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Morpho-Chemical Traits of Wheat as Influenced by Pre-Sowing Seed Steeping in Solution of different Micronutrients

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ABSTRACT

Effect of pre-sowing steeping of seed in solution of different micronutrients on the agro-chemical traits of wheat was determined under field conditions on a sandy-clay loam soil. Wheat seed was soaked in 0.1 M solutions of $CuSO_4$, $ZnSO_4$, $MnSO_4$ and distilled water at the rate of 2 mL solution/water per gram of seed for 12 hours against unsoaked seed (control). The soaked seed was dried under shade for 12 hours before sowing. Seed treated with 0.1 M $MnSO_4$ solution produced significantly the highest grain yield of 4532 kg ha^{-1} on account of significant improvement in the various yield components. Water soaked seed though enhanced seedling emergence, root and shoot dry weight, tillers per unit area, grains $spike^{-1}$ and 1000-grain weight to a considerable extent over unsoaked seed yet gave significantly less yield (4018 kg ha^{-1}) than that soaked in the solution of $ZnSO_4$ (4236 kg ha^{-1}). By contrast, seed steeping had no significant effect on grain protein content and final plant height. There was significant and positive correlation among the three yield components i.e. tillers per unit area, grain $spike^{-1}$ and 1000-grain weight. Coefficient of determination (R^2) showed that 90.05% variation in yield was due to these three factors.

Key Words: Morpho-chemical traits; Seed steeping; Micronutrients; Wheat

INTRODUCTION

In the arid and semi-arid parts of Pakistan high pH of soil coupled with aridity is a primary crop growth limiting factor which is still uncontrolled and needs special attention of the agricultural experts. Among the various agro-management practices used to raise successful crops on saline areas, pre-sowing seed steeping seems to be a promising technique as it stimulates germination and subsequent seedling growth both under normal and saline soil conditions (Idris & Aslam, 1975). An important constraint to enhancing yield of wheat under saline conditions is less availability of certain micronutrients. Treatment for micronutrient deficiency includes application of their compounds to the soil or plant. But these methods are uneconomical and in certain cases disturb the nutrient balance or cause environmental pollution.

Beneficial effects of seed treatment with micronutrients on grain yield and protein content of grain crops have been reported by Musa-Khanov (1964) and Pomogaeva and Butylkin (1977). Moreover, seed soaking with trace elements has been advocated to be more effective than soil treatment or foliar spray (Smalik, 1959; Bamberg & Balode, 1961). However, such studies are rare in Pakistan. Consequently the present study was initiated to determine the effect of pre-sowing seed steeping in solutions of different micronutrients on morpho-chemical traits of wheat under the agro-ecological conditions of Faisalabad in the irrigated environment.

MATERIALS AND METHODS

Response of wheat cultivar "Pak-81" to pre-sowing seed steeping in aqueous solution of different micronutrients was determined under field conditions on a sandy-clay loam soil at the University of Agriculture, Faisalabad. The soil had 7.95 pH, 5.94 ppm available manganese, 2.85 ppm available zinc, 0.049 % total N, 8.94 ppm available P_2O_5 and 165 ppm K_2O. The treatments comprised unsoaked seed, soaked in distilled water and 0.1 M $CuSO_4$, $ZnSO_4$ and $MnSO_4$ solutions. The seed was soaked for 12 hours at the rate of 2 mL solution/water per gram of seed and then dried for 12 hours under the shade before sowing. The crop was sown on November 16 using seed rate of 100 kg ha^{-1} with the help of single row hand drill on a well prepared seedbed. The previous crop of the experimental site was maize. A basal fertilizer dose of 120-60-65 NPK ha^{-1} was applied in the form of urea, single super phosphate (SSP) and potassium sulfate (K_2SO_4), respectively. Half of N and full doses of P and K were applied at sowing, while the remaining half of N was topdressed with first irrigation. In all three irrigations, each of 7.5 cm excluding soaking irrigation "Rauni" were given to mature the crop in addition to 6.12 cm rainfall received during the entire growth period of the crop. The crop was harvested manually on April 25 when it was fully ripe. Data on relevant parameters were recorded by using the standard procedures.

Roots and shoots of ten seedlings were taken from each plot 20 days after planting and wrapped in paper bags separately and then dried in an oven at 70ºC to the constant dry weight. Then seedling dry weight was recorded.

Harvest index (H.I) was calculated by using the following formula.

$$\text{H.I.} = \frac{\text{Grain yield ha}^{-1}}{\text{Total biomass ha}^{-1}} \times 100$$

The data recorded were subjected to Fisher's analysis of variance technique and LSD test at 0.05 P was employed to compare the treatment means (Steel & Torrie, 1984). The correlation coefficient, simple regression and multiple regression were also determined.

RESULTS AND DISCUSSION

Germination count m^{-2}. The data on germination count m^{-2} revealed that all the seed treatments differed significantly from one another (Table I). The maximum seedling count (260.63 m^{-2}) was recorded in water soaked treatment followed by $MnSO_4$ treatment 236.63 m^{-2}) against the minimum of 123.88 seedlings m^{-2} for $CuSO_4$ treatment which was significantly less than unsoaked treatment (214.88 m^{-2}). These results are in consonance with those of Idres and Aslam (1975) and Shaban and Eid (1982).

Root and shoot length. The average root and shoot length recorded 20 days after planting under the various seed treatments differed significantly. Although water soaked seed produced significantly greater root length (12.25 cm) than the unsoaked and $CuSO_4$ treated seed but was *at par* with $ZnSO_4$ treated seed. However, the difference between unsoaked and $ZnSO_4$ treated seed was non-significant. The smallest root length of 11.16 cm was recorded for CuSO4 treatment which was probably attributed to depressing effect of $CuSO_4$ because of its relatively higher dose than the optimum one. Similarly shoot length was affected significantly by the various seed treatments in the same pattern as noted in case of root length. The maximum shoot length of 27.56 cm was recorded for water soaked seed against the minimum of 25.21 cm for $CuSO_4$ treatment which was statistically equal to unsoaked and $ZnSO_4$ treated seed producing shoot length of 25.73 and 26.15 cm, respectively. These results are similar to those of Shaban and Eid (1982).

Root and shoot dry weight per 10 seedlings. Effects of different seed treatments were highly significant. Seed treated with $MnSO_4$ produced significantly the maximum root dry weight (0.5 g) against the lowest of 0.36 g in control. Both water soaked and $ZnSO_4$ treatments were although similar to each other but differed significantly from control. The next best treatment appeared to be $CuSO_4$. By Contrast, similar shoots dry weight was recorded for $MnSO_4$, $CuSO_4$ and water soaked treatments which was significantly more than control and $ZnSO_4$ treatments recording shoots dry weight of 2.88 and 2.84 g, respectively against 3.49, 3.31 and 3.6 g for $MnSO_4$, water soaked and $CuSO_4$ treatments respectively. An increase in shoot and root dry weight by micro-nutrients treated seed has also been reported by Shaban and Eid (1982) and Balwant *et al.* (1984).

Plant height at maturity. The various seed treatments had no significant effect on final plant height which on the average varied from 110.47 to 113.15 cm.

Number of spikes m^{-2}. There were significant differences among the various seed treatments with regard to spikes m^{-2} (Table I). Although $MnSO_4$ treated seed produced more number of spikes m^{-2} than control and $CuSO_4$ treatment but was statistically equal to water soaked and $ZnSo_4$ treatments. The lowest number of

Table I. Agro-chemical traits of wheat as affected by soaked seed in different micronutrient solutions

Seed treatment	Germination count m^{-2}	average root length (cm)	Average shoot length (cm)	Root dry wt of 10 seedlings (g)	Shoot dry wt of 10 seedlings (g)	Plant height at maturity (cm)
Unsoaked (control)	214.88 c	11.54 b	25.73 b	0.36 d	2.88 b	110.47 ns
Water soaked	260.63 a	12.05 a	27.56 a	0.40 c	3.31 a	112.57
Soaked in $CuSO_4$ solution	123.88 d	11.16 c	25.21 b	0.46 b	3.26 a	111.62
Soaked in $ZnSO_4$ solution	229.00 b	11.79 ab	26.15 ab	0.41 c	3.84 b	111.97
Soaked in $MnSO_4$ solution	236.63 b	12.01 a	27.75 a	0.50 a	3.49 a	113.15

Values in a column having the same letter do not differ significantly at 0.05 P (LSD); NS = Non-significant

Table II. Agro-chemical traits of wheat as affected by soaked seed in different micronutrient solutions

Seed treatment	No. of grains $spike^{-1}$	No of spikes m^{-2}	1000-grain weight (g)	Grain yield (kg ha^{-1})	Harvest index (%)	Grain protein content (%)
Unsoaked (control)	58.90 c	602.62 b	40.93 c	3965 c	32.05 b	9.95
Water soaked	60.77 abc	673.86 a	42.68 ab	4018 c	33.07 b	10.22
Soaked in $CuSO_4$ solution	59.37 bc	493.50 c	41.95 bc	3487 d	37.64 a	10.27
Soaked in $ZnSO_4$ solution	61.32 ab	666.07 a	42.12 abc	4236 b	31.53 b	10.63
Soaked in $MnSO_4$ solution	62.52 a	683.75 a	43.76 a	4532 a	34.23 b	10.50

Values in a column having the same letter do not differ significantly at 0.05 P (LSD); NS = Non-significant

Table III. A. Simple regression equation and correlation coefficient

Yield components	Regression equation	Correlation (r)	Coefficient of determination (r^2)
Number of tillers per unit area	$Y = 13.2846 + 0.0218 X_1$	0.9011	81.19 A%
Number of grains per spike	$Y = -92.1740 + 2.1998 X_2$	0.8362	69.92 %
1000-grain weight	$Y = -54.9020 + 2.2554 X_3$	0.6083	37.00 %

B. Multiple regression equation of yield and yield components

$Y = - 42.8875 + (0.0120) X_1 + (2.1078) X_2 + (-1.4024) X_3$
$R = 0.9437$ $R^2 = 9005$

spikes (987 m^{-2}) was recorded in case of $CuSO_4$ against the maximum of 1367.50 m^{-2} for MnSO4 and 1205.25 for control. The lowest number of spikes m^{-2} in case of $CuSO_4$ treated seed was attributed to less germination count due to $CuSO_4$ toxicity.

Number of grains spike^{-1}. Although seed treated with $MnSO_4$ produced significantly more grains spike^{-1} than control and $CuSO_4$ treatment but was at par with rest of the treatments. The lowest number of 58.9 grains spike^{-1} was recorded in plots seeded with unsoaked seed which was equal to that recorded in plots seeded either with water soaked seed (60.77) or $CuSO_4$ treated seed (59.37). These findings are corroborated with those of Drozdov (1952) and Kene (1976).

1000-grain weight. Seed treated with different micro-nutrients had significant effect on 1000-grain weight. $MnSO_4$ treated seed produced significantly heavier grains than control and $CuSO_4$ treatments which were on a par with each other. However, differences among water soaked, $ZnSO_4$ and $MnSO_4$ treatments were non-significant. Kuznetsov and Openlender (1971) also stated that seed treatment with $MnSO_4$ and $ZnSO_4$ helps in grain development of wheat to a considerable extent. Similarly Samui *et al.* (1980) reported that Zn increased 1000-grain weight of mustard while Lumpungu and Muteba (1983) was also of the same opnion.

Grain yield ha^{-1}. Grain yield ha^{-1} was also significantly affected by the various micronutrient treatments. The maximum grain yield of 4532 kg ha^{-1} was obtained from plots sown with $MnSO_4$ treated seed which was significantly higher than all rest of the treatments. The next best treatment appeared to be $ZnSO_4$ (4236 kg ha^{-1}) against the minimum of 3487 for $CuSO_4$. However, the difference between water soaked and unsoaked treatments was non-significant which produced 4018 and 3965 kg ha^{-1}, respectively. Higher grain yield ha^{-1} in case of $MnSO_4$ seed treatment was ascribed to more spikes m^{-2} and higher grain weight while the lowest grain yield in $CuSO_4$ treatment was due to relatively less number of spikes m^{-2} and grains spike^{-1} probably because of $CuSO_4$ toxicity. These results are quite in line with those of Agaev (1968), Dranichnikova (1977), Rao and Shamra (1982), Muthuvel *et al.* (1983) and Ali (1985) while in the opinion of Channal (1978), Ben *et al.* (1983) and Balwant *et al.* (1984), Zn reduced grain size and finally the grain yield ha^{-1}.

Harvest index. Harvest index was affected significantly by various seed treatments. Seed treated with $CuSO_4$ gave significantly the highest harvest index (37.64%) compared to rest of the treatments which were at par with one another. Higher harvest index in case of $CuSO_4$ treatment was attributed to comparatively lower stand density per unit area which ultimately resulted in better grain development.

Grain protein content. The different seed treatments had no significant effect on the protein content of wheat grain which on the average varied from 9.95 to 10.63%. This showed that seed treatment with micronutrients did not play significant role in the improvement of grain protein content. These results are in line with the findings of Bosewell and Worthington (1971).

Simple and multiple regression equation and correlation coefficient. The relationship between the grain yield and its components (Number of tillers per unit area, grains spike^{-1} and 1000-grain weight) was studied by the regression equation (Table III). This regression equation was used to estimate the yield in kg ha^{-1} for some given values, of number of tillers per unit area, number of grains spike^{-1} and 1000-grain weight considering the multiple correlation coefficient (R) of the three components under study. The multiple correlation coefficient (R) was calculated as 0.9337 and was statistically significant. Coefficient of determination (R^2) showed that 90.05% variation in yield was due to these three factors.

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