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Integrated and Management to Improve the Yield and Quality of Spring Maize Through Organic and Inorganic Fertilizers

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Abstract

A field experiment was conducted at Chota Lahor, district Swabi Khyber Pakhtunkhwa on a sandy clay loam soil to evaluate the effect of organic (FYM) and in-organic (Urea) fertilizers on maize yield. The treatments T_1(Control), T_2(30 kg Farmyard Manure), T_3(490 g urea), T_4(15 kg FYM+245 g Urea) and T_5(7.5 FYM+122.5 Urea), were arranged in randomized complete block design (RCBD), having three replications. Net plot size was 3 m x 5 m. Data was recorded on eight quantitative traits i.e. soil pH, EC, plant height (cm), cob length (cm), cob weight (g), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}) and thousand grain weight (g). All of the traits showed significant differences for the treatments applied. Maximum plant height (194 cm), cob length (18 cm), cob weight (215 g), 1000grain weight (273 g),biological yield (5680 kg ha^{-1}) and grain yield (2139 kg ha^{-1}) was obtained in the treatment where farm yard manure were applied with combination of urea i.e@15 FYM (kg) +245 Urea (g) followed combine application of 7.5 FYM (kg) +122.5 Urea (g) with plant height (181 cm), cob length (17 cm), cob weight (206 g), 1000grain weight (272 g), biological yield (5309 kg ha^{-1}) and grain yield (2084 kg ha^{-1}). Minimum plant height (168 cm), cob length (14 cm), cob weight (189 g), 1000grain weight (264 g), biological yield (3670 kg ha^{-1}) and grain yield (1400 kg ha^{-1}) was obtained in the treatment where no fertilizer was applied (control). It was observed in the study that the combination of organic and in-organic fertilizers was the valuable source and showed better result on yield and yield related traits of maize crop. It was also observed in the study that organic fertilizer gave excellent response for yield and its related traits of maize crop as compared to inorganic fertilizer. Based on the result of this study the effect of organic fertilizer on maize crop must be further evaluated before it is recommended to farmers.

Key Words: nutrient management; spring maize; quality; organic and in-organic fertilizers

Introduction:

Maize is an important cereal crop that provides staple food to large number of human populations in the world. It is a tropical plant but at present its cultivation in subtropical and temperate regions is also done intensively on worldwide bases and it can successfully be cultivated twice in a year. In developing countries maize is a major source of income to many farmers (Tagne et al., 2008). In Pakistan corn is grown on 1049.7 thousand hectares' area with a total yield of 4210.5 thousand tons and average yield of 3973 kilograms per hectare while in KPK corn is sown on 461.7 thousand hectares producing 857.7 tons' grains with an average yield of 1849 kilogram per hectare. In Pakistan its production is less due to many constraints as the climatic condition of Pakistan is arid which has low organic matter due to rapid decomposition. (Rana et al., 2013).

It is grown twice a year (spring and autumn). It is not only a source of food, feed but also utilized as a major ingredient of animal feed and industrial product. Before the advent of chemical fertilizers, farmers mostly relied on organic matter as the sole source to promote health and productivity of the soil. Later on, the era of chemical fertilizers started, and farmers left the use of organic matter because chemical fertilizers were an effective substitute as a ready source of nutrients. However, inorganic fertilizers increase the crop yield but on the other hand; their haphazard use

worsening the soil structure and causing contamination in ground water (Sagardoy, 1993).In Pakistan, maize occupies third position after wheat and rice and 98% of the crop is grown in Punjab and NWFP. Pakistan grows maize on about 1.11 million hectares with annual production of 4.04 million tons of grain and average yield of 3.62 t ha-1 (GOP, 2009). In Pakistan the potential of crop is not being exploited satisfactorily due to many constraints. Among those, inappropriate nutrients supply is important (Oad et al., 2004).

The soils of Pakistan are generally low in organic matter, firstly because of arid climate resulting in a rapid decomposition of organic matter and secondly because very little organic matter is added to the soil. On an average most of the soils of Pakistan contain less than 1% organic matter. Soil fertility can be increased through the utilization of mineral as well as organic materials (Azad and Yousaf, 1982).
Nitrogen fertilizer plays an important role on improving maize grain yield and quality. The application of nitrogen enhanced the assimilate accumulation in the kernels after silking, and stimulated kernel setting and yield improvement (Ning et al. 2018; Zhao et al. 2019). Nitrogen fertilizer plays an important role on improving maize grain yield and quality. The application of nitrogen enhanced the assimilate accumulation in the kernels after silking, and stimulated kernel setting and yield improvement (Ning et al. 2018; Zhao et al. 2019).

In spite of substantial fertilizer uses in Pakistan, the crop yield is not increasing correspondingly, which reflect low fertilizer use efficiency (FUE). There are some problems related to chemical fertilizers such as inadequate supply or even unavailability of fertilizer at the time of need, adulteration and high cost (Ahmad, 1994). Further, continuous use of fertilizers creates potential polluting effect in the environment (Oad et al., 2004). The soil and climatic conditions of Pakistan are best for maize production but a number of factors such as poor soil fertility and inappropriate nutrient management are responsible for low yield of crop.

The maize crop can tolerate a wide range of temperature (5-45^{0}C), but very high or low temperature can have negative effect on yield. The temperature greater than 33^{0}C during pollination and tasseling stage speed up the various processes of reproductive parts and results in yield reduction and seed abortion **(**Rana et al., 2013**)**. Organic fertilizers including farmyard manure, sheep manure and PM may be used for the crop production as a substitute of the chemical fertilizers because the importance of the organic manures cannot be overlooked. Worldwide, there is growing interest in the use of organic manures due to depletion in the soil fertility. Economic premiums for certified organic grains have been driving many transition decisions related to the organic production (Sasirekha, 2012). farming (Delate and Camberdella, 2004). The integrated use of organic manure and nitrogenous fertilizer (urea) on growth and yield component of spring maize had a great effect (Dellin and Engstorm, 2010).

The integration of organic sources and synthetic sources of nutrients not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards (Ahmad et al., 1996). The integrated use of organic manure and nitrogenous fertilizer (urea) on growth and yield component of spring maize had a great effect (Dellin and Engstorm, 2010). The integration of organic sources and synthetic sources of nutrients not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards (Ahmad et al., 1996).

Materials and Methods:

A field experiment was conducted at Chota Lahor, district swabi Khyber Pakhtunkhwa on a sandy clay loam soil. The treatments T_1(Control), T_2(30 kg Farmyard Manure), T_3(490 g urea), T_4(15 kg FYM+245 g Urea) and T_5(7.5 FYM+122.5 Urea), were arranged in randomized complete block design, having three replication Net plot size was 3 m x 5 m. Seedbed was prepared by cultivating the soil 2-3 times with tractor mounted cultivator each followed by planking. Maize single cross hybrid was sown on 20th of March in 2021. Sowing was done by rotary dibbling method (by placing 2 seeds per hill at 20 cm apart hills) on 75 cm apart ridges. In this experiment the crop was completely dependent upon the farmyard manure and Nitrate. Irrigation was done on weekly basis. Soil samples were collected from maize growing field of district Swabi. To keep the crop free from weeds, insect and pest chemicals like weedicides, insecticides and pesticides were applied properly. The composite soil samples were collected from a depth of 0-20cm from maize crop and 0-45 from overland soil and analyzed for the following parameters.

Results and Discussion:

Soil pH and EC (Electrical Conductivity) (ds/m):

The soil pH and soil EC data of spring maize as significantly ($p<0.05$) affected by different levels of organic and inorganic fertilizers under field condition is given in Table 1. It is obvious from the statistical analysis of the data that the application of urea increased the soil pH and soil EC of maize under field condition. The maximum soil pH (7.6) of spring maize was recorded in the treatment having 490 g urea (T_3) as compared to 15 fym+245 g urea(T_4) and the treatment applied. It was followed by the treatment control (T_1) where no fertilizers were given. Likewise, compared to control and sole FYM treatment, the maximum soil ECdS/m of 3.2 was recorded in the treatment supplied with 490 g urea. This treatment was followed by the 3.59 to which 15 FYM+245 g urea was applied.

Treatments	pH	ECdS/m
Control	7.6 ab	2.5 b
30 kg Farmyard Manure	7.5 ab	2.6 b
490 g Urea	7.6 a	3.2 a
15 FYM (kg) +245 Urea (g)	7.5 ab	3.1 a
7.5 FYM (kg) +122.5 Urea (g)	7.4 b	3.0 a
LSD (0.05)	0.164	0.3
CV	1.15	6.98

Table 1: Soil pH and EC of spring maize as affected by different levels of Organic (FYM) and inorganic (Urea) fertilizers

Plant Height and Cob Length (cm):

The data concerning the effect of different levels of Organic and

inorganic fertilizers on plant height is presented in Table 1. Results revealed that organic and in organic fertilizers significantly ($p<0.05$) increased the plant height of maize. The shorter (168 cm) plants in maize were recorded at control (T_1) whereas the long (194cm) plants were recorded at treatment receiving 15 FYM (kg) +245 Urea (g) (T4). The plant height gradually increased with combine application of organic and in organic fertilizer that argues that integrated use of organic and chemical fertilizer plays greater role in the improvement of growth and development of plant. This may be due to, firstly the incorporation of organic manure in the soil which improved the physical properties of soil and secondly the application of chemical fertilizer which make it productive. Similarly, the cob length was found highest (18 cm) at T4 and was found lowest (14 cm) at control where no application was made. These results are in line with that of Achieng, et al., (2010), and Shah, et al., (2009) who reported that plant height, number of grains per cob, 1000-grain weight, grain yield and harvest index of maize gave higher values, when N and FYM were integrated as compared to the alone application of the two sources of nutrients. Chapagain (2010), reported that application of farmyard manure along with 50% of the recommended urea fertilizer resulted in vigorous plant growth and increase in cob length, and grain yield of maize. The increase in cob length might be attributed to the availability of more nitrogen and other nutrients from both urea and organic manure required for plant development at least up to cob formation. These results suggested that adequate supply of nutrients from both organic and inorganic source throughout vegetative growth was necessary for proper cob development in maize.

Treatments	Plant height (cm)	Cob length (cm)
Control	168 d	14d
30 kg Farm Yard Manure	172 c	16c
490 g Urea	179 b	17bc
15 FYM (kg) +245 Urea (g)	194 a	18 a
7.5 FYM (kg) +122.5 Urea (g)	181 b	17b
LSD (0.05)	2.83	0.91
CV	0.84	2.90

Table 2: Plant Height (cm) and Cob length (cm) of spring maize as affected by different levels of Organic (FYM) and inorganic (Urea) fertilizers

Cob weight (g) and 1000 grain weight:

The value of Cob weight and 1000 grain weight was significantly ($p<0.05$) affected by applying different fertilizers. The highest (215 g) value was recorded at treatment combination of (15 FYM (kg) +245 Urea (g) T4 followed by T5 (206) and T3 (205). Whereas the highest 1000 grain weight was (273 g) also recorded at the same treatment followed byT3 (273) and T5 (268). There are significant differences in all treatment as compare to each other. It was followed by the 206.3 and the treatment which was applied to this was 7.5 kg farmyard manure+122.5g urea. These results are in line with that of Amoruwaet al. (1987) who reported that thousand grains weight increased with increasing nitrogen rate. Different yield attributing parameters like grain yield (t/ha), numbers of cobs/ha and thousand grain weights (g) were calculated for each variety in spring season of 2018 spring.

Organic and inorganic fertilizers on plant height is presented in Table 1. Results revealed that organic and in organic fertilizers significantly ($p<0.05$) increased the plant height of maize. The shorter (168 cm) plants in maize were recorded at control (T1) whereas the long (194cm) plants were recorded at treatment receiving 15 FYM (kg) +245 Urea (g) (T4). The plant height gradually increased with combine application of organic and in organic fertilizer that argues that integrated use of organic and chemical fertilizer plays greater role in the improvement of growth and development of plant. This may be due to, firstly the incorporation of organic manure in the soil which improved the physical properties of soil and secondly the application of chemical fertilizer which make it productive. Similarly, the cob length was found highest (18 cm) at T4 and was found lowest (14 cm) at control where no application was made. These results are in line with that of Achieng, et al., (2010), and Shah, et al., (2009) who reported that plant height, number of grains per cob, 1000-grain weight, grain yield and harvest index of maize gave higher values, when N and FYM are applied in combination (Rafiullah et.al. 2021)

Treatments	Cob weight (g)	1000 grain weight (g)
Control	189d	264c
30 kg Farm Yard Manure	197c	263c
490 g Urea	205b	272a
15 FYM (kg) +245 Urea (g)	215a	273a
7.5 FYM (kg) +122.5 Urea (g)	206b	268b
LSD (0.05)	1.7442	1.4984
CV	0.46	0.30

Table 3: Cob Weight (g) and 1000 grain weight of spring maize as affected by different levels of Organic (FYM) and inorganic (Urea) fertilizers

Biological yield and Grain Yield (kg ha^{-1}):

Biological yield of maize was significantly ($p<0.05$) increased with farm yard manure and urea application (Table 4.4). The biological yield of maize increased from 3670 in control (T_1) to 5680 kg ha^{-1} when the crop received farmyard manure with the combination of urea T_4 (15 FYM (kg) +245 Urea (g)). This biological yield further increased to 5562 and 5309 kg ha^{-1} when the application was done with 490 g urea per plot and7.5 FYM (kg) +122.5 Urea (g) per ploti.e T_3 and T_5 revealing different responses at different applications rates.The higher response at these application treatments could be the exceeding demands of plant nutrient over the rate of supply from soil due to higher vegetative growths at different stages. Similarly, the grain yield of maize increased from 1400 in control to 1717 kg ha^{-1} when received 30 kg Farm Yard Manure alone (T_2) which further increased to 2139 kg ha^{-1} when application was done with urea 490 g per plot alone, suggesting variable response to different fertilizers. However, the differences amongT_3, T_4 and T_5were statistically similar. Combination of organic and inorganic resulted in higher grain yield than single application of FYM or urea alone.These results are in consistency with Khan et al., (2013) who studied response of spring maize to integrated nitrogen management and found a significant increase in

biological and grain yield of maize under field conditions. Moreover, the reason for the significant increase in maize yield is that urea is quickly soluble fertilizer and in the presence of FYM it improves nutrients supplying capacity to plants as well as water retention capacity of soil and thus increase both the biological and grain yield (Deksissa et al., 2008). Application of nitrogen provided better nutrition to maize which resulted in higher grain yield. Increase in grain yield of maize with the application of nitrogen may be attributed to better growth of plant. The improvement in growth resulted in significant increase in yield attributes like number of cobs per plant, grains per cob, cob length and cob girth and test weight of maize which ultimately contributed to higher grain yield of maize with the application of nitrogen. The beneficial effect of nitrogen on grain yield of maize has also been reported by Sahoo and Mahapatra and Kumar (2004-2008)

Treatments	Biological Yield (kg ha-1)	Grain Yield (kg ha-1)
Control	3670.3 b	1400 c
30 kg Farmyard Manure	3945.3 b	1717 b
490 g Urea	5562.3 a	2139 a
15 FYM (kg) +245 Urea (g)	5679.7 a	2084 a
7.5 FYM (kg) +122.5 Urea (g)	5309.3 a	1918 b
LSD (0.05)	411.35	101.58
CV	4.52	2.88

Table 4: Biological yield and grain yield of spring maize as affected by different levels of Organic (FYM) and inorganic (Urea) fertilizers

Conclusions:

It is concluded from this study that farm yard manure urea were the valuable fertilizers and showed better result on yield and yield related traits of maize crop. It was also observed in the study that organic fertilizer when combine with in-organic fertilizers showed positive response to yield and other plant growth traits of maize crop as compared to alone application of inorganic fertilizer. Based on these results, the effect of organic fertilizer on maize crop productivity and soil fertility must be further evaluated before it is recommended to farmers.

Conflict of interest:

All authors declare that they have no conflict of interest.

Declaration of Funding:

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Data Availability Statement:

The data that support the findings of this study are available from the corresponding author, [rafiullah@uoswabi.edu.pk], upon reasonable request.

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