. Relationship between grain yield and number of tillers per square meter.

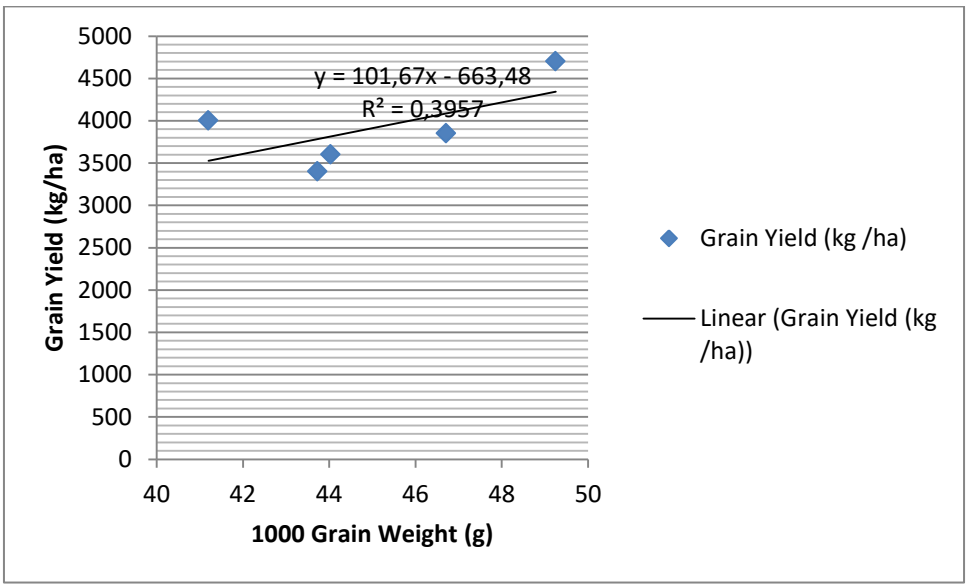

Figure-2. Relationship between grain yield and 1000-grain weight.

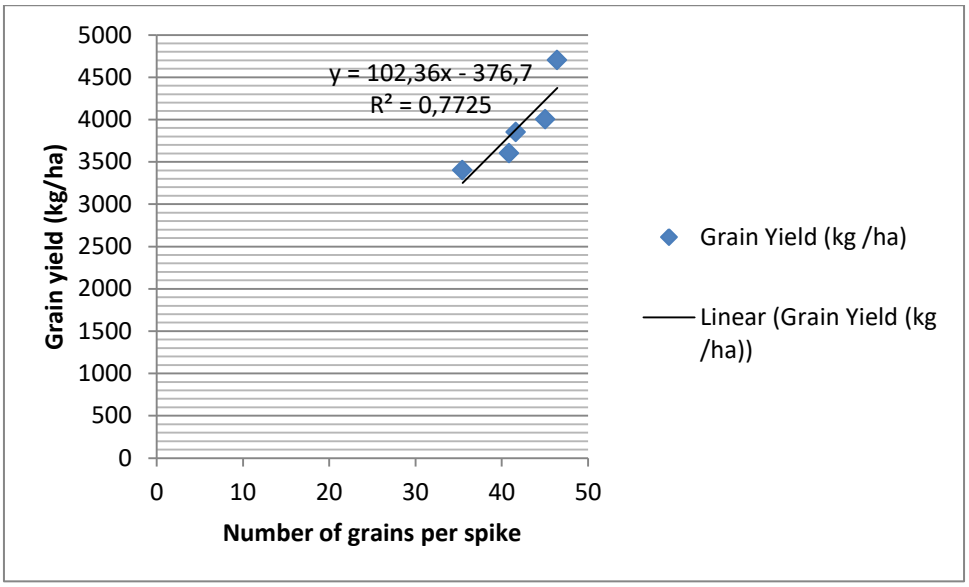

Figure-3. Relationship between grain yield and number of grains per spike.

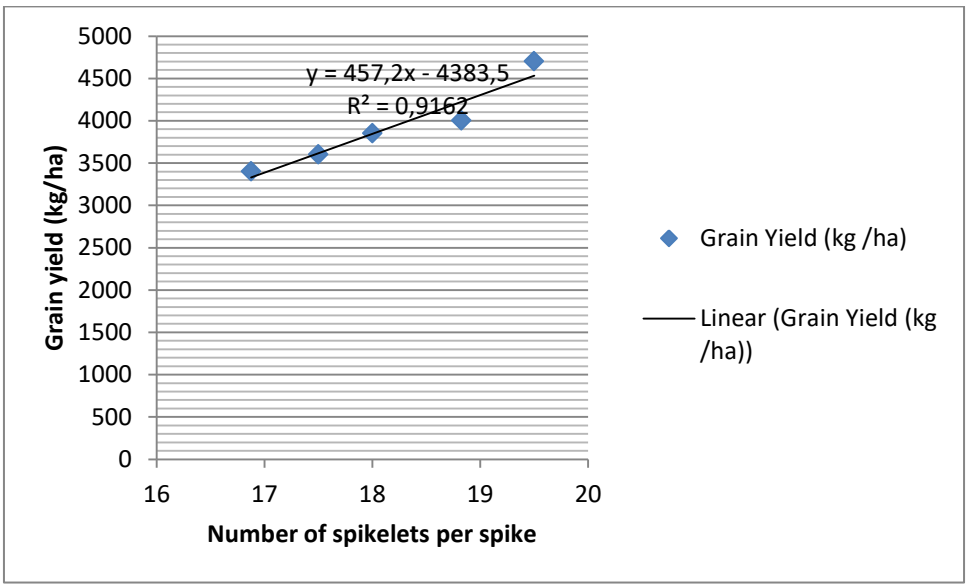

Figure-4. Relationship between grain yield and number of spikelets per spike.

Maximum harvest index (32.54) was observed in treatment T_3 where 25% recommended dose of farm yard manure was applied along with 75% recommended dose of NPK. Minimum harvest index (27.95) was observed in treatment T_1 where only recommended dose of NPK was applied .Higher harvest index indicated that maximum assimilates were moved towards grains. These results are similar to the findings reported by Nehra *et al.,* (2000).

Nitrogen contents in grain reflect the response of plant to applied nutrient sources. Data regarding the effect of farm yard manure and inorganic fertilizer on nitrogen content of wheat is presented in Table-3. Different treatment significantly influenced nitrogen contents in wheat. Maximum nitrogen contents (3.11 %) was observed in treatment T_3 (25% recommended dose of FYM+75% recommended dose of NPK) while minimum nitrogen (1.74%) was observed in treatment T_2 (Recommended dose of FYM). Increase in nitrogen might be due to more availability and uptake of nitrogen as a result of combined application of nitrogen.

Data regarding the effect of different combination of FYM and NPK fertilizer on fibre contents in wheat grain is elaborated in Table-2. Data indicated that maximum crude fibre contents (3%) were achieved in case of T_3 (25% recommended dose of FYM+75% recommended dose of NPK). Minimum crude fibre contents (1.96 %) was recorded in T_2(Recommended dose of FYM).These results are in harmony with the results of Behera *et al.,* (2007).

Positive linear correlation was observed between number of tillers m^{-2}, 1000-grain weight, number of grains per spike, number of spikelet per spike and grain yield of wheat (Figures 1, 2, 3 and 4).

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