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Research Article

Effects of Integrated Nitrogen and Beneficial Microbes Application on Wheat Growth and Yield

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Abstract

An experiment entitled "effect of integrated nitrogen and beneficial microbes application on wheat growth and yield" was conducted at Agronomy Research Farm, The University of Agriculture Peshawar-Pakistan, during Winter, 2016. The experiment was laid out in randomize complete block design with plot size of 3 × 2.4m^2 having 8 rows was used. Treatments were comprised of organic (compost) and inorganic (Urea) nitrogen sources and beneficial micro-organisms (BM) (0 and 40 liters ha^{-1}). Nitrogen was applied from organic (compost) and inorganic (Urea) sources in such combination (sole compost, sole urea and compost and Urea in 50:50 ratios), that each plot receives 120 kg ha^{-1} N. Beneficial micro-organisms (0 and 40 liters ha^{-1}) were applied in two splits; half with first irrigation and half with 3rd irrigation. Results revealed that nitrogen management and beneficial microbes significantly affected growth and yield components of wheat. Taller plants (89.2 cm) with higher leaf area index (4.1), spikelets spike^{-1} (20), grains spike^{-1} (48) and grain yield (3833 kg ha^{-1}) of wheat were recorded with application of compost and urea in 50:50 ratios. Similarly, the BM applied plots produced taller plants (91.1 cm), higher leaf area index (4.0), spikelets spike^{-1} (21), grains spike^{-1} (51) and grain yield (4048 kg ha^{-1}) as compared with no BM plots. It is concluded that integrated application of compost and urea in 50:50 ratio along with beneficial microbes resulted in higher yield and yield components of wheat and hence recommended for higher wheat productivity.

Keywords: Compost; Integrated Nitrogen; Beneficial Microbes; Wheat; Grain Yield

Introduction

Wheat (*Triticum aestivum* L.) is most important cereal crop on the basis of production. It is a rich source of protein, energy, nutrients and low in fiber [1]. Pakistan is the third largest producer of wheat in Asia. In Pakistan wheat was cultivated on about 9.25 million ha area with total production of 25.2 million tons, while in Khyber Pakhtunkhwa its area under cultivation was 0.75 million ha with production of 1.4 million tons during the same year (MNFSR, 2015). Pakistan is facing food and feed shortages due to the alarmingly increasing population rate, while the resources available for wheat production are likely to be significantly lower.

The organic nutrient sources enhance the nutrients use efficiency of the crops by decreasing the loss of nutrients from root zone through leaching and making the existing nutrients readily available to the crop plants [2]. Synthetic fertilizers are common but their prices are too exorbitant for the low resources farmers. Therefore, to balance this situation, integrated nutrient management might be practiced in which natural resources such as organic matter, minerals and microbes are used in combination with inorganic fertilizers. Organic materials consist of animal wastes, farmyard manure (FYM), poultry manure (PM), compost, crop residues and green manure which are best substitute of chemical fertilizers [3]. Application of organic manures has various advantages such as improving soil properties, water holding capacity, organic carbon content; apart from providing soil nutrients [4].

Beneficial microorganisms (BM) or effective microorganisms (EM) technology consist of mixed culture of beneficial and naturally occurring microorganisms that can be applied as inoculants to increase the microbial diversity of soil which enhance crop yield and growth [5]. The application of EM/BM culture improves physical properties of soil with organic amendments. Organic materials like compost and/or poultry manure are used for increasing crop production but pure organic farming cannot meet the demand for nutrient supply, as large quantity of organic amendments are not available. So the integration of EM/BM inoculum and organic/inorganic materials is one of the alternatives of nutrient supply for increasing crop growth and yield on sustainable basis [6].

There is less research studies carried out on integrated compost and inorganic fertilizers with and without beneficial microbes. Therefore the present study was carried out to study the effect of integrated nitrogen and beneficial microbes application on wheat growth and yield.

Materials and Methods

To evaluate the "effect of integrated nitrogen and beneficial microbes application on wheat growth and yield" an experiment was conducted at Agronomy Research Farm, The University of Agriculture Peshawar Pakistan, during Rabi 2016. The experiment was laid out in randomize complete block design (RCBD) having three replications. Plot size of 3m x 2.4m having 8 rows was used. Treatments were comprised of organic (compost) and inorganic (Urea) nitrogen (N) sources and beneficial micro-organisms (0 and 40 liters ha^{-1}). Beneficial micro-organisms were comprised of photosynthetic and lactic acid bacteria, fermenting fungi and actinomycetes. Nitrogen was applied from organic (compost) and inorganic (Urea) sources in such combination (sole compost, sole urea and compost and Urea in 50:50 ratios) that each plot receives 120 kg ha^{-1} N. High yielding wheat variety Pirsabak-2013 was sown at recommended see rate. Organic fertilizers were incorporated one week before sowing while beneficial micro-organisms were applied in two splits; half with first irrigation and half with 3rd irrigation.

Data recording procedure

Plant height data was recorded by measuring five plants randomly from base to the tip of plant using a meter rod. Leaf area index was calculated as the ratio of leaf area into ground area, while, number of spikelets $spike^{-1}$ were recorded by selecting randomly ten spikes in each plot and then their spikelets were counted and averaged. For grains $spike^{-1}$, the number of grains of ten randomly selected spikes was counted and then averaged. For grain yield, four central rows was harvested, sun dried, threshed, cleaned and weighed, and then weight were converted into kg ha^{-1} using the following formula.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{grain yield in four central rows}}{\text{row-row distance} \times \text{row length} \times \text{no.of rows}} \times 1000$$

Statistical analysis

The data was statistically analyze according to Steel*., et al.* [7] for randomized complete block design and means among different treatment was compared using least significant differences (LSD) test ($P \leq 0.05$).

Results and Discussion

Effects of organic-inorganic N sources:

Application of N from organic and inorganic N sources significantly varied plant height, leaf area index (LAI), spikelets $spike^{-1}$, grains $spike^{-1}$ and grain yield of wheat (Table 1). Significantly taller plants (89.2 cm) with higher LAI (4.1) and spikelets $spike^{-1}$ (21) were recorded in plots where compost and urea was applied in 50:50 ratios. Likewise, integrated compost and urea application produced higher grains $spike^{-1}$ (53) and grain yield (3833 kg ha^{-1}) of wheat followed by plots fertilized with sole urea. However, application of sole compost resulted in short stature plants (86.9 cm), lower LAI (3.4), grans $spike^{-1}$ (48) and grain yield (3313 kg ha^{-1}) of wheat. The possible reason for increase in plant growth, yield and yield components due to integrated application of both organic and inorganic sources might be that application of both sources provided more nutrients foxr longer duration, increased soil fertility and nutrients availability and hence resulted in improved crop growth and ultimately crop yield. Our results are in line with Ali., *et al*. [8] who reported that increase in plant height, grains spike-1 and grain yield of wheat with integrated application of organic and chemical fertilizers might be due to improved nutrients uptake and nutrients use efficiency. Confirmatory results are reported by Toor., *et al.* [9], Anatoliy and Thelen [10] and Huang., *et al* [11].

Nitrogen sources	Plant height (cm)	Leaf area index	Spikelets $spike^{-1}$	Grains $spike^{-1}$	Grain yield (kg ha^{-1})
Sole compost	86.9 b	3.4 b	19 b	48 b	3313 b
Sole Urea	88.8 ab	3.3 b	19 b	50 b	3631 ab
50% compost : 50% Urea	89.2 a	4.1 a	21 a	53 a	3833 a
LSD (0.05)	2.1	0.6	1.7	2.5	451
Beneficial Microbes (BM)					
Without BM	85.0 b	3.5 b	18 b	46 b	3416 b
With BM	91.1 a	4.0 a	21 a	51 a	4048 a
LSD/ Significance (0.05)	**	**	**	**	**
Interaction					
N x BM	NS	NS	NS	NS	NS

Table 1: Effects of organic-inorganic N sources and beneficial microbes on plant height (cm), LAI, spikelets $spike^{-1}$, grains $spike^{-1}$ and grain yield of wheat.

Effects of beneficial microbes

Statistical analysis of data indicated significant effects of beneficial microbes on wheat growth, yield and yield components (Table 1). Results indicated significant and linear increase in wheat yield with application of BM. Application of BM at the rate of 40 liters ha^{-1} produced significantly taller plants (91.1) with higher LAI (4) and spikelets $spike^{-1}$ (21). Similarly, grains $spike^{-1}$ (51) and grain yield (4048 kg ha^{-1}) was recorded higher in plots where 40 liters ha^{-1} BM was applied as compared with plots where BM were not applied (Table 1). The probable reason for increase in plant growth and yield with BM application might be the enhanced availability of plant nutrients especially N, which might have improved nutrients uptake and crop growth and thus resulted in higher grain yield of wheat [12]. Muhammad., *et al.* [13] reported that the beneficial microbes have the ability to undergo quick decomposition and increase the availability of nutrients and hence helps plant to uptake more nutrients. Confirmatory results are also reported by Singh., *et al*. [14] who reported higher spikelets spike-1, grains spike-1, biomass and grain yield by integrated application of organic and synthetic fertilizers with BM. Similar results are also reported by Hussain., *et al.* [6], Song., *et al*. [15] and Ahmad., *et al* [16].

Conclusion and Recommendation

From experimental results, it was concluded that application of integrated application of compost and urea in 50:50 ratios along with beneficial microbes resulted in higher growth, yield and yield components of wheat and thus have the ability to improve the yield. Therefore, compost and urea in 50:50 ratios along with beneficial microbes at the rate of 40 liters ha^{-1} should be used for higher wheat productivity.

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