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COMPARISON OF PHOSPHORUS FERTILIZER EFFICIENCY OF UREA PHOSPHATE AND DAP IN WHEAT UNDER SALINE CONDITIONS

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ABSTRACT

Phosphorus use efficiency of urea phosphate (17% N and 44% P_2O_5) and di-ammonium phosphate (18% N and 46% P) were evaluated in saline soil (EC_e10.05 dS/m & pH 7.64) on wheat, grown in pots containing 10 kg soil. Phosphorus application rates from either source were (0, 20, 40, 60 and 80 mg P_2O_5 kg^{-1} soil) at the sowing time whereas urea was applied @ 150 kg N ha^{-1} in two splits (at sowing and anthesis). The agronomic data revealed that plant height and spike length increased with increase in phosphorus fertilizer rate (irrespective of source). Urea phosphate showed its superiority over DAP for grain yield as well as P-fertilizer efficiency (PFE). Urea phosphate at 60ppm P_2O_5 produced higher grain yield (9.24g pot^{-1}) as compared to DAP (80ppm P_2O_5, 8.98g pot^{-1}). The straw weights obtained with UP and DAP ranged between 11.93-16 g pot^{-1} and 9.2-13.3 g pot^{-1}, respectively. Phosphorus uptake in grain was also higher with urea phosphate (9.45-13 mg pot^{-1}) as compared to DAP (7.93-11.23 mg pot^{-1}).Phosphorus use efficiency of both fertilizers was significantly effected at all levels of phosphorus, however it decreased with increasing level of phosphorus. Highest phosphorus use efficiency (18.95%) was recorded at lowest level of phosphorus by urea phosphate.

Key words: Saline soils, Phosphorus uptake, Urea phosphate,

INTRODUCTION

Wheat, an important cereal crop throughout the world, and a staple food in Pakistan is grown on an area of about 8.034 million ha. In year 2012 the wheat production is estimated at 24.030 million tons, lower by 1.184 million tons from last year's crop (Anonymous, 2012). In addition to other agronomic factors affecting wheat yield, loss of soil fertility, water scarcity, biotic and abiotic stresses like soil salinity in canal commanded areas, are major constraints of low wheat production.

Salinity is one of the important abiotic stress affecting plant growth and productivity (Din *et al*., 2011; Shazma *et al*., 2011; Yousaf *et al*., 2011). At present in Pakistan about one fifth of the canal irrigated area is affected with moderate to severe salinity (Anonymous 2011). Yield losses of wheat in moderately saline areas of Pakistan are estimated to be 65% (Quayyum and Malik 1988). The estimated economic losses due to the decreased agricultural productivity in salt-affected areas are estimated at Rs20 billion per annum.

In addition to salinity, low phosphorus availability and uptake by plants are the major limitations for plant growth in many soils around the world (Grattan and Greive, 1999). Low phosphorus availability results from precipitation, transformation, fixation of P with Ca, Mg and Al (Prafitt, 1978) and in presence of high amounts of soluble salts (Awad *et al*., 1990), and also occurs in the soil having low phosphorus. Salinity may also reduce the P flux through xylem (Navarro *et al*., 2001), reducing plant phosphorus content and concentration. Increasing phosphorus availability and enhancing phosphorus nutrition of plants through fertilization may enhance plant salt tolerance and growth.

The response of phosphorus under saline conditions is rather indecisive. In substrates with high P availability, salinity may enhance P uptake and depress plant growth by P toxicity (Roberts *et al*., 1984), while at low substrate P concentrations, salinity depresses uptake and translocation of phosphorus (Martinez and Lauchli, 1991) and additional P supply on such substrates improves the salt tolerance (Awad *et al*., 1990). Martinez *et al* (1996) found that translocation of P from the roots to the shoots and its re-circulation from older to younger leaves as well as the mobility of P stored in vacuoles was inhibited by salinity.

The major factors contributing to the reduced land productivity is soil impoverishment caused by continuous cropping without addition of adequate mineral fertilizers and manures. Moreover, negative soil nutrient balances (nutrient removal exceeding nutrient application) during our cropping history have resulted in general deterioration of fertility levels (Gruhn *et al*., 2000). Sustained, high yield agricultural production can be assured once these negative balances are addressed. The selection of suitable fertilizer according to the crop demand and soil type is one of the main tools available for the solution of above said constraints.

For saline soils urea phosphate is more suitable for solving problem of phosphorus fixation due to its characteristics (i) readily dissolves in irrigation water, (ii) is initially acidic, (iii) initially free of ammonical nitrogen and (iv) contains phosphorus in the form of phosphoric acid. Due to its soil acidifying action some minor elements such as iron, manganese, copper, zinc, and molybdenum may become available. This does not mean that the entire soil becomes acidic, just the area around each fertilizer particle or concentration of particles. This acidifying effect is usually of short duration. Keeping in view the characteristics of urea phosphate, it was applied in saline soils to study the effect on phosphorus uptake, use efficiency and yield of wheat in comparison to DAP.

MATERIALS AND METHODS

Bulk saline soil sample (0-20 cm depth) was collected from Pakka Anna Farm, Faisalabad. The soil was ground and passed through a 2mm sieve and thoroughly mixed. Representative samples were analyzed for various properties such as pH 7.64, EC_e 10.05 dS/m, available P 4.5 ppm, total N 0.04%, $CaCO_3$ 4.85% Texture – loamy sand using standard methods (U.S Salinity Laboratory Staff 1954).Phosphorus was applied @ 0, 20, 40, 60 and 80 mg P_2O_5 kg^{-1} soil either as Urea phosphate (UP) and Diammonium phosphate (DAP) at the time of sowing whereas urea was applied @ 150 kg N ha^{-1} in three splits at sowing, tillering and anthesis. Each treatment was replicated three times and the pots were arranged in completely randomized design. Six seeds of wheat variety Bhakkar were sown in each pot and after germination only three seedlings were grown up to maturity. At maturity plants were harvested, separated into grain and straw dried in the oven at 70ºC for 3-4 days and the dry matter yield was recorded. Phosphorus fertilizer efficiency (PFE%) was calculated by the formula:

$$PFE(\%) = \frac{Pf - Pc}{P} x\ 100$$

Where Pf and Pc are the P uptake of fertilized and control treatment respectively (Amount of P applied; mg kg^{-1}).

Chemical analysis

The grain samples were ground in a Wiley Mill and one gram samples were digested in tri acid mixture (Jackson, 1962). Phosphorus in the digest was determined by measuring the intensity of the metavanadate yellow color using spectrophotometer (Jenway model 6300).

Statistical Analysis

The data obtained were subjected to analysis of variance (ANOVA) with MSTAT-C computer software. The data were analyzed statistically and treatment means were compared by employing Duncan's multiple range test at 5% level of probability (Steel and Torie 1980).

RESULTS AND DISCUSSION

Agronomic parameters:

Effect of different rates of phosphorus application either as urea phosphate (UP) or Diammonium phosphate (DAP) on the yield contributing factors of wheat under saline conditions are given in Table 1. Plant height, spike length and spike weight in all the treatments receiving P showed significantly high values compared with control (having no phosphorus).Urea phosphate showed significant increase in spike length and plant height at 80 ppm P_2O_5 when compared with DAP and the increase in height was 6.7% and 7.9% respectively over same levels of DAP. Non-significant effect in spike length and plant height was observed at40 and 60ppm $P_2O_5$when both fertilizers were compared at same levels. Effect of both fertilizers on number of tillers and number of spikes at either level were non-significant while it was highly significant when compared with control without phosphorus. Renu*et al.,* 2005 also found that number of tillers per plant were less where no fertilizer was applied as compared to phosphorus fertilizer addition in wheat crop. The results are in line with Khan *et al.,* 2010 who reported that acidic fertilizers (SSP) showed better performance in grain yield, and other agronomic parameters like spike length, number of tillers and spike weight than basic fertilizers (DAP). Spike weight was significantly high at all levels of phosphorus when compared with control (without phosphorus). At 20 ppm P_2O_5 urea phosphate showed significantly high spike weight when compared with same level of DAP while at other levels of P_2O_5 no significant difference was observed at either source. Application of phosphorus either as UP or DAP increased straw weight significantly over control (Fig. 3) however, at 20 and 40 ppm significant increase was observed in urea phosphate compared with same levels of DAP.

In addition to this plant height also contributed a significant role in enhancing the straw yield, maximum straw yield was recorded at 80 ppm P as urea phosphate and maximum height was observed in same treatment.

Table 1.Response of agronomic parameters of wheat to various levels of phosphorus applied as Urea phosphate and DAP under saline conditions.

P_2O_5 levels	Treatments P-sources	Plant height(cm)	Spike length(cm)	No. of tillers pot^{-1}	No. of spikes	Spike weight(g)	Straw weight (g)
0ppm	**Control**	68 d	15d	7 c	7c	8.33 d	6.92 e
20ppm	**UP**	69 cd	16 cd	9ab	9ab	12.30 bc	11.93bc
	DAP	68 d	16 cd	9ab	8 b	11.01 c	9.21d
40ppm	**UP**	70bcd	16 cd	9ab	8 b	13.91ab	13.18b
	DAP	71bcd	16cd	9ab	9ab	12.32bc	10.35cd
60ppm	**UP**	73abc	17 ab	10 a	10 a	14.02ab	13.66ab
	DAP	73abc	16cd	9ab	9ab	13.25ab	11.77bc
80ppm	**UP**	76 a	18ab	10 a	10 a	15.25 a	16.12 a
	DAP	70bcd	16 cd	10 a	9ab	13.38ab	13.31ab

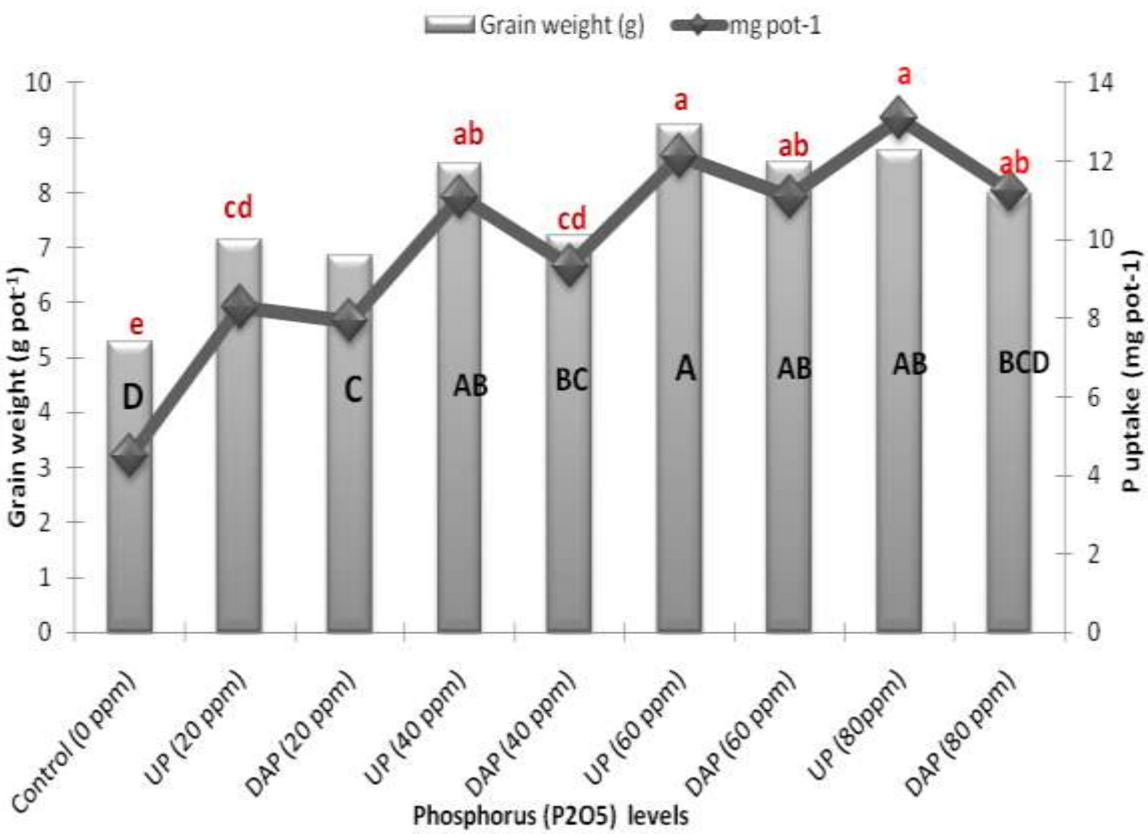

Fig. 1. Comparison of Grain yield and phosphorus uptake by grain at different levels of urea phosphate and DAP under saline conditions in wheat

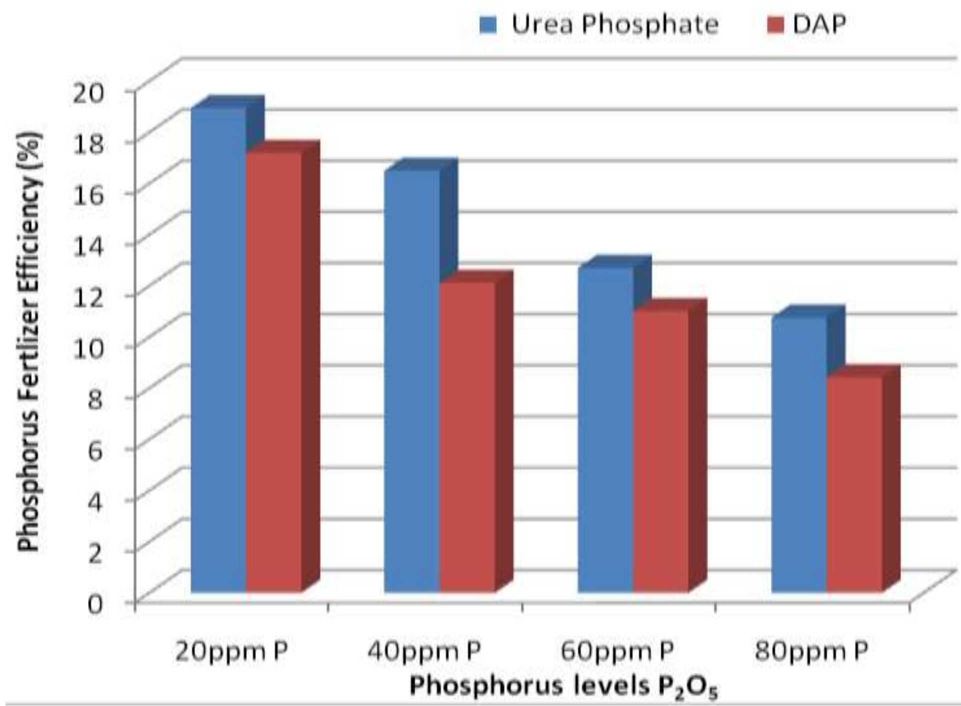

Fig 2. Phosphorus fertilizer efficiency (PFE%)of Urea phosphate and DAP at varying levels of phosphorus in wheat grain under saline conditions.

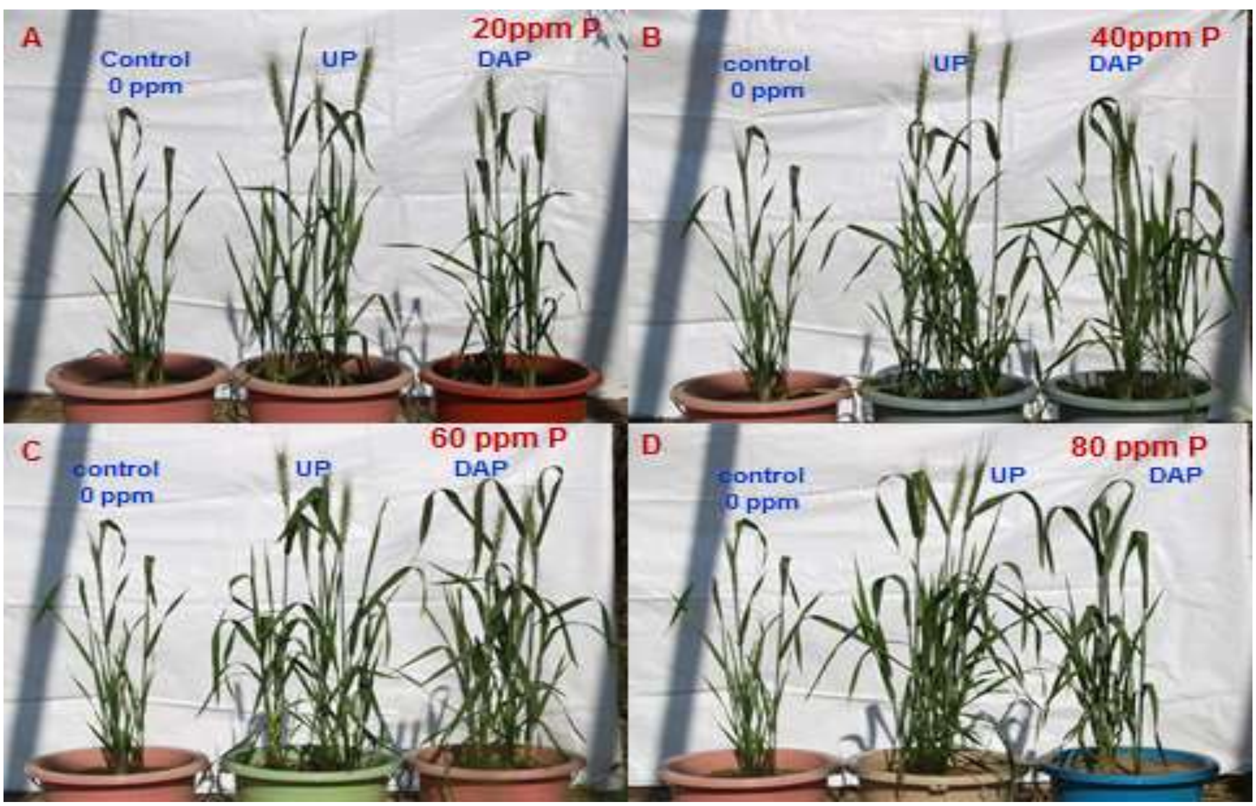

Fig. 3. Yield response of Urea phosphate (UP) and Diammonium phosphate (DAP) at A) 20 ppm P, B) 40 ppm P, C) 60 ppm P, D) 80 ppm P in wheat under saline condition.

Grain yield and phosphorus uptake

Grain yield was significantly affected by both phosphorus sources and increased with the increased level of phosphorus application. Mehdi *et al*., (2002 reported that grain yield has significantly positive correlation with increasing level of phosphorus application under saline conditions. At 60 ppm P_2O_5 urea phosphate showed highest grain yield (9.24 g pot^{-1}) and DAP showed 8.56 g pot^{-1} (Fig. 1). Between two sources of phosphorus significant difference in grain yield was recorded at 40 ppm P_2O_5 while at other levels the increase was non-significant. The results are in accordance with Reddy and Singh (2003 who reported that grain yield under different sources of P fertilizers follow the trend as SSP>Nitrophos>DAP. Phosphorus uptake by grain was increased with increase in phosphorus levels and maximum concentration of phosphorus was recorded at 80ppm urea phosphate (Fig.1). Comparison of two fertilizer sources revealed that urea phosphate showed increase in grain yield and also enhanced P uptake at all levels (20-80 ppm) of applied phosphorus when compared with di-ammonium phosphate (DAP). Roberts *et al.*, (1984) showed that under saline conditions phosphorus uptake may enhanced and depress plant growth by phosphorus toxicity while at low substrate phosphorus concentrations, salinity depress uptake and translocation of phosphorus (Martinez and Lauchli, 1991) and additional P supply on such substrates improves the salt tolerance (Awad *et al.*, 1990). These results are in agreement with Rabie *et al*., (1985); Niazi *et al*., (1991); Mehdi *et al.*, (2003); Mehdi *et al*., (2002) who reported similar findings.

Phosphorus use efficiency (PUE) of fertilizers

Phosphorus use efficiency of urea phosphate was significantly high when compared with DAP at all levels of applied phosphorus. Highest P-fertilizer efficiency (18.95%) was recorded at lowest level of phosphorus by urea phosphate (Fig. 2). Increasing rate of P application gradually decreased the PUE of both P sources, indicating reduced P-efficiency at higher rate of application. Alam *et al*., (2001) and Alam and Tahir (2005) also reported similar results for maize and wheat respectively. This may be explained that a long time interaction of soluble P with soil leads to its reaction with solid phase of soil (Kardos, 1964) and with calcium carbonate and the formation of relatively insoluble reaction products with Ca, Fe and Al leading to P fixation (Brady and Weil, 2002).

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