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Impact of Zinc and Organic Manure on Wheat Productivity and Soil Fertility

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Abstract

Use of synthetic fertilizers have some problem to farmer due to short residual effect and high cost. Since the farmers used organic manure due to long residual effect but the nutritional requirement is not fulfilling during one season of crops. So, using of organic manure and with combination of inorganic manure not only fulfill the nutrition requirement of the plants but also improve the fertility status of soil. Therefore, a field experiment was carried out in Agriculture Research Station Swabi KPK, Pakistan during 2015-16. Zinc ($ZnSO_4$) and organic manure (farmyard manure+poultry manure) were used as treatments combination T_1=Control, T_2=Zinc 10 kg ha^{-1}, T_3=FYM 20 ton ha^{-1}, T_4=PM 5 ton ha^{-1}, T_5=Zinc+FYM, T_6=Zinc+PM, T_7=FYM+PM, T_8+Zinc+FYM+PM. NP and K were applied as basal dose @ 120:90:60 kg ha^{-1}. Experimental results showed that all the treatment were significantly ($p \leq 0.05$) different. The maximum plant height (86 cm), maximum biological yield (6842 kg ha^{-1}), maximum grain yield (2827 kg ha^{-1}), higher soil N (0.40%), maximum soil P (7.6 mg/kg), maximum soil K (91 mg/kg) and maximum soil organic matter content (1.0%) from the plot having T_8+Zinc+FYM+PM. It is concluded from these result the combines used of zinc, farmyard manure and poultry manure produce higher yield and yield parameters of wheat and also enhance the fertility status of soil.

Keywords: Zinc; Farmyard manure; Poultry manure; Grain yield; Swabi; Pakistan

Introduction

Wheat (*Triticumaestivum* L.) is an important cereal crop. It is a self-pollinated annual grass from Graminae family and Triticum genus, that has many species [1]. In Pakistan the annual production of wheat is over 24 million ton which is sown on 9 million-hectare area. Under irrigated and rain fed areas the average yield is 2.9 and 1.3-tons h^{-1} [2]. Zinc is essential micronutrient and has a number of crucial functions in plant system. Its deficiency in plants results in significant decreases in both productivity and nutrient quality. Zinc is one of the most functional micro nutrient in plants and animals and it play a physiological role in the growth and development [3]. It also play an important role in the enzymatic processes [4]. But 30 to 40% of the total area of the world is reported zinc deficient [5]. Zn fertilizers are used in the bio fortification and to fulfill the Zn deficiency of cereal crop [6]. Burnett et al. [7] recommended that seed priming of wheat with $ZnSO_4$ for the highest economic returns. Study shows that the concentration of Zn can be improved by external application of Zn [8], zinc application not only improved nutritional quality but also increase grain production. The concentration of zinc in wheat grain increased by 18.8% and the dry weight of seedling roots and fruits were significantly improved by applying zinc fertilizer [9,10]. Zinc is very important essential nutrient for wheat in developing countries and ranks third in nutrients essentiality criteria in Pakistan [11]. Organic farming is accurate for integrated production systems and recent increase in the organic farming has created a new market for fertilizers permitted for use in organic farming and when some products are allowed in organic agriculture, commercial opportunities become available [12]. Organic manure is a key component of the soil and crop yield because it carries out many functions in agro ecosystem [13]. Organic outputs are beneficial for the overall health of the agro-environment [14]. But organic manure management and storage are major problem in the organic farming [15]. Wheat is one of the cereal crops which are most commonly grown in organic farming systems [16]. Economic value of certified organic grains have been lashing many transition decisions related to the organic farming [17] while chemical fertilizers consume a large amount of energy and money. However, an organic farming system with or without chemical fertilizers seems to be possible solution for these situations [18]. The integration of organic and synthetic sources of nutrients not only supply essential nutrients but also has some optimistic relations leading to increased crop yield and reduced environmental threats [19].

Materials and Methods

The experiment entitle "impact of zinc and organic manure on wheat productivity and soil fertility" was conducted at Agriculture Research Station Swabi, KPK Pakistan during 2015-16. Zinc ($ZnSO_4$) and organic manure (farmyard manure+poultry manure) were used as treatments combination T_1=Control, T_2=Zinc 10 kg ha^{-1}, T_3=FYM 20 ton ha^{-1}, T_4=PM 5 ton ha^{-1}, T_5=Zinc+FYM, T_6=Zinc+ PM, T_7=FYM +PM, T_8+Zinc+FYM+PM. NP and K were applied as basal dose @ 120:90:60 kg ha^{-1}. The experiment was carried out in randomized complete block design having three replication. The plot size was 4 m × 3 m. All the agronomic practices (irrigation, pesticides, weeding etc.) were be kept uniformly throughout the experiment.

The treatment combination were be give as:

- T_1=Control
- T_2=Zinc 10 kg ha^{-1}
- T_3=FYM 20-ton ha^{-1}
- T_4=PM 5-ton ha^{-1}
- T_5=Zinc+FYM
- T_6=Zinc+PM
- T_7=FYM+PM
- T_8=Zinc+FYM+PM

Data were recorded on following agronomic and soil parameters.

Plant height (cm)

Data regarding plant height were recorded at maturity by measuring the height of ten representative plants from soil surface to the tip of spike in each plot randomly selected and then average was taken.

Grain yield (kg ha^{-1})

Data regarding grain yield ha^{-1} was recorded from central two rows for each plot after threshing and thoroughly cleaning the grain. Grain yield then converted in to kg ha^{-1} using the formula:

Grain yield (kg ha^{-1})=[(Grain yield=(kg))/(Row to row distance × Row length × No. of rows selected)] × 10000

Biological yield (kg ha^{-1})

Biological yield was determined by harvesting four central rows in each and every plot and then sun dried and weighed and was converted into kg ha^{-1} by following formula:

Biological yield (kg ha^{-1})=[(Biological yield in middle four rows)/(R-R Distance (m) × Row length (m) × No. of rows)]

Soil total N

By the Kjekdhal method the soil total nitrogen was determine. A 0.2 g dry materials of grounded l soil sample were digested with 3 ml concentrated H_2SO_4 in the presence of 1.1 g digestion mixture containing $CuSO_4$, K_2SO_4 and placed on mental about 1 hr for heating. The digest were transported quantitatively to the distillation flask and purified in the presence of 10 M NaOH solution of 10 ml. The collected distillate were mixed with 5 ml indicator solution of boric acid and then titrate against 0.01 M HCl [6].

The following formula was used for soil total nitrogen:

(%) N=[((ml sample-mL blank) × N of HCL × meq N × 100)/(volume distilled × Wt of sampe)] × 100

AB-DTPA extractable P and K

In soil samples the P and K concentration were determine with AB-DTPA extracting soil solution. A 10 g soil sample was taken in conical flask then added solution of AB-DTPA 20 ml and for 15 min were placed on shaking machine. After filtered the sample with watt man No. 42. One ml sample were taken from individually sample then was added ascorbic acid 5 ml and made 25 ml volume. For 15 mins the sample were placed for development of color. After proper color development with the help of spectrophotometer the P was determined and with the help of Flame Photometer K was determined [20].

Soil organic matter

Organic matter in soil samples were determined by the Walkley-Black procedure as described by Petric et al. [21]. In this method, 1 g soil sample was treated with 10 mL of 1 N $K_2Cr_2O_7$ and 20 ml of concentrated H_2SO_4. After adding 200 ml of distilled water upon cooling, the suspension was filtered, and the filtrate was titrated against 0.5 N $FeSO_4.7H_2O$ solution using ortho-phenolphthalein as indicator with the appearance of maroon color as an end point. A blank was also run at the same time to correct normality of $FeSO_4.7H_2O$. The amount of organic matter was calculated from the number of moles of $K_2Cr_2O_7$ utilized in the oxidation of organic carbon in soil by using the following equation [22].

%OM=[((mL of $K_2Cr_2O_7$ × N)-(mL of $FeSO_4.7H_2O$ × N) × 0.69)]/Weight of soil (g)

Statistical analysis

Data that were collected from field and laboratory analysis were analyzed statistically by RCB design with split plot arrangement and least significant difference (LSD) at 5% level of probability was used for significance ($p \leq 0.05$) upon F-test significant through the procedure described by Rehman et al. [23].

Results and Discussion

The experimental site pH was 7.7, EC was 0.37 dSm^{-1} which is less than 1 so have no salinity problem. The organic matter content and soil total N was deficient, and P and K was medium in nature the soil texture class was silt loam. The Farm yard manure contain (0.38%) N, (0.17%) P, (1.38%) K and poultry manure contain (3.57%) N, (3.32%) P, and (0.94%) K. Data regarding agronomic parameters of wheat and soil parameters is showed in Table 1. Plant height was significantly affected the maximum plant height was observed from T_8 (Zinc+FYM +PM) while minimum was recorded from control plot. Our finding are in line with result of Rehman et al. [23] who stated that organic manure is a supplementation dose which increase the plant cell division as result taller plant produced. Zinc fertilizers held in vegetative growth as well reproductive growth [8]. Grain yield and biological yield were significantly affected the maximum grain and biological yield were recorded from the plot having (Zinc+FYM+PM) while minimum was observed from control plot. These finding are correlated with result of Rodrigues et al., Soltanpour et al. [24,25] who reported that used of organic manure resulted higher biological and grain yield. Our finding are also in line with result Swift [26] who concluded that Zn application not only improved nutritional quality but also increase grain production. Soil total N was non-significantly affected the maximum N was recorded from plot having (Zinc+FYM +PM) while the minimum was observed from plot having no fertilizers (control). These result are in agreement with Weil et al. [27] who testified that organic fertilizer provide large amount of N as well as improve soil physical properties and act as soil conditioners. Soil extractable P and K affect were significant the maximum P and K were recorded from plot where (Zinc+FYM+PM) while minimum from control plot. These result are similar with result of Jan et al. [28] observed that higher macro and micro nutrient concentrations in soil receiving organic manure in comparison to mineral fertilizers. Integration of mineral fertilizers with compost increased soil K content in addition to high yield of crop in comparison to the sole application of organic and inorganic fertilizers. The soil organic matter content

was non-significant the maximum organic matter was observed from plot having (Zinc+FYM+PM) while minimum from control plot.

Treatments	Plant height (cm)	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Soil N (%)	Soil P (mg kg^{-1})	Soil K (mg kg^{-1})	Soil OM (%)
Control	82^{d}	1923^{c}	4283^{d}	0.31^{c}	2.2^{d}	73.7^{f}	0.4^{cd}
Zinc 10 kg ha^{-1}	85.5^{bc}	2657^{ac}	6607^{ab}	0.37^{b}	2.9^{cd}	77.6^{ef}	0.5^{c}
FYM 20-ton ha^{-1}	84^{c}	2349^{b}	5147^{c}	0.38^{b}	4.2^{bc}	81.2^{de}	0.5^{c}
PM 5-ton ha^{-1}	85.4^{bc}	2407^{b}	5349^{c}	0.38^{b}	4.3^{bc}	88^{ab}	0.6^{bc}
Zinc+FYM	83.4^{abc}	2488^{ab}	6251^{ab}	0.37^{b}	5.3^{b}	82de	0.7^{b}
Zinc+PM	84^{c}	2295^{bc}	5745^{bc}	0.38^{b}	5.4^{b}	86^{bc}	0.7^{b}
FYM+PM	84.8^{ab}	2482^{ab}	5348^{bc}	0.40^{a}	4.4^{bc}	82de	0.9^{a}
Zinc+FYM+PM	86^{a}	2827^{a}	6842^{a}	0.40^{a}	7.6^{a}	91^{a}	1.0^{a}
LSD	2.14	425	791	0.05^{a}	1.65	4.3	0.1
Sig	*	*	*	ns	*	**	ns

Table 1: Wheat yield and soil parameters as effected by zinc and inorganic manure.

Conclusion

On the basis of present research work it is concluded that the higher grain yield (2827) was recorded from the treatment (Zinc+FYM+PM). While the lower was observed from control treatment. Similarly, the treatment (Zinc+FYM+PM) have higher soil nitrogen, phosphorus, potassium and organic matter improved soil fertility.

Recommendation

On the basis of given conclusion, it recommended that combine application of (Zinc+FYM+PM) produce higher yield and yield component and also enhanced the fertility status of soil. Further research work is needed to find out more suitable combination of organic and inorganic under different corps on various ecological condition of Pakistan.

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