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Effect of Integrated Use of N, P and Hal-Tonic on Soil Properties, Micronutrient Content and Yield and Yield Components of Wheat

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ABSTRACT

The effect of different levels of Hal-Tonic - a micronutrient fertilizer product, along with constant rates of N and P on soil properties, yield and yield components of wheat (cv. Anmol) was evaluated in a field experiment, conducted at Soil Fertility Section, Agriculture Research Institute, Tandojam. The study involved four treatments 0-0-0,170-85-0,170-85-10, and 170-85-15 kg N, P and Hal-Tonic ha^{-1}, respectively with four replications, in a randomized complete block design. The soil of experimental area was heavy in texture, free from salinity hazards, alkaline in reaction, calcareous in nature, poor in organic matter and Zn contents, however, it was adequate in Cu, Fe and Mn content. The results revealed that Fe, Mn and Zn content of soil increased by Hal-Tonic application. It was noted that there was very little effect of Hal-Tonic on plant height, and number of tillers. In general, wheat responded to mineral fertilizers. However, the size of ear-head, weight of 100 grain, and grain and straw yields increased significantly by the application of 10 kg Hal-Tonic ha^{-1}. Further increases in yield and yield components of wheat, with increasing rate of Hal-Tonic (15 kg ha^{-1}) was statistically non-significant.

Key Words: Integrated use; Hal-Tonic; Soil properties; Micronutrient content; Wheat yield

INTRODUCTION

According to recent agricultural statistics, the average grain yield of wheat in Pakistan is 2379 kg ha^{-1} (AEDS, 2002) which is much lower than other wheat growing countries of the world. There are several reasons for low production of wheat. Amongst these, the imbalanced fertilization only accounts for approximately 50% reduction in wheat yield (NFDC, 1996). According to an estimate, wheat crop removes 34-50 g Cu, 232-1219 g Fe, 140-330 g Mn and 66-209 g Zn ha^{-1}, to yield 2 t grain ha^{-1} (NFDC, 1998). On the other hand, the plant nutrition programs for various crops, do not take into consideration the micronutrient nutrition. Resultantly, wide-spread micronutrient deficiencies, especially that of Zinc, in most soils of Pakistan are found (NFDC, 1998). In Sindh, 47% cultivated fields are deficient in Zn, 25% in B, 1% in Cu, and negligible in Fe (NFDC, 1998). Hence, the judicious use of micronutrients in deficient soils can translate into improved crop yields. The average increase in wheat yield observed with the application of Zn, B and Fe was 13%, 14% and 9%, respectively (NFDC, 1998). These results necessitates the use of micronutrient fertilizers but they are hardly available and frequently are of dubious quality. Nonetheless, micronutrient nutrition has gained momentum and various products are being used. It is, therefore, necessary to test various fertilizer products, containing micronutrients, for their effectiveness. The fertilizer product tested in the present study was Hal-Tonic.

Hal-Tonic is claimed to be a natural fertilizer, prepared from raw material, beneficial for soil fertility, crop productivity and disease prevention. It contains plant nutrients like P-3%, K-5%, Mg-5.43%, Ca-2.50%, Cl-2%, Fe-0.5%, Zn-0.25%, Mn-O.07%, B-0.05%, S-0.2% and miscellaneous 80%. According to Dr. Muhammad Ashraf of NARC, the effectiveness of HalTonic was tested on the growth and yield of paddy at seven sites (in traditional rice zone) of Punjab, during 1998, where it was found to increase the paddy yield, from 21-31% (personal communication). In Sindh, Hal-Tonic was not tested before, and hence, it was used in wheat (cv. Anmol) to evaluate its effects on soil properties, yield and yield components of wheat at the experimental field of Soil Fertility Section, Agriculture Research Institute, Tandojam.

MATERIALS AND METHODS

The field experiment was conducted at Soil Fertility Section, ARI Tando Jam, during Rabi 2000-2001 on wheat (cv. Anmol), laid out in a randomized complete block design with four treatments, replicated four times. A blanket dose of 170 kg N and 85 kg P_2O_5 ha^{-1} was applied to all the treatments, except control. Hal-Tonic was applied at a rate of 0, 10, and 15 kg ha^{-1}. The plot size was 24 x 19 = 456 m^2. After cotton picking, land was plowed twice with gobal followed by three rounds of cultivar, and then leveled and

irrigated with a soaking dose on November 16, 2000. Nitrogen (as urea) was applied in three splits, each at sowing, and first and 2nd irrigation. All the phosphorus (DAP) was applied at sowing. The required quantity of Hal-tonic was mixed with fine soil and applied homogeneously in two splits, i.e, 1/3rd at first irrigation and the left over at second irrigation. Wheat seed was drilled at the rate of 125 kg ha^{-1}, maintaining a row spacing of 22.5 cm in proper soil moisture condition, after preparing the seed bed with gobal plow. The crop was irrigated four times, according to its requirements. Manual weeding was done to keep the crop free from weeds, throughout the growth period. Five plants per treatment were selected at random, tagged and labelled properly to record plant height at maturity, number of tillers/m^2 at tillering, size of ear heads, weight of 100 grain, and grain and straw yields. Wheat was harvested at maturity. From each treatment, one meter square crop was separated to record grain and straw yields. Soil sampling was done from 0-15 and 15-30 cm depth, before sowing and after harvesting of crop. The samples were analysed for texture (Bouyoucos Hydrometer), EC and pH (1:2 soil water extract), organic matter (Walkley Black), Lime (Acid neutralization), and DTPA extractable Cu, Fe, Mn, and Zn. The data was tabulated and subjected to statistical analysis for ANOVA, by using the statistical package MSTAT-C.

RESULTS AND DISCUSSION

Effect of Hal-Tonic on soil properties before sowing wheat. The data (Table I) indicated that surface soil (0-15 cm) was clay (44.7%) in texture, alkaline in reaction (pH 7.8), non - saline (1.98 dS m^{-1}), calcareous in nature (lime 11.7%) and low in organic matter content (1.03%). The DTPA extractable Cu, Fe, Mn, and Zn contents were 3.68, 5.74, 2.67, and 0.37 mg kg^{-1}, respectively. According to the critical limits, proposed by lindsay and Norvell (1978), Zn was the only deficient micronutrient in surface soil. With the increasing depth (at 15-30 cm), the texture remained intact, the Mn and Zn contents increased, while the values for all other soil properties decreased slightly.

Effect of Hal-Tonic on soil properties after harvesting wheat. The data (Table II) revealed that the concentration of soluble salts decreased after wheat harvest and the EC values ranged from 0.32 to 0.5 dS m^{-1}, in different treatments. This decrease in salt concentration may be due to the leaching of some soluble salts, as a result of irrigation. The Fe, Mn, and Zn content increased by the application of Hal-Tonic. Moreover, the values of all other soil properties decreased, or remained more or less same.

Plant height at maturity. The data (Table III) revealed that the values for plant height at maturity ranged from 64.55 to 93.10 cm (avg. 85.34 cm). Among the treatments, the lowest plant height (64.55 cm) was recorded for control plot. A highly significant increase in plant height was observed with the application of NP fertilizers. The maximum plant height (93.10 cm) was recorded where 10 kg Hal-Tonic along with recommended rate of NP fertilizers was applied. At 15 kg Hal-Tonic along with recommended dose of NP, the plant height, decreased to 92.05 cm. It can be assumed, from the above results, that the Hal-Tonic increased the plant height, when applied with inorganic fertilizers, but the effect was non-significant as compared to NP fertilizers alone. The results are in agreement with those obtained by Bughio (1986), who observed that the plant height of wheat increased with the application of inorganic fertilizers.

Table I. Soil properties before wheat sowing

Determination	Values	
	0-15 cm	15-30 cm
Sand (%)	17.1	12.1
Silt (%)	38.2	30.7
Clay (%)	44.7	57.2
Texture	Clay	Clay
pH	7.8	7.7
EC (dS m^{-1})	1.98	1.74
$CaCO_3$	11.7	10.7
Organic matter(%)	1.03	0.89
Cu (mg kg^{-1})	3.68	3.67
Fe (mg kg^{-1})	5.74	4.27
Mn (mg kg^{-1})	2.67	8.59
Zn (mg kg^{-1})	0.37	0.49

Number of tillers/m^2 at tillering. The results (Table III) showed that the values for number of tillers/m^2 at tillering ranged from 290 to 422.0 (avg. 379.87). Under the treatments, the control plots produced lowest productive tillers (290/m^2). The number of tillers increased with the application of NP fertilizer and Hal-Tonic. The maximum number of tillers (422/m^2) was observed with the application of NP fertilizer, along with 15 kg Hal-Tonic ha^{-1}. The data showed that the result was statistically significant with the application of fertilizers as compared to control plot; however, the application of different doses of Hal-Tonic with NP fertilizers produced statistically non-significant results. The results are in line with those reported by Mahmood and Usman (1982), and Bughio (1986) that the number of tillers increased with the increasing rates of inorganic fertilizers.

Size of ear-head. The data (Table III) showed that Hal-Tonic application caused increment in ear-head length in both the treatments i.e., 10 and 15 kg Hal-tonic along with recommended dose of NP. It was noted that maximum ear-head length (9.90 cm) was recorded when 15 kg Hal-Tonic was applied with recommended dose of NP, whereas, the lowest ear-head length (5.92 cm) was noted at control plot. It was further noted that the application of 10 kg Hal-Tonic, along with recommended dose of NP, produced statistically significant ear-head length. Similar results were reported by

Table II. Soil properties after wheat harvest

Determination	T1		T2		T3		T4	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
					(cm)			
pH	7.70	7.50	7.80	7.70	8.00	7.80	8.10	8.00
EC (dS m^{-1})	0.50	0.40	0.33	0.46	0.32	0.53	0.40	0.38
$CaCO_3$	12.55	13.30	12.70	15.30	11.00	14.70	13.70	16.00
Org. matt. (%)	0.50	0.82	1.08	0.81	0.98	0.77	1.08	0.69
Cu (mg kg^{-1})	2.60	2.85	1.50	2.69	2.10	2.35	2.35	2.95
Fe (mg kg^{-1})	6.35	4.25	4.78	4.14	11.51	8.60	12.43	10.37
Mn (mg kg^{-1})	6.57	5.85	6.46	5.51	14.64	12.77	15.81	13.60
Zn (mg kg^{-1})	0.25	0.29	0.32	0.35	0.42	0.29	0.48	0.57

Table III. Effect of Hal-Tonic on yield and yield components of wheat

Treatments (kg ha^{-1})			Plant	No. of	Size of ear-heads	Weight of 100	Grain yield	Straw yield
N	P	Hal-Tonic	height (cm)	tillers/m^2	(cm)	grain (g)	(kg ha^{-1})	(kg ha^{-1})
00	00	00	64.55**b**	**290.0b**	5.92**c**	3.125**c**	1482.5**c**	1546.25**c**
170	85	00	91.65**a**	397.5**a**	9.20**b**	4.347**b**	3997.5**c**	3316.72**b**
170	85	10	93.10**a**	410.0**a**	9.80**ab**	5.765**a**	4221.5**a**	3508.75**a**
170	85	15	92.05**a**	422.0**a**	9.90**a**	5.795**a**	4254.5**a**	3548.54**a**
Mean			**85.34**	**379.9**	**8.705**	**4.758**	**3489.0**	**2980.07**
LSD 0.05			**11.79**	**82.8**	**0.603**	**0.540**	**57.97**	**57.20**

Figure followed by the same letter denotes non-significant difference at P > 0.05

Islam *et al.* (1999).

Weight of 100 grain. The data (Table III) revealed that the values for 100 grain weight ranged from 3.125 to 5.79 g (avg. 4.758 g). Among the treatments, the control produced the lowest weight (3.125 g). The weight of 100-grain increased with the application of NP fertilizer and Hal-Tonic. The maximum increase (5.795 g) was recorded where 15 kg Hal-Tonic was applied along with recommended dose of NP fertilizer. The statistical analysis showed that the treatments receiving 10 and 15 kg Hal-Tonic were non-significant to each other, however. Hence, Hal-Tonic increased 100 grain weight to influence wheat yield. The increase may be attributed to the Zn content of Hal-tonic, which along with S, and B is reported to increase the significantly the plant height, number of tillers, spike length, and grain and straw yields of wheat (Islam et al. 1999).

Grain yield. Error! Bookmark not defined. The data (Table III) revealed that all the treatments produced higher grain yield over control. The values ranged from 1482.5 to 4254.5 (avg. 3489) kg ha^{-1}. The increasing application of Hal-Tonic (from 10 to 15 kg ha^{-1}), slightly increased the grain yield of wheat, however, the results of 15 kg Hal Tonic ha^{-1} were statistically non-significant at 5% level. This increase in grain yield of wheat may be attributed to the multi-nutrient composition of Hal-Tonic. Saif *et al.* (1997) reported that the maximum wheat yield was obtained with the application of 10 kg Zn and 100 kg P_2O_5 ha^{-1}, along with recommended dose of nitrogen. Earlier, Shukla and Warsi (1994) reported that grain yield of wheat increased with the increasing rates of NPK fertilizers, and maximum grain yield was obtained at the recommended dose of NP along with 5.3 kg Zn ha^{-1}. NFDC (1998) reported that wheat grain yield increased 13% with 5 kg Zn ha^{-1}, when applied with recommended dose of NPK. A further increase of 9% (in rain-fed wheat) and 7-11% (in irrigated wheat) over control was achieved by the application of 10 kg Fe ha^{-1} as $FeSO_4$.

Straw yield. The data (Table III) showed that the Hal-Tonic, applied with NP, gradually increased the straw yield of wheat. The values ranged from 1546.25 to 3548.5 (avg. 2980.07) kg ha^{-1}. The maximum straw yield (3548.54 kg ha^{-1}) was recorded in treatment receiving 15 kg Hal-Tonic along with recommended dose of NP, whereas, the minimum straw yield (1546.25 kg ha^{-1}) was obtained from control. The statistical analysis showed that the straw yield increased significantly with the application of Hal-Tonic and NP fertilizer, over control. However, the increase in yield as a result of the application of different Hal-Tonic doses (10 and 15 kg ha^{-1}) was statistically non-significant. The results are in line with the observations recorded by Islam *et al.* (1999).

CONCLUSIONS AND RECOMMENDATION

The application of Hal-Tonic at the rate of 10 kg ha^{-1} significantly increased the size of ear-head, weight of 100 grains, and straw and grain yields of wheat. Hal-Tonic also increased Fe, Mn, and Zn contents in soil. Keeping in view the benefits of Hal-Tonic, it is recommended that this product may be tried on other crops.

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