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RESEARCH PAPER

Contribution of liquid fertilizers to improve productivity of late sown wheat in western plain zone of Uttar Pradesh

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Abstract : The field experiments were conducted in Muzaffarnagar districtof Uttar Pradesh in winter of 2011-12 and 2012-13 to estimate the effect of liquid applied nutrients on the yield of late sown wheat at ten farmer's fields. The wheat variety PBW-373 was grown in both the year experiments. Soil of the experimental site was physico-chemically analyzed before sowing of experiments. Nutrient solution were prepared for liquid application as one per cent sulphur solution prepared from 80 per cent W.P. sulphur, 1 per cent iron solution prepared from 19 per cent ferrous sulphate, 0.5 per cent zinc solution prepared from 21 per cent zinc sulphate and 0.5 per cent manganese solution prepared from 30.5 per cent manganese sulphate commercially available from the market. These solutions were sprayed on standing crop at tillering and boot stage (30 and 60 days after sowing). All the liquid applications were in addition of farmer used fertilizer. Farmers in Muzaffarnagar district generally using NPK 145:80:40, as 5 bag NPK (12:32:16) and 5 bag of urea (46 % N) in one hectare of wheat production.The maximum grain yield (41.4 q/ ha) was recorded from zinc application and lowest (39.0 q/ ha) from control treatment. Grain yield 40.08 q/ ha had been obtained from sulphur application and 39.6q/ ha from iron 40.3q/ ha application and 39.6q/ ha from manganese treatment in *Rabi* 2011-12. It was also noted that zinc application was significantly increased yield over control.The maximum yield (39.6 q/ ha) was observed from zinc application followed by sulphur application (39.2 q/ ha) which was significant over control treatment in *Rabi* 2012-13. Lowest yield (38.0 q/ ha) was found from control treatment, 38.5 q/ ha from iron application and 37.8 from manganese treatment. Straw yield 50.1 q/ ha recorded from zinc application, followed by sulphur (49.6 q/ ha), iron (48.6 q/ ha) and 48.1 q/ ha from manganese treatment. It was observed that number of tillers, grain and straw yield were significantly increased over control fromliquid application zinc both the year of experiments.

Key Words : Liquid fertilizer, Sulphur, Iron, Zinc, Manganese, Wheat

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INTRODUCTION

Micronutrient deficiency is widespread in many Asian countries due to the calcareous nature of soils, high pH, low organic matter, salt stress, continuous drought, high bicarbonate content inirrigation water and imbalanced application of NPK fertilizers. Some of the adverse effects of micronutrient deficiency-induced stress in plants include low crop yield and quality, imperfect plant morphological structure (such as fewer xylem vessels of small size), widespread infestation of various diseases and pests, low activation of phytosiderophores and lower fertilizer use efficiency. Qualitative and quantitative plant products can only be achieved if they are combined with proper plant nutrition. Besides the three macro elements (N,P,K) essential microelements are inevitable. Because of their function in the enzyme activity we have to give priority to the essential microelements copper and zinc in the nutrient supply of soil and plants. Their lack greatly influences both the quantity and the quality of plant products. Durum wheat has an

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especially sensitive response to these microelements. Agricultural soils usually show iron, copper and zinc deficiency. The average zinc content of the earth's crust is about 70 mg/kg and its copper content about 55 mg/kg. Only a very small part of them (about 1%) is in a form that is absorbable by plants the acceptance of wheat as basic food stuff led to its wide spread dissemination as aid to its developing countries (Narimani *et al.*, 2010). Mohemed (2011) studied two concentrations (0.10 and 0.15%) of suspension micronutrient compound containing Fe, Mn, Zn in ratios 1:1:1 in concentration 2.8:2.8:2.8 per cent were sprayed. Levels of NaCl (0-1000-2000-5000 ppm) were applied to irrigation water. Results revealed that growth and nutrients uptake were reduced with increasing NaCl concentration ,Na was increased, while K, Ca, P, N as well as K/Na, Mg/Na ratios, Fe, Mn, Zn and Cu also were decreased as salinity levels increased. Foliar spraying with suspension micronutrient induced stimulatory effects on growth parameters and nutrients uptake either before or after the salinization treatments. The results of this study suggest that foliar spray with micronutrient may have a potential role for increasing wheat tolerance to salinity stress. Arif *et al.* (2006) reported, 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. 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

The current problem of wheat contributing in low yield due to time and method of fertilizer application, liquid application of macro and micro nutrients for getting maximum yield and reduce losses. Nutritional deficiency in crops mainly, unbalanced fertilizer application. Micronutrient deficiency considered as one of the major cause of reducing productivity in wheat growing areas. Availability of micronutrients mainly depends on pH, soil organic matter, soil texture, structure and also solubility of micronutrients. Soil fertility determine by presence or absence of nutrients which requires in small quantity for plant growth. Each nutrient has its own function in plant growth. example, Potarzycki and Grzebisz (2009) reported that Zinc influence basic plant life as nitrogen metabolism- uptake nitrogen and protein quality, chlorophyll synthesis carbon anhydrase, deficient plant reduce the rate of protein synthesis duo to which zinc is preferable for intensive farming system. Mn is required for biological system, enzyme activation, oxygen carrier in nitrogen fixation, disease resistance.

Iron deficiency chlorosis caused by imbalance of metallic ions as Cu and Mn. Micronutrient depleted by from soil duo to growing of high yielding varieties continuously and non-addition of organic matter. Pathak *et al.* (1979) found positive interaction between Cu and Mn when applied balanced manner. Adequate sulphur is required for carbohydrate formation, thus, it has role in photosynthesis by influencing the formation of chlorophyll. In sulphur deficiency, leaf yellowing occurs. In wheat, sulphur deficiency reduces the leaf number, plant height, tiller number, dry weight and panicle length. Fe application might cause nutritional disorder due to the antagonistic effect of Fe with other cationic micronutrients, in particular with manganese. It is evident from the above that use of both macro and micro nutrients including Fe is an important factor for crop cultivation and these essential nutrients should be used in proper doses for increasing soil fertility and to boost up crop production. Liquid applications are widely used to apply micronutrients especially iron and manganese for many crops. The present study were undertaken on wheat to determine the contribution of secondary nutrient sulphur and micronutrient Zn, Fe and Mn alone liquid applied under Western Plain Zone condition. Khan and Naved (2013)trial was laid out in a Randomized Complete Block Design with split-plot arrangements. Main plot possessed five micronutrients *viz.*, Zn, Cu, Fe, Mn and B while application methods (side dressing, foliar application and soil application) were assigned to sub-plots. The results revealed that boron application @ 2 kg ha^{-1} recorded higher crop growth rate (30.14 g m^{-2} day^{-1}), net assimilation rate (2.78 mg m^{-2} day^{-1}), number of tillers (307.00 m^{-2}), number of grains spike-1 (61.08) and grain yield (5.63 t ha^{-1}). The use of copper @ 8 kg ha^{-1} also showed encouraging results similar to boron. Among various application methods, soil application (at sowing) showed the best results as compared to side dressing and foliar application both at 4 weeks after sowing (WAS). This combination also resulted in the best net returns with higher benefit cost ratio.

MATERIAL AND METHODS

The field experiments were carried out in sandy loan of district Muzaffarnagar at tenfarmer's fields during two winter season on 2011-12 and 2012-13 to investigate to effect of liquid application of nutrients on yield and attributing character of wheat. Soil sample for the experimental site was taken to determine some physic- chemical properties. Sandy loam soils are mainly deficient in nutrients and showing character on crop plants. To evaluate the contribution of different nutrients

individually we had taken sulphur, zinc, iron and magnesium were liquid applied on the standing crop at tillering and boot stage. The 80 per cent WP Sulphur were taken and used 1.0 per cent solution, Zn from zinc sulphate ($ZnSO_4$) 21 per cent and used 0.5 per cent solution, Fe were taken from ferrous sulphate ($FeSO_4$) 19 per cent and used 1.0 per cent solution, Mn from 30.5 per cent manganese sulphate ($MnSO_4$) and used 0.5 per cent solution were taken for liquid application. These all nutrients were applied in addition to farmers practices (NPK 145:80:40), as farmer generally using 5 bag NPK (12:32:16) and 5 bag of urea in one hectare for wheat production. Treatments were arranged in a Completely Randomized Block Design with four replications. The yield attributing character were recorded 15 days before harvesting as plant height cm, fertile tillers/ m², spike length cm, spikelet/ ear, seed/ ear, straw and grain yield were recorded after harvest the crop. The combined statistical analysis was done for the one year data of farmers' fields. The least significance difference (LSD) was used to compare between means.

Table 1: Physico-chemical analysis of soil

Parameter	Units	Pre-sowing average values of composite soil sample
pH	--	7.9 alkaline
EC	dS m?¹	0.22
Organic matter	%	0.45 low
Available P	mg/100g	0.18 low
Available K	mg/ 100g	0.62 medium
Available sulphur	ppm	10.3 medium
Available Zn	ppm	0.1 low
Available Fe	ppm	1.92 low
Available Mn	ppm	2.84 medium

RESULTS AND DISCUSSION

The soil of experimental sites was loam and sowing was done between 10-15 December with commonly grown variety PBW-373. The averaged soil condition was with alkaline pH, low organic matter content and available phosphorus and medium in available potassium content. The micro nutrient was medium in sulphur, manganese and low in zinc and iron content (Table 1). The data on yield attributes were recorded before harvesting. Plant height was lowest (86.4 cm) from farmers practice and maximum (93.5 cm) from application of zinc which was not significant to control treatment. Lowest fertile tillers per sq. / m² (418) were recorded from control plots and maximum (490) from zinc application which was significant compare to control treatment and followed by sulphur, iron and manganese treatment. The maximum spikelength (10.6 cm) was recorded from zinc applied treatment followed by sulphur (10.0 cm), iron (9.6 cm) and manganese (9.1 cm) treatment lowest (9.0 cm) from farmers practice considered as control treatment. Number of spikelet per ear was maximum (20.3) from zinc treatment and lowest (18.1) from control treatment. This was indicated from the data that application of manganese is very close to control treatment. Number of grains per ear was highest (56) from zinc treatment followed by sulphur (55), iron (51) and manganese (48) applied as liquid on wheat during first year of experiment at farmers' fields. The maximum yield (41.4 q/ha) was recorded from zinc application and lowest (39.0 q/ha) from control treatment as farmers practice.Grain yield 40.8 q/ ha obtained from sulphur application and 40.3 q/ ha from iron application and 39.6 q/ ha from manganese treatment. It was also noted that zinc and sulphur application was significantly increased yield over control. Hussainet all (2005) revealed from field experiment the effect of nutrient mixture plant care sprayed on foliage at different physiological growth stages of wheat. The composition of the nutrient mixture plant care was N 200 g, P_2O_5 200 g, K_2O 200 g, Zn 750 mg, Iron were found maximum contribution. Zeidan *et al.* (2010) also reported that wheat yield was increased significantly by liquid application of Fe, Mn and Zn. Hasina *et al.* (2011) observed the effect of liquid spray of 0.5 per cent zinc increased grain and straw yield. The straw yield was maximum recorded (52.2 q /ha) from zinc applied treatment, followed by sulphur (51.3 q/ ha) which was significant increased over control (Table 2). Abbas *et al.* (2009) said that iron application enhances yield parameters but not significantly.Narimani *et al.* (2010) observed all fertilizer treatments imposed positive effects on economic yield, but Fe+ Cu had highest positive

Table 2 : Average values of yield attributing characters and yield of wheat during 2011-12

Treatments	Plant height cm	Fertile tillers/m²	Spike length cm	Spikelet/ ear	Seed /ear	Grain yield q/ ha	Straw yield q/ ha
FP+ $FeSO_4$ 1.0 %	90.2	450	9.6	19.0	51	40.3	50.5
FP+ $MnSO_4$ 0.5 %	88.3	460	9.1	18.2	48	39.6	50.2
FP+ Zn SO_4 0.5 %	93.5	490	10.6	20.3	56	41.4	52.2
FP+ sulphur 1.0 %	92.7	475	10.0	19.5	55	40.8	51.3
Farmer practice	86.4	418	9.0	18.1	48	39.0	49.6
S.E. ±	4.1	24	0.42	0.68	3.75	0.53	0.57
C.D. (P= 0.5)	NS	69	NS	NS	NS	1.76	1.69

NS=Non-significant

effect on it (34.1% compared to check). Although all fertilizer treatments imposed positive effects on fertile tiller number, but Cu+ Zn had highest positive effect on it (61.6% compared to check). This treatment, also, had highest positive effect on 1000-kernel weight and spike number per unit area, and highest negative effect on sterile floret number (9.2, 17.3 and -18% compared to check, respectively). Fe+ Cu+ Zn treatment had highest positive effect on plant height, fertile floret number and kernel number per spike (15.1, 17.6 and 14.3% compared to check, respectively). If only one micronutrient was to be utilized, Zn is obviously the best choice for improvement of yield and its components. Since all fertilizer treatments had positive effects on most of important traits, it can be suggested the utilization of Fe+ Zn+ Cu treatment in the form of foliar spray in culture of durum wheat. Maralian (2009) found the increased wheat yield and quality by the foliar application of Zn and Fe. Wroble (2009) observed the non- significant contribution foliar applied boron under reduced boron availability condition. Jama *et al.* (2011) also observed that application of Zn and Fe micronutrients brought about significant differences in grain yield and the highest grain yield (9732.2 kg ha^{-1}) was obtained from Fe and Zn treatment although showing no significant differences with that of Fe Zn.

The data of second year experiment on yield attributes were recorded before harvesting of crop. Plant height was maximum (90.8 cm) from application of zinc and lowest (84.3 cm) from farmers practice. Lowest fertile tillers per sq / m^2 (425) were recorded from control plots and maximum (488) from zinc application which was significant compare to control treatment and followed by sulphur iron and manganese treatment. Majid *et al.* (2012) observed significant on the number of spikes per plant, grain per spike, grain in square meter, harvest index (HI%) and grain yield (kg/ha) but had no effect on thousand grain weigh. Boron and zinc showed higher amounts in mentioned traits than copper, although boron in chenaran and zinc in Mashhad were more effective the number of spikes per plant, grain in square meter and grain yield increased with raising in doses of foliar application, so that highest of these were in dose of 2 lit/ha. Varieties and locations resulted different in evaluated traits generally. The findings found at this study can be used in management recommendations of wheat. Arshad *et al.* (2012) indicated tillering, number of grains spike-1, 1000- grain weight, grain yield significantly increased by enhancing the rate of sulphur application . The maximum spike length (10.3 cm) was recorded from zinc applied treatment followed by sulphur (9.6 cm), iron (9.2 cm) and manganese (8.8 cm) treatment lowest (8.7 cm) from farmers practice were considered as control treatment. Number of spikelet per ear was maximum (18.8) from zinc treatment and lowest (16.5) from control treatment. Number of grains per ear was highest (51) from zinc treatment followed by sulphur (49), iron (44) and manganese (43) applied as liquid on wheat during second year of experiments at farmers' fields. The maximum yield (39.6 q/ ha) was recorded from zinc application and lowest (38.0 q/ ha) from control treatment as farmers practice. Grain yield 39.2 q/ ha obtained from sulphur application and 38.5 from iron application and 37.8 q/ ha from manganese treatment. It was also noted that zinc and sulphur application was significantly increased yield over control. Maralian Habib (2009) reported liquid application of Zn and Fe increased seed yield and its quality compared with control. Among treatments, application of (Fe + Zn) obtained highest seed yield and quality. Khan *et al.* (2010) observed that foliar application of micronutrients improves the wheat yield and net economic return. Khan *et al.* (2013) concluded that N and S spray at the rate of 10-15 per cent during different growth stages would improve the grain yield and yield components of wheat in the study area and contributed significantly to increased production.The straw yield was maximum recorded (50.1 q /ha) from zinc applied treatment, followed by sulphur (49.6 q/ ha) which was significant increased over control (Table 3).Ahmadikhah *et al.* (2010) studied the effects of foliar spray of micronutrient on yield and yield components of durum wheat and observed that every increment of nutrient increased yield. Bameri *et al.* (2012) showed that micronutrient application significantly affected plant height, number of spike per plant, number of grain per spike, 1000-grain weight, grain yield, biological yield and harvest index. Application of Mn+Fe had the highest positive effect on yield components and grain yield. The combination of Zn+ Fe+ Mn and control gave the lowest values of most studied traits. It could be concluded

Table 3: Average values of yield attributing characters and yield of wheat during 2012-13

Treatments	Plant height cm	Fertile tillers/m²	Spike length cm	Spikelet/ ear	seed/ ear	Grain yieldq/ ha	Straw yield q/ ha
FP+ $FeSO_4$ 1.0 %	88.4	474	9.2	17.8	44	38.5	48.6
FP+ $MnSO_4$ 0.5 %	86.2	445	8.8	17.2	43	37.8	48.1
FP+ Zn SO_4 0.5 %	90.8	488	10.3	18.8	51	39.6	50.1
FP+ sulphur 1.0 %	89.7	481	9.6	18.3	49	39.2	49.6
Farmer practice	84.3	425	8.7	16.5	42	38.0	47.2
S.E.±	3.7	19	0.46	0.89	3.46	0.38	0.78
C.D. (P= 0.5)	NS	59	NS	NS	NS	1.17	2.2

NS= Non-significant

that micronutrient application had positive effect on wheat growth and yield.

Conclusion :

This was concluded from the experiments that liquid applied sulphur, zinc, iron and manganese along with farmers applied fertilizers, increases yield and attributing characters of wheat in Western Plain Zone of Uttar Pradesh.

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