

ARTICLE

EFFECTS OF ORGANIC AND CHEMICAL FERTILIZERS ON YIELD COMPONENTS OF COMMON WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

This experiment was laid out in order to study on effect of organic fertilizer and P fertilizer on yield and yield components of common wheat (*triticumaestivum* L.) cv. Chemran Islamic Azad University, Khorramabad branch, Iran in 2015. The experiment was laid out in a split-plot design based on randomized block design with three replications. Treatments were organic fertilizer (0, 10, 20 ton/ha manure and 10, 20 ton/ha compost) in main plots and phosphate fertilizer (0, 50, 75 and 100 percent based on proposed soil analyzing) in sub plot. Analysis of variance results showed that effect of organic and chemical fertilizers and interaction effect of them were significant on some yield components of common wheat. Based on the results, combined application of organic manure or vermicompost with chemical fertilizer has a better effect on yield and yield components of common wheat rather than single application of them and control treatments. Higher grain yield was obtained in 20ton/ha organic matter and 75% phosphate fertilizer recommendation treatment with the average of 5472 kg/ha as compared with control treatment (without consuming organic matter and phosphate about 3 ton/ha). Therefore, we can conclude that combined application of organic and chemical fertilizers had more efficiency because of some positive interaction between their microorganisms in soil that result to synergistic effect and laid to increase in yield components and in final grain yield. In final our results indicated that higher grain yield observed in combined application 20ton/ha organic matter and 75% chemical P fertilizer and application of combined fertilizer is better for farmer in wheat field of Khorramabad region for high yield and economic benefits in common wheat.

INTRODUCTION

Wheat (*triticumaestivum* L.) is the national staple food in forty-three countries. According to the statistics of the food and agriculture organization (FAO), during 2008-2009 growing season 682 million tons of wheat were produced and it is estimated that up to 690 million tons will be produced in 2012- 2013 growing season. The experts contend that the amount of the annual wheat production must be 2% higher than the annual demand. The world does not have enough potential for increasing the soil level cultivated with wheat; therefore in order to increase the wheat production, we have to increase the productivity of the fields which have been cultivated with wheat. Grain yield of small grain cereals is determined by two main components, grain number per unit area (grains perm²) and mean grain weight. Environmental conditions around 20 days pre- and 10 days post-anthesis are considered critical for grain yield determination [1]. During pre-anthesis, the potential grain number per unit area [2] and potential grain weight [3] are defined. The final grain number per unit area is set immediately after anthesis, while grain filling occurs during the remaining post-anthesis period [4].

Grain yield of small grain cereals is determined by two main components, grain number per unit area (grains perm²) and mean grain weight. During pre-anthesis, the potential grain number per unit area [2] and potential grain weight [3] are defined. The final grain number per unit area is set immediately after anthesis, while grain filling occurs during the remaining post-anthesis period [4]. Grain yield is usually strongly associated with the number of grains per unit area [1, 2]. While this association has been extensively reported for a relatively wide range of environments and nutrition.

The use of organic fertilizers, such as manure, vermicompost and crop residues in crop production has been a known activity for hundreds, even thousands of years, thanks to new varieties, changing climatic conditions, new aims in cultivation (higher yields, better quality, maximum efficiency of production), new technologies of food processing and efforts for nature protection and sustainable agriculture, these „old“ materials and new technologies are nowadays a target of refinement and globally focused attention [5, 6]. Organic fertilizers are the products of the degradation of organic matter through interactions between earthworms and microorganisms. Organic fertilizers are finely divided peat-like materials with high porosity, aeration, drainage, and water-holding capacity and usually contain most nutrients in the available forms such as nitrates, phosphates, exchangeable calcium and soluble potassium [7]. The preparation and use of organic manures as a nutrient management may provide a hygiene and useful way of disposal and utilization of waste which would otherwise have created a healthy environment [8]. They told that, French bean was most responsive to vermicompost treatment on growth and yield in comparison to farmyard manure, chemical fertilizer and mixed treatments under irrigated condition of Srinagar valley. They also concluded that vermicompost is particularly good for farmers, consumers and ultimately for soil as it can be used as a resource for maximum crop productivity with more financial output in comparison to those chemical fertilisers. [9] found better yield in vermicompost treatment. Same observation was also reported [10]. [11] reported that yield increased with fertilizer and manure application.

KEY WORDS

Common wheat, Grain yield, Manure and straw

Received: 15 Aug 2016
Accepted: 25 Sep 2016
Published: 30 Oct 2016

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Therefore the aim of this study is evaluation of effects of some organic fertilizer such as manure and vermicompost and chemical fertilizers on yield and yield components of common wheat in Lorestan province, Iran.

MATERIAL AND METHODS

Field material and experimental design

A field experiment was laid out in the Faculty of agronomy and plant breeding, Islamic Azad University, Khorramabad Branch, Iran during the growing seasons 2014- 2015. The experiment was laid out in order to evaluate the effects of manure and vermicompost and chemical fertilizers on yield and yield components of common wheat. The Khorramabad region has a continental semi-arid climate with annual precipitation of 500 mm. About 50% of this falls during the wheat and barley growing period.

Treatments

The experiment was laid out in a split-plot design based on randomized block design with three replications. Treatments were organic fertilizer (0, 10, 20 ton/ha manure and 10, 20 ton/ha compost) in main plots and phosphate fertilizer (0, 50, 75 and 100 percent based on proposed soil analyzing) in sub plot.

Yield and yield components determination

There were 15 rows in each from plot; rows were 6 m long with 0.2 m row spacing. At maturity, two outer rows for each plot, 50 cm from each end of the plots, were left as borders and the middle 1 m² of the three central rows were harvested. Then yield components were calculated as standard methods with using 10 plants. To determine grain yield, biomass yield and harvest index, we removed and cleaned all the seeds produced within two central rows in the field. Then grain yield and biomass yield recorded on a dry weight basis. Yield was defined in terms of grams per square meter and quintals per hectare. Replicated samples of clean seed (broken grain and foreign material removed) were sampled randomly and 1000-grain were counted and weighed. The straw yield was accounted with follow:

$$\text{Straw yield} = \text{biological yield} - \text{grain yield}$$

Statistical analysis

The statistical analysis to determine the individual and interactive effects of treatments was conducted using MSTAT-C software [12,13]. Statistical significance was declared at $P \leq 0.05$ and $P \leq 0.01$. Treatment effects from the two runs of experiments followed a similar trend, and thus the data from the two independent runs were combined in the analysis.

RESULTS

Spike length: The results showed that, the effect of organic fertilizer, P fertilizers and interaction between them on spike length was not significant [Table 1]. The comparison of the mean values of the spike weight for interaction effect of organic fertilizer and P fertilizers showed that application of 20 ton/ha vermicompost and 100% P fertilizer treatment had the highest (8.99 cm) and control treatment had the lowest spike length (7.6 cm) and difference between them were significant [Table 2].

Table 1: Analysis of variance (mean squares) for yield and yield components of common wheat under application of organic manure and P fertilizer

S.O.V	df	Spike length	Spike weight	Number of grain per spike	1000 grain weight	Grain yield	Straw yield	Biomass yield
R	2	1.82	0.24	0.95	0.14	0.58	0.44	1.57
Organic fertilizer	4	1.78	0.48	0.36	5.24*	3.64*	0.54	2.4
P fertilizer	3	0.18	4.69**	4.47**	1.12	5.08**	5.61**	5.43**
O*P	12	1.33	1.69*	2.53**	0.52	0.83	5.6**	0.75
CV	-	24	7.07	16.8	5.95	15	16	14.5

ns: Non-significant, * and **: Significant at 5 and 1% probability levels, respectively

Spike weight: The results showed that, the effect of P fertilizers and interaction between organic fertilizer and P fertilizer on spike weight was significant only [Table 1]. The comparison of the mean values of the spike weight for interaction effect of organic fertilizer and P fertilizers showed that application of 20 ton/ha manure and 100% P fertilizer treatment had the highest (1.85 g) and application of 20 ton/ha vermicompost and 0% P fertilizer treatment had the lowest spike weight (1.01 g) and difference between them were significant [Table 2].

Number of grain per spike: The effect of P fertilizers and interaction between organic fertilizer and P fertilizer on number of grain per spike was significant and the effect of organic fertilizer was not significant on it [Table 1]. The comparison of the mean values for interaction of organic fertilizer and P fertilizers on number of grain per spike of wheat showed that combined application of application of 20 ton/ha manure and 50% P fertilizer treatment had the highest (33) and combined application of 10 and 20 ton/ha vermicompost and 0% P fertilizer treatment had the lowest number of grains per spike (19) and difference between them was significant [Table 2].

1000 grain weight: The effect of organic fertilizer on 1000 grain weight was significant and the effect of P fertilizers and interaction between organic fertilizer and P fertilizer was not significant on it [Table 1]. The comparison of the mean values for interaction of organic fertilizer and P fertilizers on 1000 grain weight of wheat showed that combined application of application of 10 ton/ha vermicompost and 75% P fertilizer treatment had the highest (43.5 g) and control treatment had the lowest 1000 grain weight (36 g) and difference between them was significant [Table 2].

Table 2: Mean comparison interaction effect organic fertilizer and P fertilizer on yield components of common wheat

Treatments	Spike length (cm)	Spike weight (g)	Number of grain per spike	1000 grain weight (g)	Grain yield	Straw yield	Biomass yield (kg/ha)
M ₀ P ₀	7.6c	1.33b-e	21.7j	36d	2475f	5031c	7736d
M ₀ P ₁	8.6abc	1.59a-e	29c	38cd	3313ef	6573abc	9708a-d
M ₀ P ₂	8.2abc	1.45a-e	27g	38.3cd	3503ef	5176c	9617a-d
M ₀ P ₃	7.7c	1.28b-e	29.3c	37.3cd	3896cde	6483abc	9167bcd
M ₁₀ P ₀	7.7c	1.48a-e	26h	40abc	4125b-e	5479bc	10570a-d
M ₁₀ P ₁	8.8abc	1.47a-e	26h	40.4abc	5129abc	6681abc	11331abc
M ₁₀ P ₂	7.9abc	1.18c-e	26h	41.5abc	5267ab	6980abc	12147a
M ₁₀ P ₃	7.7c	1.37b-e	28de	40.2a-d	4652a-d	6248abc	10250a-d
M ₂₀ P ₀	7.7c	1.15d-e	22j	41.2abc	4134b-e	6987abc	11781ab
M ₂₀ P ₁	8.2abc	1.85a	30b	41.2abc	4712a-d	6979abc	11093a
M ₂₀ P ₂	8.8abc	1.65a-c	28ef	41.2abc	5462a	6704abc	12200a
M ₂₀ P ₃	7.7c	1.71ab	33a	42abc	4567a-e	5683bc	9500a-d
C ₁₀ P ₀	8.4abc	1.12de	19k	40.2a-d	4000b-e	5570bc	10136a-d
C ₁₀ P ₁	8.2abc	1.44a-e	27g	42.5ab	4912abc	7463ab	12292a
C ₁₀ P ₂	8.3abc	1.75a-b	23i	43.5a	4242a-e	6333abc	10836abc
C ₁₀ P ₃	8.5abc	1.48a-e	28d	39.4a-d	4754a-d	5004c	9650a-d
C ₂₀ P ₀	7.7c	1.01e	19k	41abc	4133b-e	5271c	9417a-d
C ₂₀ P ₁	8.99a	1.3b-e	27fg	40.63a-d	4718a-d	7671a	11436abc
C ₂₀ P ₂	8.3abc	1.2c-e	29c	39.9a-d	4418a-e	5248c	11327abc
C ₂₀ P ₃	8.9ab	1.54a-d	27g	39.5a-d	4215a-e	5689abc	8833cd

Means by the uncommon letter in each column are significantly different ($p < 0.05$). (M₀=Nom application of organic fertilizer, M₁₀= application of 10 ton/ha manure, M₂₀= application of 20 ton/ha manure, C₁₀= application of 10 ton/ha vermicompost, C₂₀= application of 20 ton/ha vermicompost, P₀= 0% phosphor fertilizer, P₁= 100% phosphor fertilizer, P₂=75% phosphor fertilizer and P₃=50% phosphor fertilizer)

Grain yield: The results showed that, the effect of organic and P fertilizers on grain yield were significant [Table 1]. The comparison of the mean values of grain yield for interaction effect of organic fertilizer and P fertilizer showed that application of 20 ton/ha manure and 75% P fertilizer treatment had the highest (5462 kg/ha) and control treatment had the lowest grain yield (2475 kg/ha) and difference between them were significant [Table 2].

Straw yield: The effect of P fertilizer and interaction effect of organic and p fertilizers on straw yield were significant only [Table 1]. The comparison of the mean values of straw yield for interaction effect of organic and P fertilizer showed that combined application of 20 ton/ha vermicompost and 100% P fertilizer treatment had the highest (7671 kg/ha) and combined application of 10 ton/ha vermicompost and 0% P fertilizer treatment had the lowest straw yield (5004 kg/ha) and difference between them were significant [Table 2].

Biomass yield: The effect of P fertilizer was significant on biomass yield [Table 1]. The comparison of the mean values of biomass yield for interaction effect of organic and P fertilizer showed that combined application of 10 ton/ha vermicompost and 100% P fertilizer treatment had the highest (12292 kg/ha) and control treatment had the lowest biomass yield (7736 kg/ha) and difference between them were significant [Table 2].

DISCUSSION

These results of study showed that application of organic fertilizers such as manure and vermicompost had the positive effect on yield components of common wheat, but combined application of them with P fertilizer had the synergistic effect of common wheat yield components. The positive effect of organic and bio-fertilizer on yield and yield components of many crops were revealed by many authors [16, 17]. This may result from its ability to increase the availability of phosphorus and other nutrients especially under the

specialty of the calcareous nature of the soil, which cause decreasing on the nutrients availability, results agree with [16].

The results of this study showed that effect of organic and chemical P fertilizer was significant on some wheat yield components such as 1000 grain weight, number of grain per spike and grain yield [Table 1]. Grain yield for treatments was mainly determined by grain number per unit area. Grain yield variability was the result of the potential growing conditions in each treatment generated by differences in different amounts of application of organic and chemical fertilizers during the vegetative and reproductive stages. This was also reported in other studies [17]. In the present study application of organic and chemical P fertilizer increased number of grain per spike that results to increase in high grain yield and productivity. The results correspond to Kato and Yamagishi (2011) finding that spikes density of wheat varieties were higher in organically managed field than conventional field due to higher pre-anthesis dry matter production.

However, organic manure and vermicompost had a significant effect on grain yield and biomass [Table 1]. The grain yield was significantly higher in combined application of 20 ton/ha organic manure and 100% P fertilizer treatment. With increased in application of these organic and chemical fertilizers grain yield increased significantly [Table 2]. Using organic manure and the application of biofertilizers such as vermicompost and nitrogen fixing bacteria has led to a decrease in the use of chemical fertilizers and has provided high quality products free of harmful agrochemicals for human safety [18]. According to the present study, vermicompost with high water-holding capacity and proper supply of macro and micro-nutrients [7], has a positive effect on production of barley and subsequently enhanced grain yield. Improved growth, development and yield of plants have previously been reported in the presence of optimal amounts of vermicompost [19]. These findings are in accordance with the observations of [18, 20].

In the present study, significant differences were observed among organic and P fertilizers regarding the average number of grain per spike, 1000 grain weight, biomass and grain yield. For application of organic fertilizer increased average number of grain per spike and biomass yield in simple mean comparison. This means that we can apply these fertilizer with together for achieved to maximum of some yield components for increase of grain yield as well. Higher grain yield in common wheat achieved in combined application of 20 ton/ha manure and 75% P chemical fertilizer. Application of different organic and biological fertilizers increase the yield of many crops. For example, some biological fertilizer consist the most effective species of nitrogen stabilizing bacteria for increase efficiency of crop production [21]. [14] revealed that application nitrogen and phosphate biofertilizers increased yield and yield components of maize under Boroujerd environmental condition.

In present study biomass increased with application of organic and chemical fertilizers. Many field studies showed a significant contribution of organic and biological fertilizers for the yield and biomass increase of the field crops, which vary in range from 8-30% of control value depending on crop and soil fertility. Biomass yield was increased under application of some biological fertilizers, which positively influenced the plant photosynthesis and dry matter accumulation more actively that agree with [22]. [23] founded that this fertilizers had significant effects on main yield components, seed yield, essential oil in Chamomile. They concluded that this fertilizer can be considered as a replacement for chemical fertilizers in Chamomile medicinal plant production. A significant difference was observed among manure and vermicompost regarding the average yield and yield components, but in many treats both application of these fertilizers had a better effect on above treats. In the present study 1000 grain weight increase may under the effect of combined application of organic and chemical fertilizers which induced the uptake ability of the roots to nutrients and positive increase in the yield parameters because of improving the root system as a source-sink relationship to the reproductive part (shoot). [24] suggested that photosynthetic material exchange activity is stimulated through symbiosis with microorganisms in plants with using of organic biofertilizers that increases the efficiency of photosynthetic phosphorus. They also told that may be photosynthetic capacity of plants treated with phosphorus-solving microorganisms increases due to increased supply of phosphorus nutrition. Combined application of organic and chemical fertilizers increased number of grain per spike, 1000 grain weight, biomass, straw and grain yield in interaction mean comparison. Therefore, this is a synergic effect of these fertilizers on yield components of common wheat too. This means that we can apply nutrient with together for achieved to maximum yield and its components as well. Given the importance of these elements by improving growth conditions and they can increase yield and its components somewhat. Meanwhile, plant type, variety and concentration of macro-nutrients in the root environment and stages of plant growth can be effective on how to use and how these elements impact on seed quality and quantity [15].

According to the present analysis, organic fertilizers such as manure and vermicompost had increased weight of 1000 seeds by enhancing the rate of photosynthesis and the biomass production [25] and increase in yield of barley was more than nitrogen fertilizer [Table 2]. The present result is in agreement

with the report of [26] on *F. vulgare*. 20 ton. ha⁻¹ application of organic fertilizers such as manure and vermicompost was more efficient rather than P fertilizer on grain yield and harvest index [Table 2]. However the results clearly demonstrate the effectiveness of organic fertilizers in increasing the biomass yield rather than chemical fertilizer [Table 2]. Vermicompost increases the growth rate because of the water and mineral uptake, such as; nitrogen and phosphorus [27], which leads to the biomass and grain yield improvement. In final we concluded that application of organic fertilizers increased yield and yield

components of wheat rather than chemical P fertilizer. It is clear from the present study that vermicompost and manure fertilizer successfully manipulate the growth of wheat, resulting in beneficial changes in yield and yield components of wheat.

CONCLUSION

Organic and chemical fertilizers had a positive effect on grain yield of wheat due to synergistic effect of them. Based on the results, combined application of manure and vermicompost with chemical fertilizer has a better effect on yield and yield components of common wheat rather than single application of them. Therefore, we can conclude that combined application of these fertilizers had more efficiency because of some positive interaction between some microorganisms with plant root in soil that result to synergistic effect and laid to increase in yield components and in final grain yield. In final the result of the present study showed that for achieve to highest wheat yield in Lorestan province of Iran we can apply 20 ton/ha manure and 75% P fertilizer with together.

CONFLICT OF INTEREST

There is no conflict of interest

ACKNOWLEDGEMENTS

None

FINANCIAL DISCLOSURE

None

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