Pak. J. Biotechnol. Vol. 13 (3) 205 - 209 (2016) ISSN Print: 1812 - 1837
www. pjbt.org ISSN Online: 2312 - 7781

# GRAIN YIELD, PHOSPHORUS CONTENT AND UPTAKE OF WHEAT (*TRITICUM AESTIVUM L.*) AS AFFECTED BY PHOSPHORUS FERTIGATION

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Article received 19.5.2016; Revised 26.9.2016; Accepted 30.9.2016

## ABSTRACT

Most of the Pakistani soils are alkaline and calcareous in nature; therefore the efficiency of P-uptake by wheat is low. Among the agronomic practices that influence the efficiency of applied fertilizer, time and method of application are critically important. Fertigation is one of the techniques which enable the application of water soluble fertilizers and other chemicals along with irrigation water to the plant, uniformly and more efficiently. Two years field studies on wheat was undertaken to compare the response of P applied in the irrigation water with broadcast method. The treatments include: control (no P applied), P applied through broadcast method (farmers practice) and P applied with irrigation water (Fertigate P). The experiment was conducted in four replications using randomized complete block design. Generally, fertigated applied P increase grain yield, P content and P-uptake in wheat as compared to broadcast method. In wheat, fertigated P increased grain yield by 7-8%, P content by 8-16% and P uptake by 15 to 23% during two cropping years as compared to broadcast method. In conclusion, the use of P fertilizer through fertigation could be useful technique to increase grain yield and P uptake in cereals.

## INTRODUCTION

Wheat is the most popular food crop of Pakistan. Wheat being the staple diet of most of the people of Pakistan, dominates all other crops in terms of acreage and production. We use wheat and its products in a number of ways. It accounts for over 70% of the gross cereals and over 36% of the country's acreage is devoted to wheat cultivation. Despite of being grown on larger area, average yield at farmers' fields is still far below than the potential (Mann *et al*., 2004). Wheat production decreased to 25, 478 thousand tonnes in 2014-15 as compared to 25, 979 thousand tonnes in 2013-14 showing a decrease of 1.9 percent (GOP, 2015). The reduced yields can be attributed to number of factors i.e., lack of irrigation water and promising cultivars, delaying planting, poor land preparation, inappropriate soil management and imbalanced and ineffective nutrient utilization. Besides other factors, low soil phosphorus (P) may be one of the reasons for poor harvest.

Ninety percent soils of Pakistan are deficient in available P and suffer from moderate to severe P deficiency (Ahmad *et al*., 1992; Nisar *et al*., 1992). For optimum crop production, plants require adequate P from the very early stages of growth (Grant *et al*., 2005). P fixation is of great significance in the interpretation of soil tests and fertilizer recommendations. Therefore, site and crop specific P recommendations on scientific basis are needed (Nisar *et al*., 1992). Only soil solution play the key role by which wheat roots absorb P (Johnston *et al*., 1999); therefore, external soil solution P requirement may be a plant characteristic (Fox, 1981).

Phosphorus fertilization is essential for exploiting maximum yield potentials of different crop plants (Rashid *et al*., 1994). The regular recovery of P fertilizer by crops is very low and varies from 15-20% on single crop basis (Rashid, 1994). This may be attributed to reversion of applied phosphates to less available forms such as octacalcium phosphates, carbonate apatite, hydroxy apatite and flour apatite by reacting with clays and calcium compounds (Tisdale *et al*., 1985). According to Rashid & Din (1993), degree of P fixation depends on the ratio of applied P, the fixation of broadcasted P is much greater than the P applied through bands. Fertigation is a method that involves application of plant nutrients through irrigation. It is an operative means of placement of fertilizers and improving fertilizer use efficiency (Latif & Iqbal, 2001). Flood P-fertigation (P fertilizer through irrigation water) seems to be an innovative technique where nutrients in the form of solution are applied through irrigation water to reach the crop roots rapidly. It is also an effective means of controlling the time and placement of fertilizers and improving fertilizer use efficiency by reducing nutrient losses from leaching, and fixation in the soil to lessavailable forms (Zafar *et al*., 2013). Keeping in view the importance of fertigation, the present study was undertaken to assess the impact of fertigated P on yield, P content and P-uptake by wheat crop.

## MATERIAL AND METHODS

Two-year field experiments were laid out in randomized complete block design (RCBD) with four replications and net plot size of 5×7m at the experimental area of Wheat Research Institute Sakrand, Pakistan. Nitrogen was applied at the rate of 120 $kgha^{-1}$ as source of urea to all the treatments in two splits, half at sowing time and the remaining half at the time of first irrigation. Phosphorus fertilizer was applied as treatments; control, broadcast and fertigation for method assessment. The source of P was single super-phosphate (SSP), which was applied at the rate of 55 kg P $ha^{-1}$. SSP in broadcast method was spread over respective plots and incorporated in soil at the time of sowing of wheat. Fertigated-P was applied as a single full dose at the time of 1st irrigation. The solution of fertilizer P was prepared at 1:5 fertilizer to water ratio in a container fitted with water tap and placed at inlet of irrigation water flowing from water channel to the sub plots. At the beginning of the irrigation, stopper of the container was opened, releasing the phosphorus solution in such a way that the entire solution was finished with the termination of irrigation water from channel. Without P fertilizer plots were used as control. Wheat variety TD-1 was sown by drilling method at the seed rate of 120 kg $ha^{-1}$. For physicochemical properties of soil, a compost soil sample was taken before sowing of wheat.

Table 1: Physical and chemical properties of experimental soil before sowing

| Soil property | Value |
|---|---|
| Sand (%) | 15.0 |
| Silt (%) | 44.8 |
| Clay (%) | 40.2 |
| Textural class | Silty clay |
| EC dS $m^{-1}$ | 0.32 |
| Ph | 8.2 |
| $CaCO_3$ (%) | 10.76 |
| Organic matter (%) | 0.72 |
| Olsen's P mg $kg^{-1}$ | 0.025 |

The experimental soil was silty clay in texture and having an EC of 0.32 dS $m^{-1}$, pH of 8.2, $CaCO_3$ content of 10.76, organic matter content of 0.72 and Olsen's P 5.8 mg $kg^{-1}$. The crop was harvested at maturity. Grain and straw samples were taken and dried in an oven at 70°C, ground in Wiley's mill and 1 g of ground material was digested in HNO3: HClO4(1:5) mixture. The acid digested material was analyzed for total phosphorus by metavanadate yellow color method Jackson (1979). The data were assessed statistically using software MSTAT-C (Russel & Eisensmith, 1983). The phosphorus uptake was calculated as

P uptake (kg $ha^{-1}$) = $\frac{\text{Yield (kg ha}^{-1}\text{) x Plant P (\%)}}{100}$

## RESULTS AND DISCUSSION

**Grain yield:** Fertigation gave significantly higher grain yield ($p<0.05$) as compared to the yield obtained with the same dose of P applied by broadcast method during two cropping years (Figure 3). Fertigated P yielded 5930 and 5727 $kgha^{-1}$grain over the two cropping seasons while, corresponding grain yield by broadcast method was 5580 and 5425 kg $ha^{-1}$respectively (Figure 3). The grain yield of fertigated plots was 7 to 8% greater than broadcast method and 21 to 32% greater than the control treatment during two cropping years (Table 2). This indicated the relatively higher performance of fertigated applied P as compared to broadcast method. These findings are in close conformity with those reported by Stewart *et al*., 2005, who observed that fertigation was effective in supplying P to the cotton crop and increased lint yield. Fertigation allowed a balanced nutrient blend in a moist soil region where a large percentage of plant roots are located and proved to be the most consistent method of increasing yield across the three years of study. Banded preplant application of P produced more cotton than the control and side-dress method.

**Grain P content of wheat:** P content by wheat grain significantly increased over control due to P application and maximum was with fertigated-P, however, P-uptake was higher in 2nd cropping year (Figure 2). P content data shows an increase of 8 to 16% in P content by fertigation over broadcast method during the two cropping years with the maximum (16%) in 2nd cropping year (Table 2). Higher P content in 2nd year could be ascribed to the higher grain yield in this year. Improvement in grain P content seems due to readily available P through fertigation to the developing roots and thereby result in improved P use efficiency (Hussein, 2009).

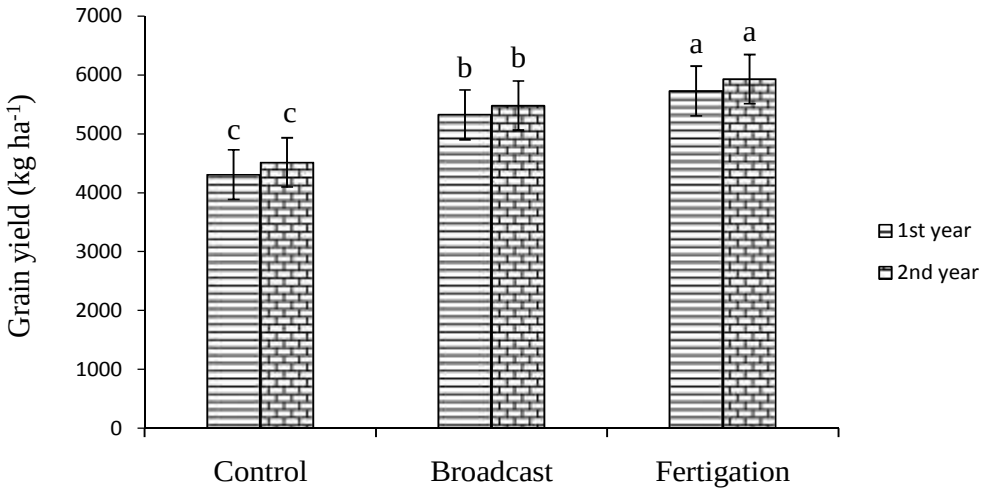


**Figure 1. Wheat grain yield as affected by method of P application during two cropping years**

Low recovery of broadcast P is an indication of relatively high P fixation and conversion of applied phosphates to less available form owing to alkaline calcareous nature of the soil (Memon *et al*., 2011). Similarly, Latif *et al*., 1997 and Hussein, 2009 reported that maize plant receiving P in solution form at first irrigation contained significantly higher P content as compared to P applied by broadcast at sowing.

**Table 2:** Increase in grain yield, P content and uptake under wheat by fertigation over broadcast method during two cropping season

| | **Grain yield** | **Grain P content** | **P-uptake** |
|---|---|---|---|
| **Cropping season** | **Percent increase by fertigation over broadcast** | | |
| **Year-1** | 7.5 | 8.3 | 14.9 |
| **Year-2** | 8.2 | 16.6 | 22.7 |

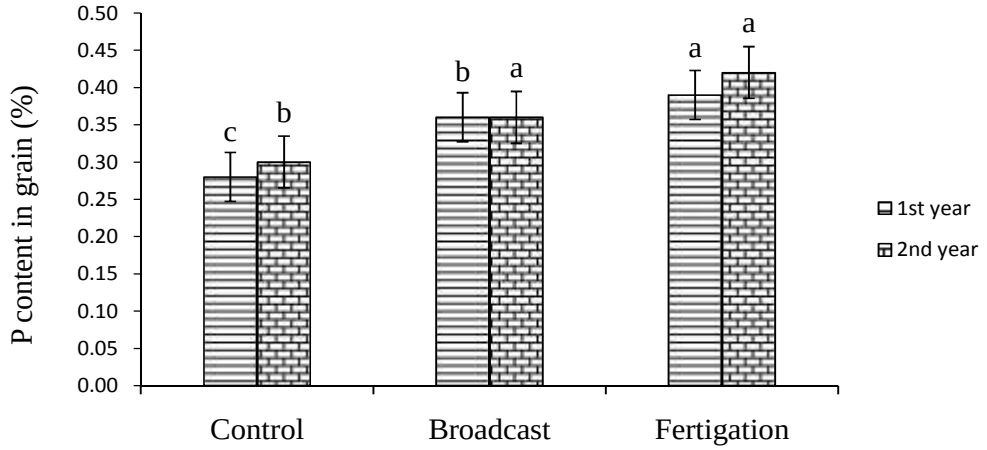


**Figure -2:** Wheat P content in grain as affected by method of P application during two cropping years

**Grain P uptake of wheat:** Fertigation applied P gave significantly higher grain P uptake (Figure 3) as compared to the P taken-up by broadcast method during two cropping years. With fertigated applied P an increase of 14 to 22% was noted in mean P-uptake over broadcast method and 15 to 23% over control, across the two cropping years (Table 2). Similarly Iqbal *et al*., (2003) reported that P uptake was significantly higher where P was applied as fertigation.

Fertigated DAP and SSP had higher P fertilizer efficiency as compared to their broadcast application. Fertigation of acid fertilizers like SSP and TSP perform proficiently in calcareous soils (Sharma *et al*., 1990). Latif *et al*. (2001) reported that lower dose of nitrogen along with full dose of P when applied through fertigation gave equal P uptake to that by full dose of N and same dose of P. It shows that crop benefited maximum from balanced P supply through fertigation. Rauschkolb *et al*. (1976) studies were also reported similar results.

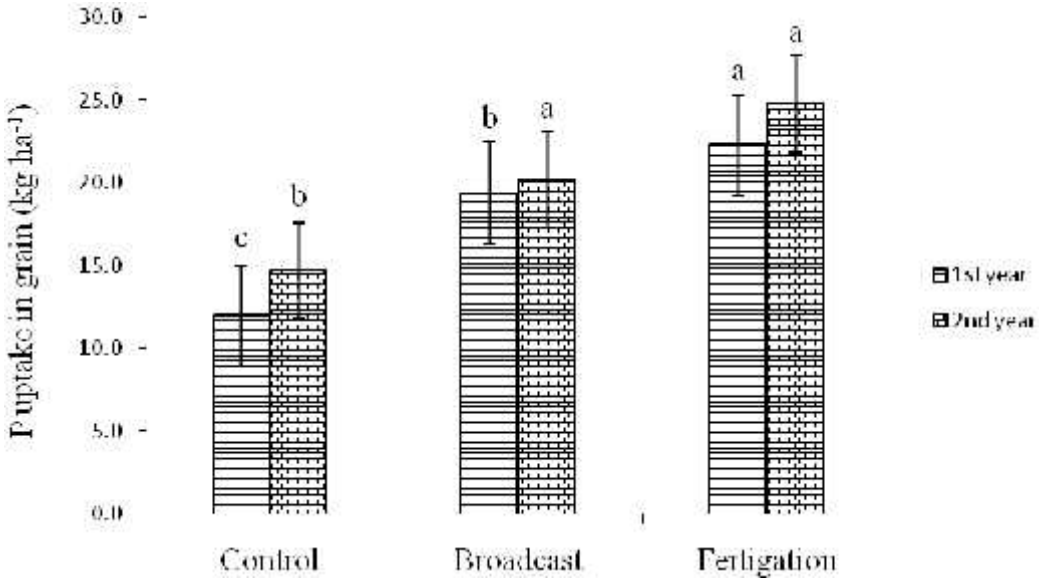


**Figure -3:** Wheat P uptake in grain as affected by method of P application during two cropping years

## CONCLUSION

From this study, it was concluded that fertigated-P enhanced the grain yield of wheat and improved P content as well as P uptake over broadcast method. On overall basis fertigation seemed a more efficient method of P application and could save considerable amount of P fertilizer and net economic returns as compared to broadcast method of application.

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