



Estimating the impacts of different fertilizers on the growth and yield of wheat (*Triticum aestivum* L.)

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Abstract

The effects of different fertilizers on the growth and yield of wheat were examined. Five different plots including: Control plot, Urea treated plot, NPK treated plot, Natural manure treated plot and UREA+ NPK+ natural manure treated plot size 10.4m * 10.4m each were developed. For estimating their impacts 2.5 kg of NPK and urea was used at the rate of 100 kg per Acre, .375 kg of natural manure was used at the rate of 15000 kg per Acre. Other conditions such as, light exposure, irrigation, soil natures etc. were kept same for all plots. From each plot 500 plants were randomly selected. Their Height, dry weight (biomass), grain mass and grain numbers were analyzed. Maximum average height was observed for Urea+ NPK+ Natural manure (39cm), for Urea it was 38cm, NPK 36cm, Natural manure 35cm and Control 24cm. Maximum plants weight was again observed for Urea+ NPK+ Natural manure that was 19.02kg, for Urea it was 18.78kg, for natural manure 15.05kg, for NPK it was recorded 13.29kg and for Control 10.94kg. Maximum grain weight was recorded for NPK 6.01kg, for Urea+ NPK+ Natural manure it was 4.46kg, for Urea 4.40kg, for Natural manure 4.09kg and for Control was 3.26kg, while maximum grain number was obtained for NPK 132531, for Urea+ NPK+ Natural manure 102482 grains were counted, for Urea 99453 grains, for Natural manure 95443 grains and for Control it was 80387. The conducted research therefore recommend fertilizers with adequate amount of N,P and K and appropriate timing for a soil fertilization.

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Introduction

Human being is using wheat as staple food since ages and now it is cultivated throughout the world as a highly important cereal crop as well as its plant is a good source for fodder purpose of Animals. Owing to the great importance of wheat, many researchers have worked out on it to introduce new varieties for better yield to overcome food shortage and according to (Nasir and Ali, 1982) its genus *Triticum* consists of about 25 species while, four species including: *Triticum durum*, *T. turgidum*, *T. sphaerococcum* and *T. aestivum* are cultivated in Pakistan. The average yield of wheat in Pakistan is low even as compared to its neighboring countries such as India, which produces 2910 kg/ha, and China, producing 4910 kg/ha and the average yield of wheat in the world is about 3010 kg/ha. (Anonymous, 2009-10). However, according to UN's food and agriculture organization (FAO), Pakistan is the 9th largest country in wheat production; which account for about 3.04% of the world's total wheat production using an area of 3.57% of the world. It is cultivated on an area of more than 9 million hectares in Pakistan, which has a production of about 24 million tons. Its cultivation time ranges from the months of October-November and harvested in the months April-June of the following year. Pakistan had a record wheat production in 2014 of 25.4 million tons from the area of 8.66 million hectares. Of which Punjab produces 76%, Sindh shares 16%, Khyber Pakhtunkhwa produces 5% and Baluchistan produces 3% of total wheat production across the country (Farzana panhwar, 2014). This should further be increased by the addition of minerals to the soil on the basis of its needs because the requirement of wheat is increasing every year due to population growth, which increases the yield gap.

Application of farm manure for many times and during a long period improved crop production compared to those with no or low applications (Frankart *et al.*, 1974). In tropical regions continuous monoculture of cereals, using chemical fertilizers as main source of nutrients led to considerable decrease in yield after only a few years of cropping because of soil acidification and compaction. However, addition of organic inputs adequately improved physical,

chemical and biological properties of these soils (Frankart *et al.*, 1974). Human beings have been using natural manure from a long time which consists of cattle dung, dead leaves and twigs with some other materials. By the addition of which the water holding capacity of the soil increases and it become soft and suitable for the growth of plants and even dry and barren soil can be reclaimed by addition of manure. Because manure are rich in microorganisms especially bacteria which are capable of breaking the organic inputs and release the bound nutrients into the soil and become available for absorption to the plants.

According to (Zia *et al.*, 1991) fertilizers when applied in time and according to the needs of the field, greatly improve per hector yield of wheat. Therefore, the gap between realized and potential yield can be filled by collective use of suitable types of fertilizers, as appropriate combination of fertilizers can boost yield by almost 50%. Similarly, (Liu and Shin, 2013) showed that, simultaneous increase occurs in the quality and yield with the increase of nitrogen fertilizer in winter wheat when the amount of nitrogen fertilizer was in the range of 0 and 225 kg/hm²; once the amount of nitrogen fertilizer reached 300 kg/hm², the winter wheat showed the best quality and decline both in the percentage of weight gain in grain filling stage to kernels and the kernels yield. (Abedi *et al.*, 2010) showed that, both organic and inorganic fertilizers impacts on protein banding pattern and grain yield of wheat and the highest yield of wheat grain attained when the wheat plants fertilized with 160 kg nitrogen per hector and 30 Mg compost per hector. Therefore, the natural manure is very important for agro industries and farming. Natural manure increases soil fertility as well as soil microbial level. The soil must contain 5% natural manure to give maximum yield. (Noreen and Noreen, 2012) reported the practice of organic and inorganic sources is very good for the productivity of wheat crop and the alone use of chemical fertilizers have disadvantages because they are not environmental friendly as pollutes our environment as well as kills the beneficial soil microorganisms. Furthermore, the use of farmyard manure raise water

holding capacity of soil, and also improves infiltration rate of water. The application of Phosphorous significantly improve all growth parameters when applied at the rate of 80kg per hecter as single super phosphate (SSP) showed better results as compared to nitrogen-phosphate (NP), triple super phosphate (TSP), and di-ammonium phosphate (DAP) on soil deficient in phosphorus (Khan *et al.*, 2010). (Niamatullah *et al.*, 2013) demonstrated the treatment of T6 (NPK applied at 80-40-30 kg/ha) most economical while, according to (Jan *et al.*, 2011) the production of wheat improves through timing and source of nitrogen fertilizers therefore, efficient nitrogen fertilizer management and its application timing is necessary.

Hence, to cover up the yield gap fertilizers are of great importance and its proper combination can increase yield by many folds. Similarly, non productive soil can be improved and crops can be grown economically. Thus, both natural and chemical fertilizers have great impact on the production of wheat and greatly affect the growth of wheat plant, its production and per hector yield.

Therefore, this research is focused to analyze the impact of different fertilizers on wheat crop, its impact on dry weight of wheat plant, plant height and its impact on yield. In addition it also aims to aware farmers to fertilizers, which has best output in wheat yield and also to aware them with those fertilizers which has the best impact on dry weight of fodder in the area.

Materials and method

Location

The research was carried out in Tindodag an area of District Swat, Pakistan by the Department of Botany, Government Postgraduate Jahanzeb college, Mingora Swat, with Latitude: 34°41'6.73", and Longitude: 72°13'33.62" in the year 2014-15.

Variety

The NARC variety of Wheat (*Triticum aestivum* L.) was sown to analyze the impacts of different fertilizers on the growth and yield of wheat crop.

The different fertilizers including: Natural manure, Urea and NPK were applied to different plots. For their applications five different plots including: Control plot, Urea treated plot, NPK treated plot, Natural manure treated plot and UREA+ NPK+ natural manure treated plot of size 33' * 33' each were developed.

Nature and analysis of Soil

The Soil of the field was also analyzed before applying fertilizers in the field. The soil analysis was conducted in Soil Sciences Department, Agriculture Research Institute Mingora, Swat. The soil was sandy loam (Clay 12.8%, Silt 22%, and Sand 65.2%). Soil texture was light and Soil pH was 7.6. Organic matter in soil was 1.65% while Nitrogen level was 0.082% (Low), Phosphorous was 16 ppm (Adequate) and Potassium was 184 ppm (Adequate).

Experimental design

The experiments were set for 5 treatments according to different fertilizers. Five plots of same size were prepared. To the best of my knowledge, sun light exposure of each plot was equal. Each plot was irrigated by tube well water equally. Each plot was irrigated and drained separately, in order to minimize the chances of transfer of fertilizer from one plot to another through soil erosion. In plot 1, i.e. Control, no fertilizers were added. In plot 2, Urea was added. Plot 3 was treated with NPK fertilizer, Plot 4 was treated with Natural manure and plot 5 was treated with all three fertilizers i.e. Natural manure, NPK fertilizer, and Urea. These fertilizers were applied to the plots, along with sowing.

Data collection

During crop harvesting 500 plants were selected from each plot randomly along with roots. The average heights of plants of each plot were measured to get an average height. The whole plants of every plot were weighed to conclude dry weight. Grains of these plants were gathered and weighed to know mass of the grains. Finally the grains were counted to calculate mass to grain ratio for each plot.

Results

The result showed great impacts on the growth and yield of wheat in terms of Plant Height (cm), Plant Weight (kg), Grain Mass (kg), Grain Number and Mass to Grain ratio (g) as specified in Table 1.

Table 1. Data collected for 500 plants.

Results	Control	Urea	Npk	Natural manure	Natural manure + urea+ npk
Plant height (cm)	24	38	36	35	39
Plant weight (kg)	10.94	18.78	13.29	15.05	19.02
Grain weight (kg)	3.26	4.40	6.01	4.09	4.46
Grain number	80387	99453	132531	95443	102482
Grain to mass ratio (g)	0.040	0.044	0.045	0.042	0.043

Plant Height (cm)

Data of the final plant heights as affected by different fertilizers is shown in the table 1. Different plants from each field were collected randomly and average data was calculated. The analysis of the variance revealed that there was difference in height of plants, when different fertilizers are applied. Maximum average plant height was attained when all of the fertilizers were added i.e. Natural manure, Urea, NPK fertilizer (39 cm), while minimum plant height was observed for ‘control’, when no fertilizers were added (24 cm). Urea gave best results, when all fertilizers were applied separately (38cm) Fig. 1.

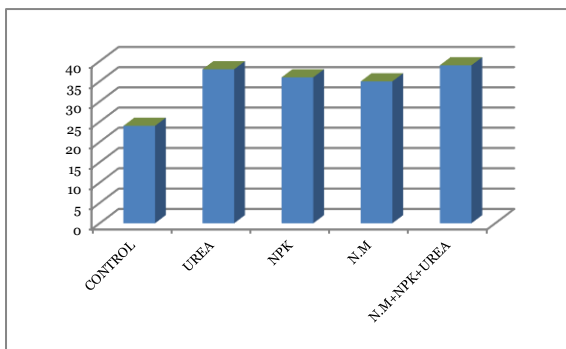


Fig. 1. Plant Height (cm).

Plant Weight (kg)

On harvest, 500 plants were selected randomly from each plot. They were weighed separately. The data is mentioned in the table.

The analysis of the variance revealed that there was noteworthy difference in mass of plants when different fertilizers were added. Maximum weight was calculated when all of the fertilizers were added (19.02 kg). Minimum weight was calculated for control when no fertilizers were added (10.94 kg). Urea gave best results, when all fertilizers were applied separately (18.75 kg) Fig. 2.

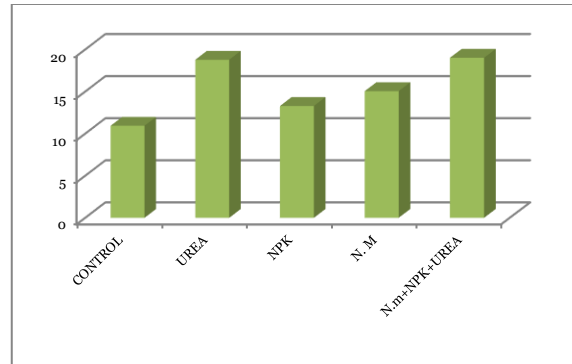


Fig. 2. Plant dry weight (kg).

Grain Mass (kg)

The result showed that there was significant difference among treatments of different fertilizers. The highest grain yield (6.01 kg) from 500 plants was achieved where NPK fertilizer was applied. The Control (no fertilizers added), lowest grain yield (3.26 kg) was attained Fig. 3.

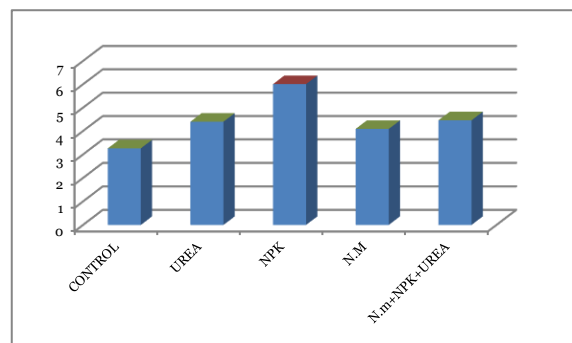


Fig. 3. Grain weight (kg).

Grain Number

There is significant difference in grain numbers of different fertilizers treatments which is evident from the data. Grains of 500 plants of each treatment were counted separately and then they were compared. Large number of grains was counted for NPK fertilizer (132500), while minimum grains (80500) were counted for control (no fertilizers added) Fig. 4.

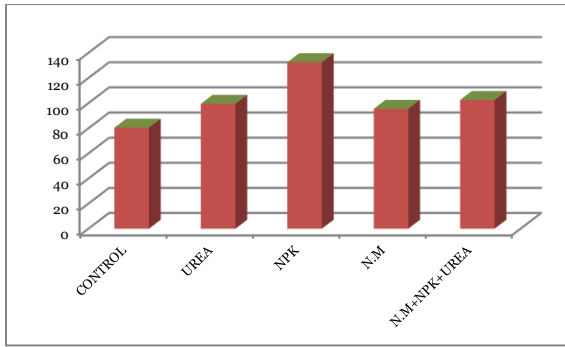


Fig. 4. Grain number (in 1000s).

Mass to Grain ratio (g)

Mass to grain ratio is an important value for cereal crops. The grain to mass ratio is mentioned in the table 1, which shows significant effect of fertilizers on grains. The highest value (0.045 g) was obtained when NPK fertilizer was applied, while lowest value was calculated for control (0.040 g) Table 1.



Fig. 5. Plants for data collection from plots treated with different fertilizers including; Natural manure, NPK, Urea, Control and Natural manure+NPK+Urea from left to right.

Discussion

The conducted research showed that soil was slightly alkaline (7.6 pH) as indicated from the soil analysis and when the soil is neutral or slightly alkaline as is the case in the conducted research then the fertilizer having nitrogen has great influence on soil reactions. The acid reactions of ammonium and urea are positive and cause phosphate and heavy metals mobilization. Therefore, in the present study the use of chemical fertilizers Urea and NPK have played important role in crop productivity.

There is highest percentage of nitrogen in Urea that is 46%. Though it is not ammonium fertilizer in the form but is hydrolyzed to ammonium carbonate very quickly, when it is added to the soil. Therefore, in the current research Urea has showed great impact on wheat plant. The data of the final plant heights as treated with different fertilizers showed the maximum average plant height for all fertilizers (Natural manure + Urea + NPK fertilizer) which was 39 cm, followed by Urea (38cm), while minimum plant height was observed for ‘control’, when no fertilizers were added (24 cm) (Fig. 5).

The result revealed that it has increased plant growth, its dry weight, its size and also has impact on productivity of the crop. It is also evident from the result of the research conducted that, when nitrogen level is increased in soil by applying Urea, NPK and natural manure, the plant growth was increased due to availability of Phosphorus and other heavy metals as a result of soil reactions in slightly alkaline soil as previously discussed. The analysis of the variance revealed that there was noteworthy difference in mass of plants which was calculated maximum for all the three in combination (19.02 kg), minimum for control plot (10.94 kg) and maximum for Urea (18.75 kg) when all fertilizers were applied separately. However, from the application of NPK where Nitrogen, phosphorus and potassium are in equal proportion of 17%, it become cleared that phosphorous and potassium give best results when applied with nitrogen. The result showed the highest grain yield (6.01 kg) for NPK from 500 plants and lowest grain yield (3.26 kg) for control plot. Similarly, the large number of grains (132500) was also counted for NPK fertilizer, while minimum grains (80500) were counted for the plot with no fertilizers. Another important aspect of the research found in the result was mass to grain ratio which is an important value for cereal crops. The highest value was again for NPK (0.045 g) while, lowest value was calculated for control (0.040 g). (Shown in Table 1)

The result also showed that, Natural manure is very important for wheat growth and improves the growth of plants directly or indirectly.

One of the most important and beneficial roles of organic matter is improving the chemical, physical and microbial state of soil due to the presence of large number of microorganisms especially bacteria in it. The natural manure also contain large quantities of minerals especially nitrogen, phosphorous and potassium which are integral part of some of essential organic compounds making the plant body. These three major nutrients are very important for plant growth. Nitrogen is necessary for cell division and has major role in plant growth. The phosphorous apart from increasing cell division and photosynthesis also improves fruit quality. Similarly, Potassium influence enzyme function and is also important for fruit formation. Therefore, the soil must contain 5% natural manure to give maximum yield.

Thus it becomes clear from the conducted research that plants required a number of minerals from the soil for quality production and healthy growth. As a result a soil get depleted of some of essential minerals and in order to be fertile, an adequate supply of essential mineral elements both micro and macro-nutrients are required. In an infertile soil the yield and quality is greatly affected especially of crop plants which the present study revealed. Therefore, to keep agricultural land productive and economical then, the fertilizers must be regularly added to restore deficient nutrients.

This research also proved that, a good fertilizer must have adequate quantities of Nitrogen, Phosphorous and potassium because, the highest yield of wheat crop was attained while, with NPK fertilization.

Conclusion

From the present research it is concluded that for better crop and maximum yield, NPK fertilizer is the best option to be used while Urea proved to be very effective for vegetative growth. The conducted research therefore recommend fertilizers with adequate amount of N,P and K and appropriate timing for a soil fertilization. However, it is highly important to analyze the soil first and ascertain the deficiency before the application of fertilizers.

Furthermore, the nature of soil and crop as well as age and stage of plant development must be considered.

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