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Productivity Enhancement of Wheat (Triticum Aestivum L) by Integrated Nutrient Management under Salt Affected Soils

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ABSTRACT

Excessive and imbalanced use of expensive chemical fertilizers may pose devastating effect on soil fertility and sustainable productivity. Bio-organic amendments improve soil fertility and sustainable crop productivity. The application of integrated nutrient management (INM) bio-organic amendments couple with chemical fertilizers is one of the promising strategies that not only enhances crop productivity on sustainable basis but also reduces the use of chemical fertilizers. Therefore, a field experiment was conducted to evaluate the productivity enhancement of wheat by combined application of Biofertilizer and chemical fertilizers including Zinc Sulphate and Boric Acid on growth and nutrient concentration of wheat variety (Faisalabad 2008) directly sown in a saline sodic soil (ECe=4.92 dSm^{-1}, pH=8.22 and SAR=16.15 dSm^{-1}) at Soil Salinity Research Institute (SRRI) Farm, Pindi Bhattian during Rabi 2019-20. Treatments were arranged in randomized complete block design (RCBD) with three replications. The crop was harvested at maturity, data on tillering, plant height, number of grains $spike^{-1}$, 1000- grain weight, straw and wheat grain yields were recorded. N, P, K, Zn and B concentration in grain and straw were estimated using atomic absorption spectroscopy. Wheat productivity was significantly ($p \leq 0.05$) increased by INM. Wheat grain yield was the maximum (4.76 tha^{-1}) at the application of 120 kg N, 90 kg P 60 kg K, 5 kg Zn and 1kg B ha^{-1} along with Biozote and it was registered 35% more than Farmer practice. This study confirms that INM has tremendous potential of plant nutrients supply for productivity enhancement of Wheat on sustainable basis

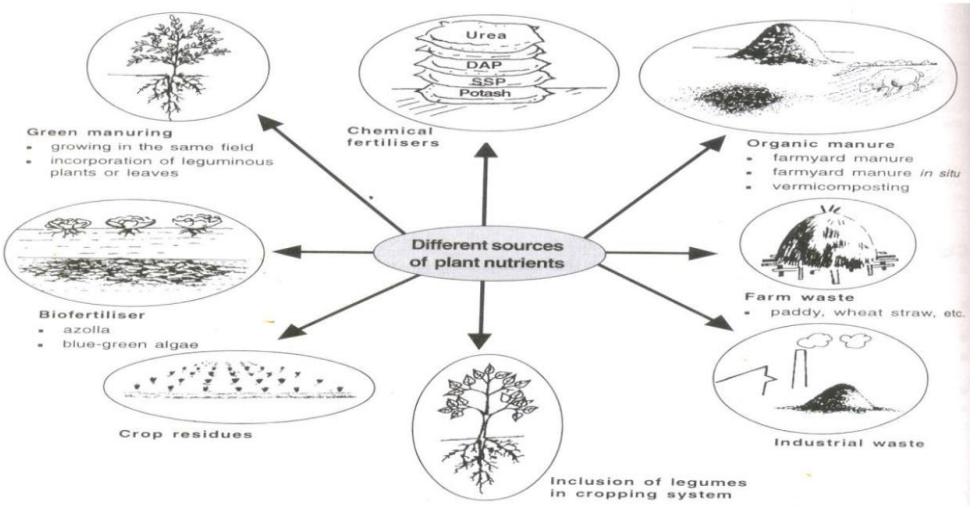
Keywords: *Integrated nutrient management, Biozote, Zinc, Boron and Wheat*

INTRODUCTION

Wheat (*Tritium aestivum L.*) is the most momentous cereal food crop in the world. It is efficiently grown in Pakistan on more than 9 million hectares with a production of 25.51 million tons. The average yield of wheat in Pakistan is 2.893tha^{-1}[1]. The fast-growing population of our country makes it essential to boost wheat productivity consequently. In the wake of increasing population @ 1.8% per annum and restraining wheat productivity PSDP program has been launched under PM instruction to meet the challenges of increasing food demand. Targets have been set to enhance wheat productivity from 28.8 million tons up to 2020 with productivity improvement for 2.893 tha^{-1} (25.51 million tons 2017-18) existing to 3.2 tha^{-1} and have to go to 31.4 million tons in 2025 @ 3.5 tha^{-1} and likewise, in 2030 shall be at 34.3 million tons @ 3.8 tha^{-1}, respectively. Multiple factors play significant role in low wheat productivity like improper and imbalanced fertilization, irrigation, time of sowing, use of low-quality seed etc. The calcareous nature of soils, high pH, high ECe, low organic matter, salt stress, continual drought, high bicarbonate content in irrigation water and imbalanced application fertilizers including micronutrient deficiency, especially Zn, at Pakistani study sites are major factors to low productivity. Too much chemical fertilizers application may affect soil health and sustainable productivity. They have not only left soils degraded, polluted and less productive but have also posed severe health and environmental hazards. Application of bio fertilizers which is environment friendly and low cost input, with organic and inorganic fertilizers as a part of the integrated nutrient management strategy and play significant role in plant nutrition [2]. The role of bio fertilizers is perceived as growth regulators besides biological nitrogen fixation collectively leading

to much higher response on various growth and yield attributing characters [3]. Integrated use of manures and chemical fertilizers is known to have a promising effect in fascinating the decline in productivity through correction of marginal nutrient deficiencies and their positive inf1uence on the physical and biological properties of soil [4]-[5]. Integrated Nutrient Management (INM) promotes the use of balanced and judicious use of chemical fertilizers in conjunction with manures like compost, farm yard manure, vermicomposting, green manures and use of fertilizers fortified with micro-nutrients, use of bio-fertilizers (phosphate solubilizing bacteria, Azospirillum, Azotobacter, Rhizobium, and Potash mobilizing bio-fertilizers) that can supplement a part of NPK fertilizers.

In the coming decades, a major issue in designing sustainable agricultural systems will be the management of soil organic matter and the rational Use of organic inputs such as animal manures, crop residues, green manures, sewage sludge, and food industry wastes. The basic concept underlying the integrated nutrient management remains the maintenance and possible improvement of soil fertility for sustained crop productivity on long-term basis and also reduction of fertilizer inputs. In South Asia, use of organics substances along with fertilizers is less popular in arable farming especially wheat than in summer season crops like rice and maize because during winter when wheat is in the fields, mineralization of organic materials is slow. However, in wheat-based cropping systems, substantial residual effect of organic materials applied to preceding summer season crops can be observed in wheat. Different kinds of organic materials such as FYM, animal manures, green manures, crop residues, composts, and industrial wastes have been used in wheat systems. The amount and availability of nutrients in organic materials vary widely, which makes interpretation of the value of nutrients supplied by these materials a difficult task. The residual effect of organic substances on following wheat crop showed that maximum tillers pot^{-1}'. Grain and straw yields were noted from FYM 20-ton ha^{-1} plus 300-200-100 kg ha^{-1} NPK treatment. The NPK contents grain of wheat was significantly higher and maximum in treatment where organic substances at 20-ton ha^{-1}' plus 300-200-200 kg ha^{-1} NPK in case of wheat were applied. Long term application of chemical fertilizer caused deleterious effect on soil health leading to unsustainable yields [6]. Thus, judicious use of organic manure, bio-fertilizer and inorganic fertilizer helps to sustain the production of wheat. The objective of this protocol is to evaluate the productivity enhancement of wheat by integrated nutrient management at salt affected soil.



MATERIALS AND METHODS

A field experiment was conducted to evaluate the productivity enhancement of wheat (Faisalabad 2008) by integrated nutrient management at salt affected soil (ECe = 5.29 dS m^{-1}, SAR =17.58, pH = 8.47) at Soil Salinity Research Institute, Pindi Bhattian during *Rabi* season 2019-20 (Table-1). Soil samples were analyzed for various physico-chemical properties using ICARDA manual [7]. Treatments were assigned randomized complete block design (RCBD) with three replications. Treatments were control, Farmer Practice (FP), FP + Biozote, Balance Nutrition (BN) and BN+ Biozote. A balanced nutrition of N, P, K, Zn and

B @ 120, 90, 60, 5 and 1kg ha $^{-1}$ was applied respectively. The crop was irrigated with tube well water (ECw =1.8 dSm^{-1}, RSC = 14.2 mmol L^{-1})$^{1/2}$ throughout the growth duration (Table 1). All necessary plant protection measures were done whenever required. Data on tillers, spike length, grains spike^{-1}, and 1000-grain weight, straw and grain yield were recorded at harvesting time. Plant samples were oven dried at 60^{o}C to a constant weight and recorded dry matter yield. Grain samples were ground using Wiley mill. Ground samples were digested in perchloric nitric diacid (2:11N) mixture [8] to estimate N, P K, Zn and B by atomic absorption spectrometry. The data thus collected were subjected to standard procedures of statistics and means were compared using LSD test at P<0.05 [9].

Table1. *Physico-chemical analysis of soil and tube-well water at SSRI Farm, Pindi Bhattian*

Parameters	Soil Value	Water Value
pH (1:1)	8.47	8.1
ECe (1:1) dSm^{-1}	5.29	1.8
SAR	17.58	
Organic matter (%)	0.5	
RSC (mmol L^{-1})$^{1/2}$		14.2
NO_3-N	2.14	
Extractable P (ABDTPA) mg kg $^{-1}$	2.7	
Extractable K (ABDTPA) mg kg $^{-1}$	84.0	
Sand (%)	62	
Silt (%)	18	
Clay (%)	20	
Textural Class	Sandy Loam	

RESULTS AND DISCUSSIONS

Wheat productivity-growth and yield parameters were significantly improved with integrated nutrient management (INM). INM showed significant variation in # of tillers and plant height (Table 2). Integrated nutrient management technology significantly affected number of tillers and yield parameters. The maximum # of tillers (88 m^{-2}) were recorded by BN+Biozote-INM, whereby minimum # of tillers (58 m^{-2}) recorded in control. The interaction of Biozote and integrated plant nutrient was found statistically significant. These results were in consonance to findings of [10], who reported that different organic materials with mineral fertilizers significantly increased the yield parameters. The treatment of BN+ Biozote produced tallest plants of (86.0 cm) height whereby the lowest value of plant height (69.0 cm) was recorded in control treatment. Present results are in consonance with the findings of [11], who observed that plant height of sorghum and wheat enhanced due to different microorganisms' inoculum. Integrated nutrient management significantly increased the number of grains spike^{-1} (NGS). The data (Table 2) expressed that number of grains spike^{-1} had significant values due to Biozote and BN wheat crop. The treatment of BN (Balance Nutrition) + Biozote produced maximum number of grains spike^{-1} (62). The minimum number of grains spike^{-1} (43) was recorded in control. The interaction between Biozote and balance nutrient management was found statistically highly significant. These results corroborate the findings of [12] who investigated that yield attributes tiller numbers, grain number and 1000-grain weight increased with the addition of INM that ultimately improved the productivity of wheat. The data indicated that Biozote along BN significantly affected the 1000-grains weight. The maximum 1000 grain weight (47 g) was registered by Biozote-BN while minimum 1000-grains weight (34 g) was recorded in control treatment. These results were completely in lined with results of [13], who concluded that the cumulative effects of different organic sources i.e., FYM and phosphorus solubilizing bacteria (PSB) with rock phosphate on wheat. Straw yield significantly enhanced (9.24 tha^{-1}) as compared to control which was recorded (4.23 tha^{-1}). [14], reported similar kind of findings, who observed that application of organic matter and effective microorganisms along with NPK resulted in the highest cotton yield, which was economically more viable than fertilizer application alone. These findings were agreed with those of [15] who studied that different yield parameters including total biomass were significantly increased with the use of organic and inorganic

fertilizers. Grain yield showed significant results due to applying Biozote and BN. The maximum grain yield (4.76 tha^{-1}) was recorded with Biozote and BN application as compared to farmer practice (3.66 tha^{-1}). It was 30 % more than FP (Figure 1). These results are in agreement with findings of [16] who observed the crop productivity enhanced by the application of effective microorganism along with chemical fertilizer.

Table-2: *Wheat productivity-growth and yield parameters as affected by INM application*

Treatments	No. Tillers	Plant height (cm)	No grain/spike	1000 grain weight (g)	Straw Yield (t/ha)	Grain yield (t/ha)
Control	58 e	69 e	43 e	34 d	4.23 e	2.59 e
Farmer practice	63 d	75 d	48 d	39 c	6.59 d	3.50 d
FP+ Biozote	75 c	78 c	53 c	43 b	7.15 c	3.78 c
Balanced Nutrients	83 b	81 b	57 b	46 a	8.57 b	4.29 b
BN+ Biozote	88 a	86 a	62 a	47 a	9.24 a	4.76 a
LSD	1.70	2.1	3.42	1.03	0.21	0.16

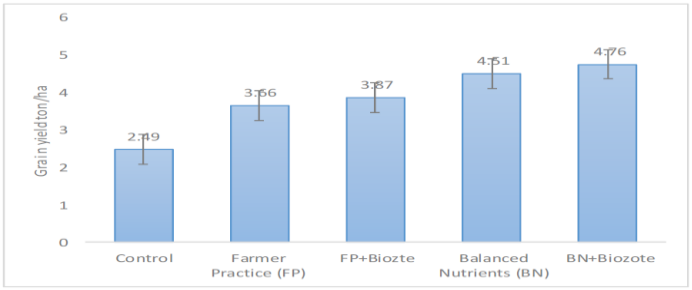


Fig1. *Productivity enhancement of wheat by INM at SSRI Farm, Pindi Bhattian*

It is clearly showed by the data that NPK (%) in wheat grain have significant results due to applying Biozote and BN. The maximum NPK (%) in wheat grain (2.4:0.58: 1.68) were analyzed with Biozote and BN application as compared to farmer practice (2.14:0.4:1.28). The NPK concentration indicated that to what extent the amount of the Biozote and INM fertilizer is efficiently utilized in different plant parts (Figure 2). The results get support from the findings of [17]. Similarly [18], reported that NPK concentration in wheat grain increased with application of NPK fertilizers along with biofertilizers. This might be due to (i) increased supply of all essential nutrients directly through organic and inorganic source to crop, (ii) by increasing in the nutrient use efficiency

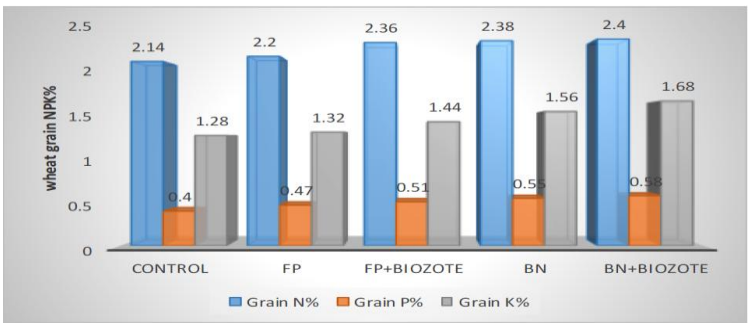


Fig2. *Effect of INM on NPK (%) in wheat grains at SSRI Farm, Pindi Bhattian*

Among the different treatments of fertilizers maximum residual effect on (NPK, Zn and B) was observed where Biozote and INM technology was used as compared to farmer practice (Figures 3 to 7). These are in confirmation with findings of [19]- [20]. Interaction effect of fertilizer NPK and bio-fertilizers was found to be significant. There is significant increase in available N status of the soil with the application of fertilizer NPK in conjunction with Bio-fertilizers as compared to fertilizer NPK alone. Highest availability of N was found at BN + Biozote treatment as compared to rest of the treatments (Figure 3). [21], also investigated similar findings. Similar results with the application of Bio-Fertilizers

were also found by [22]. The data depicted in Figure 5 revealed that available P increased significantly with BN + Biozote dose whereas available K also increased (Figure 6) significantly with same application of BN + Biozote as compared to control and farmer practice. Among organic substances, application of Bio-Fertilizer increased available P and K status of the soil significantly as compared to alone NPK application. The appreciable build up in available P with organics and inorganics may be attributed to the influence of organic manure in increasing available P in soil through complexion of cations, which are responsible for P fixation. [23]-[24] also reported similar results with the application of Bio-Ferilizers. [25], studied that the combination of organic fertilizers with inorganics considered a stock of nutrients which can continuously supply the current crop with their requirements; it can also be considered as a scheme which has greater residual effect on subsequent crops than sole application of inorganic fertilizers.

The amount of micronutrients (Zn and B) was progressively higher with the crop growth period suggesting a buildup of this micronutrient in soil resulting from the adoption of Integrated Nutrient Management systems (Figure 6 and 7). Such buildup of (Zn and B) in soil might be partly owing to release of native soil micronutrients resulting from the dissolution action of Bio-Fertilizers and also partly due to release from applied Bio-Fertilizers. The results of the present study are similar to that of [26]. Integration of inorganic fertilizers with bio-fertilizers will not only help sustain the crop productivity but also will be effective in hastening the nutrient-use efficiency [27]. Use of Bio-fertilizers with INM helps in mitigating multiple nutrient deficiencies in soil [28].

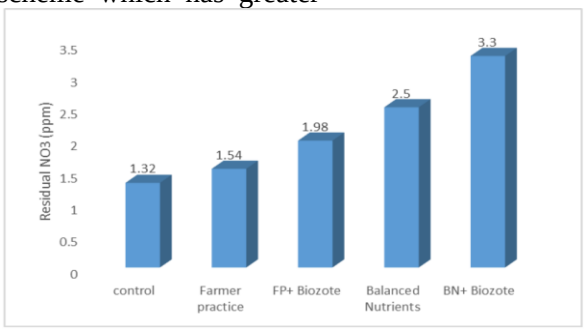


Fig3. *Effect of INM on Residual NO3 (ppm) at SSRI Farm, Pindi Bhattian*

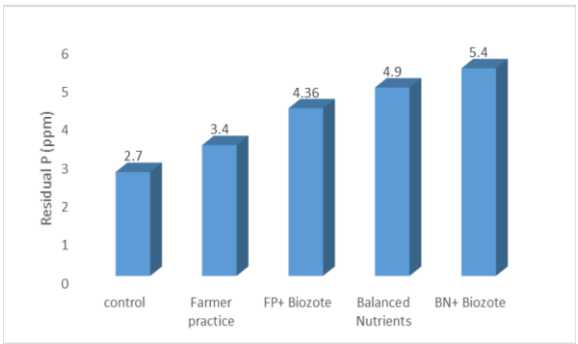


Fig4. *Effect of INM on Residual phosphorus (ppm) at SSRI Farm, Pindi Bhattian*

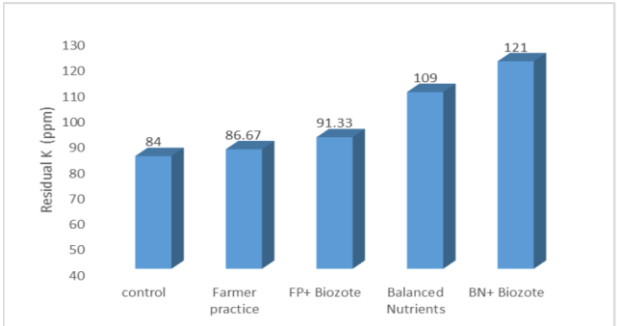


Fig5. *Effect of INM on Residual Potassium (ppm) at SSRI Farm, Pindi Bhattian*

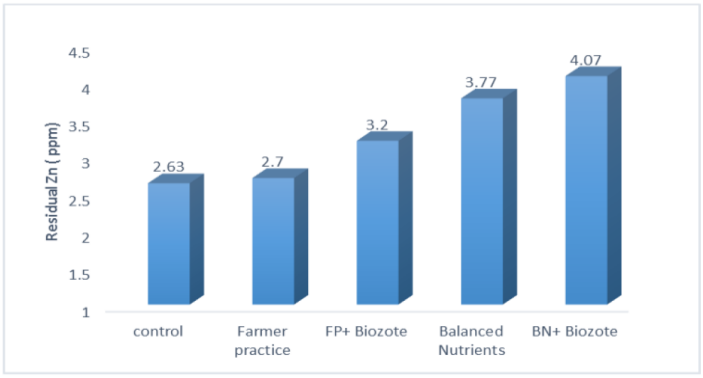


Fig6. *Effect of INM on Residual Zinc (ppm) at SSRI Farm, Pindi Bhattian*

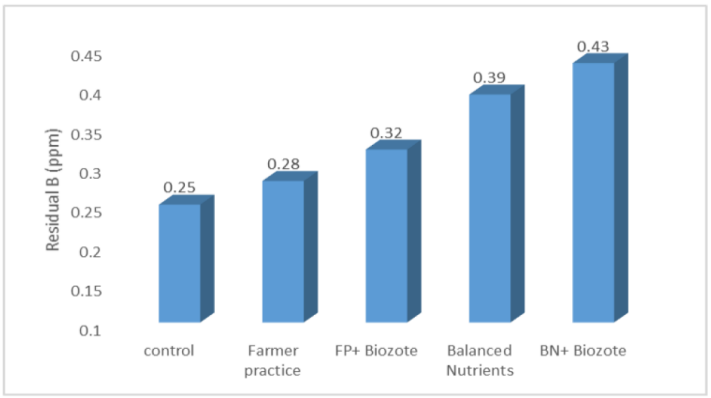


Fig7. *Effect of INM on Residual Boron (ppm) at SSRI Farm, Pindi Bhattian*

CONCLUSION

Wheat productivity was significantly ($p \leq 0.05$) increased by INM. Wheat grain yield was the maximum (4.76-ton ha^{-1}) at the application of 120 kg N ,90 kg P 60 kg K, 5 kg Zn and 1kg B ha^{-1} along with Biozote and it was registered 30% more than Farmer practice. This study confirms INM has tremendous potential of plant nutrients supply for productivity enhancement of Wheat on sustainable basis.

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