

COMPARATIVE EFFICIENCY OF BIO-POWER AND N CHEMICAL FERTILIZER IN SUPPORT OF GROWTH, YIELD AND N UPTAKE OF WHEAT

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ABSTRACT

A field research was undertaken to evaluate the comparative efficiency of Bio-power (a multi microbe) and nitrogen (N) chemical fertilizer; alone and in combination on the growth, grain yield and N uptake of wheat. The chemical fertilizer was band incorporated after sowing the crop. The experiment was laid out under Randomized Complete Block Design (RCBD) having 4 replications. The seeds were treated with bio-fertilizer before sowing. Significant effect was recorded only on 1000 grain weight but all the treatments performed at par except control. The treatment 100 kg N ha⁻¹ resulted in 30.21 % increase in 1000 grain weight over control. Bio-power alone or along with ½ recommended N @ 50 kg ha⁻¹ or full recommended dose of N fertilizer and N chemical fertilizer did not significantly affect grain yield, biomass and N uptake. Insignificant difference was established between bio-power and N chemical fertilizer to have any effect on the growth, grain yield and N uptake in wheat. However, the maximum increase in grain yield and N uptake was attained with 100 kg N ha⁻¹.

Key words: Bio-power, chemical fertilizer, N uptake, grain yield, growth and wheat

INTRODUCTION

Bio-fertilizers are eco-friendly and have proved to be effective and economical alternate of chemical fertilizers with lesser input of capital and energy (Hafeez *et al.*, 2002). *Azospirillum* has previously been reported to increase grain yield by reducing the effect of drought through mitigating the effect on water potential and chlorophyll content of leaves (Casanovas *et al.*, 2003). The presence of a huge number of bacteria in the rhizosphere is important since they may convert organic and inorganic substances into available plant nutrients (Badahuccho and Kuikman, 2001). Solubilization of insoluble compounds is due to the excretion of microbial metabolites such as organic acids (Puente *et al.*, 2004). Trial with phosphorous solubilizing bacteria (PSB) indicates yield increase (Khokhar *et al.*, 2006). Indeed, the production of microbial metabolites including organic acids may result in a decrease in soil P^H, and can play a major role in solubilization of some nutrients (Rodriguez and Fraga 1999; Nautiyal *et al.*, 2000). Moreover, N is one of the major nutrients limiting plant growth which is rapidly immobilized after addition to soil as a soluble fertilizer, and thus, it becomes less available to plant. Seed or soil inoculation with nitrogen fixing bacteria such as *Azospirillum*, *Azotobacter* can solubilize fixed soil nitrogen and applied nitrogen, resulting in higher crop yields (Yadav and Dadarwal 1997; Puente and Bashan, 2004). However, some of the previous work on seed inoculation also describes that *Rhizobium* inoculation increased nodule formation and N₂ fixation in only one out of the three experiments; conversely, it did not affect the yield of wheat as compared with uninoculated soil (Soon and Lupwayi, 2008) and inoculation with the bacterial culture did not cause a significant change on N uptake by plants (Shabaev and Voronina, 2007). Sala *et al.*, (2008) reported that inoculation did not substitute N fertilizers.

The plan of the study was to evaluate novel N solubilizing and N fertilizer so as to assess the efficiency of Bio-power (a multi-microbe) in comparison to the chemical N fertilizer in enhancing the crop growth, grain yield and N uptake of wheat.

MATERIALS AND METHODS

A multimicrobe (serologically distinct) inoculum having trade name Bio-power was obtained from Biofertilizer Division, National Institute for Biotechnology & Genetic Engineering (NIBGE), Faisalabad, Pakistan and has been tested in the experiment. The inoculum was composed of growth promoting strains of *Azospirillum*, *Pseudomonas*, and *Agrobacterium*.

The research trial was conducted during 2004-2005 at National Agricultural Research Centre (NARC), Islamabad, Pakistan in a randomized complete block design (RCBD) with four replications having six treatments (with uninoculated control) in the presence and absence of nitrogen. Before sowing, seeds were inoculated according to standard procedure of seed treatment. Prior to the application of fertilizers, the composite soil samples were collected from each site at a depth of 0-30 cm and analyzed for physico-chemical characteristics of soil (Table 1).

The piece of land for experiment was thoroughly prepared. Fertilizer was broadcasted into the soil prior to sowing. Data on various morphological and yield traits, i.e., total biomass, 1000-grain weight and grain yield were recorded. At maturity (130 days after planting), plants were manually harvested at random from central rows of each plot, to estimate the plant height, total biomass / plot and grain yield / plot. Grains were taken from each plant, cleaned and weighed. Then, yield was computed on a per-hectare basis. The following treatment comparisons were made: T1 = Control, T2 = Biofertilizer, T3 = Biofertilizer + $\frac{1}{2}$ N (50 kg N ha⁻¹), T4 = Biofertilizer + full N (100 kg N ha⁻¹), T5 = $\frac{1}{2}$ N (50 kg N ha⁻¹), T6 = full N (100 kg N ha⁻¹). Urea fertilizer was used as a source of nitrogen.

The data were subjected to standard analysis of variance using MSTATC, a computer software package (Bricker, 1991).

RESULTS AND DISCUSSION

1000-grain weight

Significant effect of the treatments was recorded on 1000-grain weight but all the treatments performed at par except control (Table 2). Maximum 1000-grain weight was produced (48.70g) by T6 treatment, where full N (100 kg ha⁻¹) chemical fertilizer was applied, and hence, 100 kg N ha⁻¹ resulted in 30.21 % increase in 1000 grain weight over control. While T4 (Biopower + N) was the next best treatment, where Bio-power was applied along with full N fertilizer, which produced 1000-grain weight (46.65g), thus causing 24.73% increase over control. Rest of the treatments also increased 1000-grain weight over control and it ranged from 16.47 to 22.9%. Positive effect of co-inoculation of *Azospirillum* and *Azobacterium* on 1000-grain weight on wheat has been reported by El-Hawary *et al.*, (2002). These results are in consistency to the findings of Zade and Kaleem (2008) who studied that seed inoculation by *Azospirillum brasilense* or *Azotobacter chroococcum* strains with nitrogen levels significantly influenced the yield attributes of wheat.

Total biomass (kg ha⁻¹)

Non-significant difference was found among different treatments. However, the increase in total biomass caused by different treatments ranged from 10.09-26.48 % over control (Table 2). All the treatments were statistically alike. The previous work on seed inoculation also describes that *Rhizobium* inoculation did not affect the yield of wheat as compared with uninoculated soil (Soon and Lupwayi, 2008) and inoculation with the bacterial culture did not cause a significant change on N uptake by plants (Shabaev and Voronina, 2007). These results are alike to those of Sala *et al.* (2008) who concluded that inoculation did not substitute N fertilizers. However, Afzal and Bano, (2008) reported contrarily to the findings of this study that significant increase in yield and yield components resulted from seed inoculation with *Rhizobium* strains. These results are also in divergence to the findings of Zade and Kaleem (2008) who studied that seed inoculation by *Azospirillum brasilense* or *Azotobacter chroococcum* strains with nitrogen levels significantly influenced the growth attributes of wheat, nevertheless, these results were in partial uniformity to the findings of this study that actual straw yield and test weight was slightly higher with 100% recommended dose of N.

Grain yield (kg ha⁻¹)

The results revealed that diazotrophs inoculation associated with the roots increased thousand grain weight and grain yield. Mixed microbial cultures allow their components to interact synergistically, thus, stimulating physical or bio-chemical activities.

Increase in grain yield by different treatments was ranged from 30.72-9.36% over control (Table 2). The effect of treatment T6 (100 kg N ha⁻¹) was found more pronounced (30.72% increase) over control. However, there was non-significant difference of 100 kg N ha⁻¹ to the treatments; T5 (50% recommended chemical N fertilizer), T4 (Biopwer with full N dose) and T3 (Biopower with 50% chemical N fertilizer) and T2 (Biopower). The results indicated that wheat (Chakwal 86) supported microbe-plant interaction. Signal molecules from plants have been reported to play interaction and influence microbe-soil interactions in the soil (Barea *et al.*, 2005). These results are in agreement to the findings of Zade and Kaleem (2008) who found that actual grain yield was slightly higher from 100% recommended dose of N. In sandy loam soils, seed inoculation with *Azospirillum* or *Azotobacter* strains supplemented 25% of recommended dose of nitrogen (25 kg N/ha) in wheat which reduced the use of inorganic fertilizers with a view to attain an eco-friendly environment. These conclusions are in partial consistency with those of Soon and Lupwayi (2008) who determined that *Rhizobium* inoculation increased nodule formation and N₂ fixation in only one out of the three experiments; conversely, it did not affect the yield of wheat as compared with uninoculated soil; Shabaev and Voronina (2007) who concluded inoculation with the bacterial culture did not cause

a significant change on N uptake by plants and Sala *et al.* (2008) who committed that inoculation did not substitute N fertilizers.

Table 1. Soil characteristics of experimental field (pre-sowing).

Texture	pH	O.M. %	Olsen-P (mg kg ⁻¹)	Total nitrogen %
Sandy loam	7.75	0.96	9.68	1.92

O.M.= organic matter, and P = phosphorous

Table 2. Effect of N fertilizer and bio inoculant on growth and yield of wheat.

Treatment	1000 grain weight (g)	Above ground dry biomass (kg)	Grain yield (kg ha ⁻¹)
Control	37.40 b	11100 NS	3999 NS
Bio power	45.06 a	12400	4374
Bio power + 1/2N	44.77 a	12220	4570
Bio power + N	46.65 a	14040	4620
1/2N	45.98 a	13240	4709
Nitrogen	48.70 a	13640	5228
Level of significance (P value)	0.0008	0.2677	0.1413

Means in a column not sharing a letter in common differ significantly at (P≤0.05) and NS = Non-significant

Table 3. Effect of N fertilizer and bio inoculant on Flag leaf and seed Nitrogen of wheat.

Treatment	Flag leaf Nitrogen (%)	Seed Nitrogen (%)
Control	1.15 NS	1.23 NS
Bio power	1.23	1.35
Bio power + 1/2N	1.29	1.42
Bio power + N	1.37	1.47
1/2N	1.35	1.39
Nitrogen	1.43	1.52
Level of significance (P value)	0.1876	0.1227

NS = Non-significant

N concentration in flag leaf and grain

The treatments exhibited non-significant effect on N concentration in flag leaf and grain (Table 3). Bio-power and chemical N fertilizers did not perform differently. Nitrogen concentration in flag leaf and grain ranged from 1.15 to 1.43 % and 1.23 to 1.52 %, respectively. These findings are different from those of S.N. Khokhar *et al.*; 2006 who concluded that available soil-N increased N-uptake by plant roots. These results are in accordance with those of Shabaev and Voronina, (2007) who made out that inoculation with the bacterial culture did not cause a significant change on N uptake by plants. These conclusions are also in consistency to those reported by Sala *et al.*, (2008) that inoculation did not substitute N fertilizer.

CONCLUSION

The best over all performance was revealed by 100 kg N ha⁻¹ which increased grain yield by 30.72% and nitrogen contents in seed by 23.15% as compared to that of control. Bio-power along with 100 Kg N ha⁻¹ increased wheat biomass by 26.48% over control and grain yield by 17.74 %. Although the treatments performed better over control for 1000 grain weight but they were at par with one another. However, insignificant difference was established between Bio-power and N chemical fertilizer to have any different effect on the growth, grain yield and N uptake of wheat. It is, therefore, concluded that the applying of 50 or 100 kg ha⁻¹ chemical N fertilizer or Bio-power alone or with 50 or 100 kg N ha⁻¹ are equally good to attain superior wheat yield under high rainfall conditions. As an alternate source of fertility, Biopower can be used as biofertilizer to acquire higher crop yields in an environment friendly mode.

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