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RESPONSE OF WHEAT TO FOLIAR APPLICATION OF NUTRIENTS

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ABSTRACT

Foliar application can guarantee the availability of nutrients to crops for obtaining higher yield. To study the response of wheat to foliar application of nutrients, an experiment was conducted at Agricultural Research Farm of NWFP Agricultural University Peshawar during winter 2005-06. The treatments consist of control (water spray), spray at tillering (single spray) and/or spray at jointing (two sprays) and/or spray at boot stage (three sprays). Significant increase was recorded in number of spikes m^{-2}, grains $spike^{-1}$, thousand grain weight, biological yield and grain yield with foliar application of nutrients. Three foliar applications of nutrients resulted in maximum number of spikes m^{-2}, grains $spike^{-1}$, thousand grains weight and biological yield. Maximum grain yield was recorded for two foliar sprays which was statistically similar to that of three foliar sprays.

It was concluded that three foliar sprays of nutrient solution at tillering, jointing and boot stages along with half of the recommended doses of N and P helped in enhancing yield and yield components of wheat.

Keywords: wheat, nutrient, foliar, yield, grain, spray.

INTRODUCTION

The role of macro and micronutrients is crucial in crop nutrition and thus important for achieving higher yields. Nitrogen (N), phosphorus (P) and potassium (K), being primary essential nutrient, have prime importance in crop nutrition. Nitrogen is a primary constituent of proteins and thus all enzymes (Raun and Johnson, 1999). P is involved in almost all biochemical pathways as a component part of energy carrier compounds, ATP and ADP (Khalil and Jan, 2003). Six micronutrients i.e., Mn, Fe, Cu, Zn, B and Mo are known to be required for all higher plants (Welch, 1995). These have been well documented to be involved in photosynthesis, N-fixation, respiration and other biochemical pathways (Marchner, 1986; Romheld, 1987 and Warman, 1992).

Due to increased cropping intensity along with minimal use of fertilizers inputs, a serious depletion of both macro and micronutrients from soils is occurring. Soils of Pakistan are deficient in organic matter and available phosphorus content (Azam, 1988). Macro and micronutrients deficiencies have been reported for different soils and crops (Hussain *et al.*, 2006, Mondal *et al.* 1992; Jahiruddin *et al.* 1995). Increased crop response has been reported for application of different macro and micronutrients (Strong, 1982, Bhatti *et al.*, 1983 and Jahiruddin *et al.*, 1992). Chaudhry and Loneragan (1970) reported integrated application of micronutrients along with macronutrients to avoid micronutrients deficiency.

Both macro and micronutrients availability is influenced by soil chemical and physical properties. The soil nutrient content may not be always enough to fulfill crop requirement. Similarly, most of micronutrients, for example Fe and Mn are readily fixed in soil having alkaline pH. Plant roots are unable to absorb these nutrients adequately from dry topsoil (Graham et al., 1992 and Foth and Ellis, 1996). Similarly some, like Ca, Mg and Mn are not easily translocated to leaves within the plant system (Foth and Ellis, 1996). Thus, the application of macro and micronutrients fertilizer in the cultivation zone may not be meeting the crop requirement for root growth and nutrient use. The alternative approach is to apply these micronutrients as foliar sprays. Finney *et al.* (1957) found that N applied preplant will normally give a response equal to that of N applied up to tillering in wheat. Strong (1982) reported late application of N to increase grain yield and protein content. Alston (1979) reported that foliar application of nitrogen and phosphorus increased grain yield of wheat. Similarly, foliar spray of different micronutrients has been reported to be equally or more effective as soil application by different researchers (Grudon, 1980, Modaihsh, 1997, Torun *et. al.*, 2001 and Grewal *et al.*, 1997). They suggested that foliar spray could be used effectively to overcome the problem of micronutrients deficiency in subsoil. Leiw (1988) have reported increase in crop production due to micronutrients application. He further urged that foliar application of micronutrients may be 6 to 20 times more efficient than soil application, depending on soil type.

The reported experiment was undertaken to study the effect of foliar application of both macro and micro nutrient on yield and yield components of wheat.

MATERIALS AND METHODS

To evaluate the effect of foliar application of macro and micronutrients on yield and yield components of wheat, an experiment was conducted at Agricultural Research Farm of NWFP Agricultural University Peshawar during winter 2005-06. The experimental site has a warm to hot semi-arid sub-tropical continental climate with mean annual rainfall of about 360mm and silty clay loam soils with pH of 8.3. The soil is deficient in N and P but has adequate K. Organic matter is less than 1%.

The experiment was laid out in Randomized Complete Block design with four replications. Wheat cultivar Saleem-2000 was sown on November 25, 2005 at

the seed rate of 100 kg ha^{-1} as broadcast. The plot size was 15m x 5m. Half of the recommended doses of N and P were applied at the rate of 50:30 kg ha^{-1}. The nutrient solution consists of N, P and K at the rate of 100 g L^{-1} and all micro nutrients at the rate of 0.8 g L^{-1}. The nutrient solution was applied at the rate of 25 L ha^{-1}. The treatments consist of control (water spray), spray at tillering (single spray) and/or spray at jointing (two sprays) and/or spray at boot stage (three sprays).

Statistical analysis

The data were statistically analyzed using analysis of variance appropriate for Randomized Complete Block Design and means were compared using LSD test at 0.05 level of probability when the F-values were significant (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Number of spikes m^{-2}

Analysis of the data revealed that foliar application of nutrients resulted in a significant increase in number of spikes m^{-2} (Table-1). Maximum number of spikes m^{-2} were produced by three sprays (297) while minimum number of spikes m^{-2} was produced by single spray (191) which was statistically similar to control (202) and two sprays (220). These results are in agreement with those of Alston (1979) who reported better performance of wheat with foliar application of N and P. Similarly, Soylu *et al*., (2005) and Kenbaev and Sade (2002) reported significant increase in number of spikes m^{-2} with foliar application of different micronutrients individually or in combination.

Table-1. Effect of foliar sprays of nutrients on number of spikes m^{-2}, number of grains $spike^{-1}$, thousand grain weight and biological yield of wheat.

	Spikes m^{-2}	Grains $spike^{-1}$	1000-grain weight	Biological yield
Water spray (control)	202 b	198 ab	20.8 b	1333.3 d
Single Spray	191 b	180 b	23.0 ab	2166.7 c
Two Sprays	220 b	213 ab	25.7 a	4000.0 b
Three Spray	297 a	230 a	26.8 a	4833.3a
Mean	**228**	**205**	**24.0**	**3083.3**
LSD value	**31.15**	**37.63**	**4.292**	**448.8**

Number of grains $spike^{-1}$

Perusal of the data revealed significant effect of foliar application of nutrients on number of grains $spike^{-1}$ (Table-1). Maximum number of grains $spike^{-1}$ was produced by three sprays of nutrients (230) followed by two sprays (213), while minimum number of grains $spike^{-1}$ was produced by single spray (180) which was statistically at par with control (198). It may be due the provision of nutrients to the crop at later growth stages which may have resulted in more number of grains $spike^{-1}$. Previously, Gooding and Devies (1992) had reported better performance of wheat crop for foliar application of N. Similarly, Guenis et al., (2003) and Soleimani (2006) reported marked increase in number of grains $spike^{-1}$ of wheat for foliar application of boron and zinc, respectively.

Thousand grains weight

Analysis of the data revealed that foliar application of nutrients solution resulted in a significant increase in thousand grains weight (Table-1). Three sprays resulted in heavier grains (26.8g) followed by two sprays (25.7g) while control (water spray) treatment produced grains with least weight (20.8g). This may be due to the provision of micro and micro nutrients at latter stages which might have enhanced accumulation of assimilate in the grains and thus resulting in heavier grains of wheat. The results are in line with Soylu *et al*., (2005) and Guenis *et al*., (2003) who reported significant increase in thousand grains weight with foliar application of micronutrients.

Biological yield

The data on biological yield revealed significant increase with foliar application of nutrients (Table-1). Maximum biological yield was produced by three sprays (4833 kg ha^{-1}) followed by two sprays (4000 kg ha^{-1}), while minimum biological yield was recorded by control (water spray) treatment (1333 kg ha^{-1}). The results are confirmed by Alston (1979) who reported increased straw yield with foliar application of N. Similarly, Sadana *et al.* (2002) reported increased dry matter yield with Mn application. Similarly, Soleimani (2006) reported increase in biological yield for foliar application of zinc. The results also agreed with Torun *et al.*, (2001) and Grewal *et al*., (1997) who reported increased dry matter production for application of micronutrients over control.

Grain yield

The data on grain yield revealed significant increase in grain yield with foliar application of nutrients (Fig-1). Maximum grain yield was produced by two sprays (2751.7 kg ha^{-1}) and three sprays (2641 kg ha^{-1}) while

minimum grain yield was produced by control (1695 kg ha^{-1}). Both two and three sprays were found beneficial as compared to control (water spray) and single spray. This increase may be mainly due to the additional availability of macro and micro nutrients till later growth stages of wheat. Alston (19979), Strong (1982) and Gooding and Devies (1992) also reported increased grain yield for foliar application of N and P, individually or in combination. These results agree with Torun *et al*., (2001) and Grewal *et al*., (1997) who reported increased wheat production with application of zinc and boron over control.

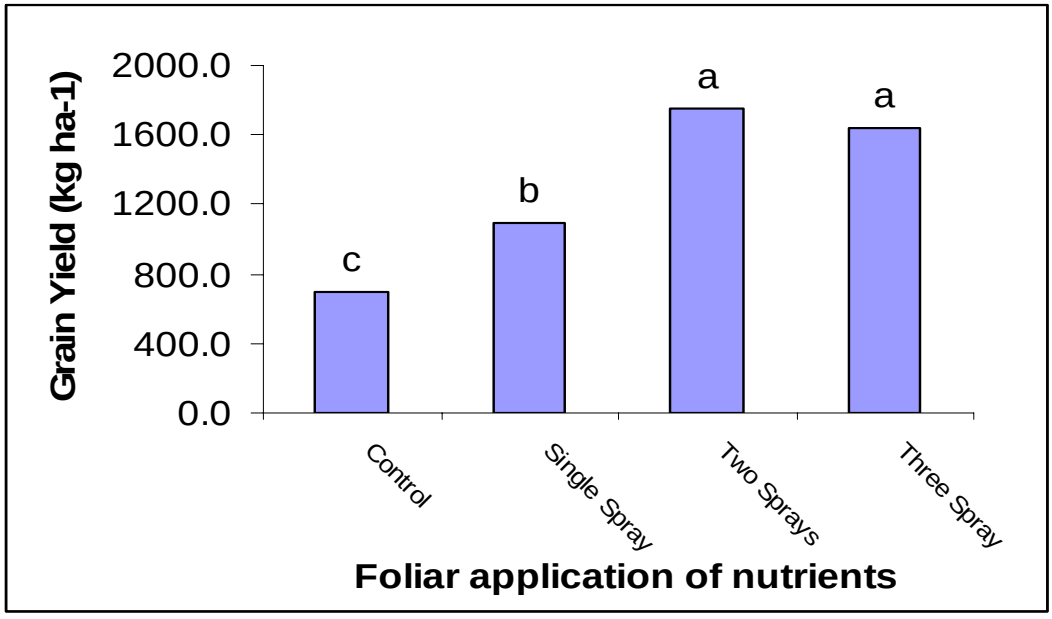

Figure-1. Effect of foliar sprays of nutrients on grain yield of wheat.

REFERENCES

Abedin M.J., Jihiruddin M, Hoque M.S., Islam M.R. and Ahmed M.U. 1994. Application of boron for improving grain yield of wheat. Progress. Agric. 5 (1): 75-79.

Ahmed, S. 1982. Crop response to applied molybdenum in Brahamputra floodplain soil of Bangladesh. Bangladesh J. Soil Sci. Vol. 18: 36-41.

Alston, A.M. 1979. Effects of soil water content and foliar fertilization with nitrogen and phosphorus in late season on the yield and composition of wheat. Aus. J. Exper. Agric. Animal Husbandry. Vol. 30(4): 577-585.

Bonilla I, Mergold-Villaseñor C, Campos M.E., Sanchez N, Perez H, Lopez L, Castrejon L, Sanchez F, Cassab G.I. 1997. The aberrant cell walls of boron-deficient bean root nodules have no covalently bound hydroxyproline-/proline-rich proteins. Plant Physiol. Vol. 115: 1329-40.

Brennnan R.F. and McGrath J.F. 1988. The vertical movement of zinc on sandy soils in southern Western Australia. Aust. J. Agric. Res. Vol. 26: 211-216.

Cakmak I and Marschner H. 1988. Increase in membrane permeability and exudation in roots of zinc deficient plants. J. Plant Physiol. Vol. 132: 356-361.

Finney, K.F., J.W. Meyer, F.W. Smith, and H.C. Fryer. 1957. Effect of foliar spraying on Pawnee wheat with urea solutions on yield, protein content, and protein quality. Agron. J. Vol. 49: 341–347.

Foth, H. D. and B.G. Ellis. 1996. Soil fertility. 2nd Ed. Lewis Pub. New York.

Goldbach H.E., Blaser-Grill J., Lindemann N., Porzelt M., Hörrmann C., Lupp B., Gessner B. 1991. Influence of boron on net proton release and its relation to other metabolic processes. Curr. Top. Plant Biochem. Physiol. 42: 925-929.

Gooding, M.J. and W.P. Devies. 1992. Foliar urea fertilization of cereals. Nutrient Cycling in Agroecosystems. Vol. 32: 209-222.

Graham R.D. and Ascher, J. S. 1993. Nutritional limitations of subsoils. In. Plant nutrition- from genetic engineering to field practice. Ed. N T Barrow. pp 739-742, Kluwer Academic Publishers, Dordrecht.

Graham R. D., Ascher J. S. and Hynes S. C. 1992. Selecting zinc-efficient genotypes for soils of low zinc status. Plant and Soil. 146: 241-250.

Graham R. D., Welch R. M., Grunes D. L., Cary E. E. and Norvell W. A. 1987. Effect of zinc deficiency on the

accumulation of boron and other mineral nutrients in barley. Soil Sci. Soc. Am. J. 51: 652-657.

Grewal, H.S., L. Zhonggu and R.D. Graham. 1997. Influence of subsoil zinc on dry matter production, seed yield and distribution of zinc in oilseed rape genotypes differing in zinc efficiency. Plant and Soil. 192(2): 181 – 189

Guenis, A., M. Alpaslan, A. Unal. 2003 .Effects of Boron Fertilization on the Yield and Some Yield Components of Bread and Durum Wheat. Turk J Agric. 27: 329-335.

Hussain, M.Z., N. Rehman, M.A. Khan, Roohullah and S.R. Ahmed. 2006. Micronutrients status of Bannu basen soils. Sarhad J. Agric. Vol. 22(2): 283-285.

Hussain T., G. Jilani, J.F. Parr and R. Ahmad. 1995. Transition from conventional to alternative agriculture in Pakistan: the role of green manures in substituting for inorganic N fertilizers in a rice-wheat farming system. American J. Alternative-Agric. Vol. 10(3): 133-137.

Kenbaev, B. and B. Sade. 2002. Response of field-grown barley cultivars grown on zinc-deficient soil to zinc application. Comm. Soil Sci. Plant Anal. Vol. 33(3-4): 533-5544.

Paull J.G., Rathjen A.J. and Cartwright B. 1991. Major gene control of tolerance of wheat (*Triticum aestivum* L.) to high concentrations of soil boron. Euphytica. 55: 217-228.

Pushnik J.C., Miller G.W., Manwaring J.H. 1984. The role of iron in higher plant chlorophyll biosynthesis, maintenance and chloroplast biogenesis. J. Plant Nutr. Vol. 7: 733-758.

Raun, W.R., and G.V. Johnson. 1999. Improving nitrogen use efficiency for cereal production. Agron. J. 91: 357-363.

Rerkasem B. and S. Jamjod. 1997. Genotypic variation in plant response to low boron and implications for plant breeding. Plant and Soil. Vol. 193: 169-180.

Sadana, U.S., K. Lata and N. Claassen. 2002. Manganese efficiency of wheat cultivars as related to root growth and internal manganese requirement. Journal of Plant Nutrition 25 (12): 2677 – 2688.

Singh J P, D.J. Dahiya and R.P. Narwal. 1990. Boron uptake and toxicity in wheat in relation to zinc supply. Fert. Res. Vol. 24: 105-110.

Soleimani, R. 2006.The effects of integrated application of micronutrient on wheat in low organic carbon conditions of alkaline soils of western Iran. 18th world congress of soil sci.

Spiller S.C., Castelfranco A.M., Castelfranco P.A. 1982. Effects of iron and oxygen on chlorophyll biosynthesis: I. *In vivo* observations on iron and oxygen-deficient plants. Plant Physiol. 69: 107-111.

Torun, A., I. G.Ã. ltekin, M. Kalayci , A. Yilmaz, S. Eker, I. Cakmak. 2001. Effects of zinc fertilization on grain yield and shoot concentrations of zinc, boron, and phosphorus of 25 wheat cultivars grown on a zinc-deficient and boron-toxic soil. J Plant Nut. Vol. 24(11): 1817 – 1829.

Deb, D.L. 1986. Zinc and Sulphur deficiency (in rice production) in Bangladesh. FAO-UNDP Tech. Report, AG.TCP/3GD/2203: p. 164.

Hosseini, S. M. 2006. Zinc- Boron Interaction Effects on Yield, Yield Components and Chemical Composition of Wheat. The 18th world congress of soil science.

Jahiruddin M., Ali MS, Hossain MA, Ahmed MU and Hoque M.M. 1995. Effect of Boron on grain set, yield and some others of wheat cultivers. Bangladesh J. Agril. Sci. 22: 179-184.

Liew, C.S. 1988. Foliar fertilizers from Uniroyal and their potential in Pakistan. Proceedings of seminar on micronutrient in soils and crops in Pak. 277. (Abstract).

Modaihsh, A. S. 1997. Foliar application of chelated and non-chelated metals for supplying micronutrients to wheat grown on calcareous soil. Experimental Agriculture. 33: 237-245.

Rerkasem B, Nestsangtip R, Lordkaaew S and Chang C. 1993. Grain Set failure in boron deficient Plant. In proc.: Plant nutrition from Genetic Engineering to Field Practice, N. J. Barrow Ed. 401-404.

Rerkasem B, Saunders D.A. and Dell B. 1989. Grain set failure and boron deficiency in wheat. Thailand. J. Agric. (Chiangmai Univ.). Vol. 5: 1-10.

Sharma R.C., V.K. Dua. 1995. Fertilizer management in potato based cropping systems in India. Fertilizer News. 40(5): 79-93.

Soylu, S. B. Sade, A. Topal, N. Akgun and S. Gezgin. 2005. Responses of Irrigated Durum and Bread Wheat Cultivars to Boron Application in Low Boron Calcareous Soil. Turk. J. Agric. 29: 275-286.

Strong, W.M. 1982. Effect of late application of nitrogen on the yield and protein content of wheat. Aus. J. Exper. Agric. Animal Husbandry. Vol. 22(115): 54 – 61.

Suhog, S.M., M. Makhdoom and A.M. Rustmani. 1988. Wheat yield as affected by micronutrients. Proceedings of

seminar on micronutrient in soils and crops in Pakistan. pp. 226-232.

Welch R.M., Allaway W.H., House W.A., Kubota J. 1991. Geographic distribution of trace element problems. In: Mortvedt J.J., ed. Micronutrients in agriculture, 2nd Ed. Madison, Wisconsin: SSSA Book Ser. 4. SSSA. pp. 31-57.

Zorita, M.D., M.V.F. Canigia and G.A. Grosso. 2001. Applications of Foliar Fertilizers Containing Glycinebetaine Improve Wheat Yields. J. Agron. Crop Sci. 186: 209.