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Research Article

Demonstration and evaluation of the effect of time of application of NPK fertilizers on the yield of wheat in standing cotton.

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Abstract

Wheat (*Triticum aestivum* L.) is the staple food of Pakistan. It adds share in country's gross domestic product (GDP). A field experiment was conducted during winter seasons 2010-11 and 2011-12. The effect of split application of different fertilizers on the yield of wheat as relay crop sown in standing cotton was evaluated at Adaptive Research Farm Rahim Yar Khan. Five split doses of fertilizer in wheat sown in standing cotton were evaluated in a three replicated RCBD method. Results revealed that all the yield and yield parameters were significantly affected by split doses of different fertilizers as Nitrogen, Phosphorous and Potassium (at sowing, after the removal cotton sticks and at booting stages). The average of two years result revealed that significant maximum plant population i.e 131.83 m^{-2}, tillers i.e 325.67 m^{-2}, height 106.6 cm, 1000 grain weight i.e 42.33 gram (g) and grain yield of 4473 kg ha^{-1} was obtained when the dose of full Phosphorus and Potassium + ½ Nitrogen after the removal of cotton sticks and ½ Nitrogen at booting stage was applied in split form. The split dose of fertilizers was economical for all wheat varieties when sown in standing cotton.

Keywords: Wheat (*Triticum aestivum* L standing cotton, RCBD method, yield parameters.

Introduction

Wheat (*Triticum aestivum* L.) is one of the important staple food of the world. In Pakistan wheat is an important cereal crop in both production and area wise. Wheat contributes 13.1 % to value added in agriculture and 2.7 % to GDP. During the year 2010-11 wheat was cultivated on an area of 8805 thousand hectares, showing a decrease of 3.6 percent over last year's. Last year wheat was cultivated on an area of 9132 thousand hectares. However, a bumper yield of wheat crop of 24.2 million tons was obtained with 3.9 percent increase over the last year's. Last year production was of 23.3 million tons. (Government of Pakistan, 2010-11).

Chemical fertilizers application has played a vital role in increasing crop production. The alkaline and calcareous soils of Pakistan are low both in nitrogen (N) and in phosphorus (P) elements capapibility that are the major elements and addition of these

nutrients in appropriate amounts is very necessary for improving crop yields. Consequently, the use of N and P fertilizers increased day by day since late fifties (Ahmad, 2000). Plants require the same mineral elements, however, the dose, rate and timing of uptake vary with crop, variety, climate, soil characteristics and their management point of view. A balanced dose of nutrients requires plants throughout their grpwth and development. However, they have accumulated most of their nutrients by between flowering and ripening stages. Approximately 50 to 90 % of N and P in the plant at flowering stage moves from the leaves and stem to the developing seed (Chapin et al., 1988). In cereal crops the growth of a plant is divided into five basic stages i.e early leaf, tillering, and stem elongation, heading and ripening. Tillering refers to development of small shoots coming from buds. Heads begin to develop on each tiller before the stem becomes visible between leaves. Moreover, heading begins when the seed head is pushed up through the last leaf. On ripening, lower leaves may die due to insufficient food availability because nutrients stored in the lower leaves are moved to the grain (Weiss, 2005). Crop fertilizer balanced ratio should be timed based for growth stages, when possible rather than time of year. Nitrogen topdresseing at tillering stage increased both yield and protein contents of wheat, especially at low (N levels) soils (Lorbeer et al., 2000). N application near the time of heading may help in obtaining optimum protein levels that automatically effects wheat yield (Westcott et al., 1997). At tillering stage application of urea obtained highest yield, while late fertilization increased nitrogen recovery (Melaj et al., 2003). The demand of Nitrogen and phosporous increased consistently, thus leading to a serious imbalance in the use of these two nutrients. It is well known that balanced fertilization (NPK) helps in efficient utilization of other agricultural inputs and increases crop yields (Rashid, 1994; Alam et al., 2000). The application of Potassium (K) is best by subsurface banding at seeding stage, although K can also be broadcast at or near the time of seeding. According to (Orvis and Hellums, 1993) the first crop takes up only about 10-20% of applied P during the first year after application, and the remainder goes to build up of soil reserves. (Khan and Makhdum 1988) noticed that a single application of NP to wheat could be made at sowing stage, but the better results were obtained if half of the nitrogen and all of the phosphorous were applied at sowing stage and another half of N was top dressed at first irrigation stage (Ahmad et al.,1992). The time and rate of N application had profound effects on protein quality of the grains (Farrer et al., 2006). Over the last three decades, increased agricultural productivity occurred largely due to the deployment of high yielding varieties and increased fertilizer use. Wheat is grown in different cropping systems, such as cotton-wheat, rice - wheat, sugarcane-wheat, maize-wheat, fallow - wheat. Of these, cotton-wheat and rice-wheat systems together account 60% of the total wheat area whereas rain-fed wheat covers more than 2.2 million ha (Farooq et al., 2007). Late planting of wheat crop has resul in lower germination, less tillers, smaller heads, shrivelled grains and lower biomass than the timely sown wheat crop (Ugarte et al., 2007). Proper amount and time of fertilizer application is considered a key point in obtaining better crop yield. Time of fertilizer application can affect the nitrogrn utilization efficiency in most of cereal crops (Ragheb et al., 1993). Nitrogen (N) accumulation accured by heading and ripening stages, while maximum K accumulation occurred just after flowering, or mid heading. (Boatwright and Hass, 1961).

Materials and Methods

The experiment was conducted at Adaptive Research Farm Rahim Yar Khan during 2010-12. The objective of this study was to check the effect of time of application of different fertilizers NPK on the yield of wheat in standing cotton. The experiment was laid out in Randomized Complete Block design (RCBD) with three replications. Wheat variety Sehar-2006 was used to check five different split doses of fertilizers as mention in table 1. In 1st treatment Phosphorous was applied to previous crop, in 2nd treatment full dose of NPK means recommended dose (128-114-62 kg/ha), Phosphorous and Potassium was used at sowing with ½ dose of Nitrogen after the removal of cotton sticks and ½ dose of N at booting stage, in 3rd

treatment full dose of Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stage, in 4th one full dose of NPK after the removal of cotton sticks and in last treatment ½ PK was used at sowing, ½ NPK after the removal of cotton sticks and ½ N at booting stage were used to check their effect in wheat when sown in standing cotton. Seed rate of wheat was used 173kg ha^{-1} (70kg $Acre^{-1}$) in standing cotton. High seed rate was used for attaining maximum germination so that plant population may not be suppressed by the standing cotton plants. The previous crop was cotton in this field which was sown on 22nd May. The stomp weedicide was used to control weeds of cotton @ 3.75 litre ha^{-1}. Cotton picking was done from the month of October to December. Irrigation was stopped one month before wheat sowing to this field. Field was irrigated and after four hours wheat seed was broadcasted carefully. Cotton sticks were pulled out at the first week of January next year. Weedicide Isoproturan @ 2000g ha^{-1} was used for the control of narrow and broad leaved weeds during mid January. During wheat season six irrigations were applied. Harvesting was done during 1st week of May and threshing was done during 2nd week of May.

Following growth and yield parameters were recorded.

1. Germination count/m^2
2. Tillers/m^2
3. Plant height (cm)
4. 1000 grain weight(g)
5. Yield kg/ha

Collected data were subjected to analysis of variance test to discriminate the treatments (LSD).

Table 1. Time of application of different fertilizers (NPK) at different growth stages in wheat when sown in standing cotton.

Treatments	Time of application of different Fertilizers NPK
T_1	full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and Phosphorous was applied to previous crop
T_2	full dose of Phosphorous and Potassium was used at sowing with ½ dose of Nitrogen after the removal of cotton sticks and ½ dose of N at booting stage
T_3	full dose of Phosphorous and Potassium at sowing + ½ N after removal of cotton sticks and ½ N at booting stage
T_4	full dose of NPK after the removal of cotton sticks
T_5	½ PK was used at sowing, ½ NPK after the removal of cotton sticks and ½ N at booting stage

Note: full dose means recommended dose (128-114-62 kg ha^{-1})

Results and Discussion

All the treatments showed significant effect on the growth and yield parameters during two years of experiment. During 2010-11 as mentioned in table 2 plant population was maximum (129.67 m^{-2}) when wheat was applied with a full dose of fertilizer, Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stages in standing cotton followed by full dose of Phosphorous and Potassium (114 and 62kg/ha) was used at sowing with ½ dose of Nitrogen after the removal of cotton sticks and ½ dose of N at booting stage i.e (128.33 m^{-2}), followed by full dose of NPK after the removal of cotton sticks i.e (125 m^{-2}) and (127 m^{-2}) when fertilizer ½ dose of PK was used at sowing, ½ NPK after the removal of cotton sticks and ½ N at booting stage. The results of studies by (Alam *et al.*, 1999; 2002; Latif *et al.*, 2001) revealed that split application of N and P by top dressing or by fertigation methods could produce higher grain yield as compared to P at sowing stage.

The minimum plant population (120m^{-2}) was obtained when full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and Phosphorous was applied to previous crop. If germination is low it will automatically lowers the yield and tillering capacity of the wheat plant. An adequate moisture supply was continued for facilitating seed germination and seedling establishment (Zhang, 2007). Important parameter which directly affected economic yield was fertile tillers m^{-2}. The maximum fertile tillers m^{-2} were observed (321) when wheat was applied with a full dose of fertilizer, Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stages in standing cotton followed by (292.33) for the treatment T_5, (291.67) for T_4 and (278.33) for the treatment T_2. The minimum fertile tiller m^{-2} (263.33) was observed when full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and Phosphorous dose was applied to previous crop. The fertilizer doses were non significant for the height (cm) of wheat crop in all above five treatments. The height observed in T_3 fertilizer treatment was 107.6 followed by 105.87 for T_4, 104.07 and 104.2 for the treatments T_5 and T_2. The height 102.27 was observed in T_1 which is less than all others treatments. The maximum 1000 grain weight was recorded as (41.67g) and (41g) for the treatments T_3 and T_5. Then it was observed for the treatments T_4 and T_2 as (41g) and (38g) respectively. The lowest (36g) was observed for the treatment T_1. The data regarding grain yield ha^{-1} as mentioned in table 2 during 2010-11 envisaged that yield was affected significantly by different doses of fertilizer used in split method. The highest grain yield (4417 kg ha^{-1}) was obtained for the T_3 in which full dose of Phosphorous and Potassium (114 and 62 kg/ha) + ½ N after removal of cotton sticks and ½ N at booting stages in standing cotton was applied followed by (4200kg ha^{-1}) and (4100kg ha^{-1}) for the fertilizer doses of T_4 and T_5 respectively. A yield of (3900kg ha^{-1}) was observed for T_2. The lowest yield (2923kg ha^{-1}) was observed for the T_1 (full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and Phosphorous was applied to previous crop). Incorporation of lower P dose at sowing gave significantly lower yield than the recommended rate, whether it is applied full at sowing or applied as a split dose (Latif *et al.*, 1997; Shah *et al.*, 2001).Khan and Salim (1986) reported that early planted wheat crop resulted in higher yields as compared with late planting crop.

During 2011-12 as mentioned in table 3 plant population was maximum (134 m^{-2}) when wheat was applied with a full dose of fertilizer, Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stages in standing cotton followed by T_2 and T_5 having a plant population of (133 m^{-2}) and (131.33 m^{-2}). A population of (130 m^{-2}) was observed when full dose of NPK was applied after the removal of cotton sticks. The minimum plant population (125 m^{-2}) was obtained when full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and only Phosphorous was applied to previous crop. The maximum fertile tillers m^{-2} were observed (329.66) when wheat was applied with a fertilizer full dose of Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stages in standing cotton followed by (300) fertile tillers m^{-2} for treatment T_4, (297.33) for T_5 and (287) for T_2 respectively. The minimum fertile

Table 2. Effect of time of application of fertilizers on the yield of wheat in standing cotton during 2010-11

Treatments Fertilizer applied	Plant population (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield (kg ha^{-1})
T_1 Phosphorous applied to previous crop 111c	120c	263.33d	102.27	36c	2923d
T_2 Full PK@ sowing, ½ N after removal of cotton sticks and ½ N at booting stage	128.33a	278.33c	104.2	38bc	3900c
T_3 Full PK+1/2 N after removal of cotton sticks & ½ N at booting stage	129.67a	321.67a	107.6	41.67a	4417a
T_4 Full NPK after the removal of cotton sticks	125b	291.67b	105.87	40ab	4200b
T_5 ½ PK @sowing, ½ NPK after removal of cotton sticks & ½ N at booting stage	127ab	292.33b	104.07	41a	4100b
LSD (0.05)	**3.226**	**9.147**	**N.S**	**2.6406**	**189.089**

Table 3 Effect of time of application of fertilizers on the yield of wheat in standing cotton during 2011-12

Treatments Fertilizer applied	Plant population (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield (kg ha^{-1})
T_1 Phosphorous applied to previous crop 111c	125c	273d	100.13	37b	3120d
T_2 Full PK@ sowing, ½ N after removal of cotton sticks and ½ N at booting stage	133ab	287c	102.93	39.33ab	4023c
T_3 Full PK+1/2 N after removal of cotton sticks & ½ N at booting stage	134a	329.66a	105.6	43a	4530a
T_4 Full NPK after the removal of cotton sticks	130b	300b	103.73	41.33ab	4300ab
T_5 ½ PK @sowing, ½ NPK after removal of cotton sticks & ½ N at booting stage	131.33ab	297.33bc	104.6	42a	4210bc
LSD (0.05)	**3.894**	**11.50**	**N.S**	**4.477**	**242.300**

Table 4 Effect of time of application of fertilizers on the yield of wheat in standing cotton average of two years (2010-11 & 2011-12).

Treatments Fertilizer applied	Plant population (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield (kg ha^{-1})
T_1 Phosphorous applied to previous crop	122.5c	268.17d	101.2	36.5c	2982d
T_2 Full PK@ sowing, ½ N after removal of cotton sticks and ½ N at booting stage	130.83a	282.67c	103.57	38.6bc	3962c
T_3 Full PK+1/2 N after removal of cotton sticks & ½ N at booting stage	131.83a	325.67a	106.6	42.33a	4473a
T_4 Full NPK after the removal of cotton sticks	127.5b	295.83b	104.8	40.6ab	4250b
T_5 ½ PK @sowing, ½ NPK after removal of cotton sticks & ½ N at booting stage	129.17ab	294.83b	104.3	41.5ab	4155bc
LSD (0.05)	**2.726**	**8.8011**	**N.S**	**2.891**	**194.736**

tiller m^{-2} (273) was observed when full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and only Phosphorous dose was applied to previous crop. The fertilizer doses were non significant for the height (cm) of wheat crop in all above five treatments. The height observed in T_3 fertilizer treatment was 105.6 followed by 104.6 for T_5, 103.73 and 102.93 for the treatments T_4 and T_2. The height 100.13 cm was observed in T_1 which is less than all others treatments. The maximum 1000 grain weight was recorded as (43g) and (42g) for the treatments T_3 and T_5. Then observed for the treatments T_4 and T_2 as (41.33g) and (39.33g) respectively. The lowest (37g) was observed for the treatment T_1. The highest grain yield (4530 kg ha^{-1}) was obtained for the treatment T_3 in which full dose of Phosphorous and Potassium (114 and 62) + ½ N after removal of cotton sticks and ½ N at booting stages in standing cotton was applied followed by (4300kg ha^{-1}) and (4210kg ha^{-1}) for the fertilizer doses of T_4 and T_5 respectively. A yield of (4023 kg ha^{-1}) was observed for T_2. The lowest yield (3120kg ha^{-1}) was observed for the T_1 (full dose of K at sowing, 1/2 N after the removal of cotton sticks, 1/2 N at booting stage and Phosphorous was applied to previous crop). At present, average fertilizer use is less than half that recommended and some farmers do not apply P at all (Khan, 2003).

From the two years average (pooled) data 2010-12 in table 4, it was concluded that maximum grain yield (4473 kg ha^{-1}), plant population (131.83 m^{-2}), fertile tillers m^{-2} (325.67 m^{-2}), height (106.6cm) and 1000 grain weight (42.33g) were observed when wheat was applied a fertilizer split full dose of Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stage.

Conclusions

Balanced supply of nutrients should be provided to all plants throughout the growing season for proper development at their different growth stages for getting maximum yield. Nitrogen should be applied at tillering stage , although uptake rates of P and K come at a later growth stages. In the light of aforementioned results it can be safely concluded that in case of wheat when sown in standing cotton, a split application of fertilizer full dose of Phosphorous and Potassium + ½ N after removal of cotton sticks and ½ N at booting stage followed by a full dose of NPK after the removal of cotton sticks produced a maximum yield of wheat when sown in standing cotton which is an important cereal crop of our country.

References

Ahmad, N., Saleem, M.T. and Twyford, I.T.. 1992. Phosphorus research in Pakistan-a review. In: Proc. Symp. On the role of phosphorus in crop production, NFDC, Islamabad. pp. 59-92.

Ahmad, N. 2000. Integrated plant nutrition management in Pakistan: status and opportunities. In: Proc. Symp. Integrated plant nutrition management, NFDC, Islamabad. pp. 18-39.

Alam, S.M., Zafar Iqbal and Latif, A. 2000. Effect of P and Zn application by fertigation on P use efficiency and yield of wheat. Tropical Agric. Res. Ext. 3(2): 115-119.

Alam, S.M., Iqbal, Z. and Latif, A. 1999. Fertigation technology for improved phosphorus use efficiency in wheat. Pak. J. Sci. Ind. Res. 42: 380-383.

Anonymous, 2011. Government of Pakistan. Economic Survey of Pakistan 2010-11, Finance Division Islamabad pp: 20.

Boatwright, G.O. and H.J. Haas. 1961. Development and composition of spring wheat as influenced by nitrogen and phosphorus fertilization. Agronomy Journal. 53:33-36.

Chapin, F.S. III. and I.F. Wardlaw. 1988. Effects of phosphorus deficiency on source sink interactions between the flag leaf and developing grain in barley. Journal of Experimental Botany. 39 (2):165–177.

Farrer, D.C., W Randy, H.J Ronnie, M. Paul and G.W. Jeffrey. 2006. Minimizing protein variability in soft red winter wheat: Impact of nitrogen application timing and rate. Agron. J. 98 (4):1137–1145.

Farooq U, Sharif M, Erenstein O, 2007. Adoption and impacts of zero tillage in the rice–wheat zone of irrigated Punjab, Pakistan. Research Report. CIMMYT India & RWC, New Delhi,

India. pp 9-42.

Khan, M.A. 2003. Wheat crop management for yield maximization. Wheat Research Institute, Faisalabad. pp.94.

Khan, M.S. and Makhdum, M.I. 1988. Optimum time of NP application to wheat under irrigated conditions. Pak. J. Agric. Res. 9 (1): 6-9.

Khan, A. and Salim, M., 1986.Grain yield as influenced by seeding dates in wheat NWFP. Pakistan J. Agric. Res.,. 7(1)**:** 14-16.

Latif, A., Alam, S.M., Iqbal, Z. and Shah, S.A. 2001. Effect of fertigation applied nitrogen and phosphorus on yield and composition of maize. Pak. J. Soil Sci. 19 (1) : 23-26.

Latif, A., Alam, S.M., Hamid, A. and Iqbal, Z. 1997. Relative efficiency of phosphorus applied through broadcast-incorporation, top dressing and fertigation to crops. Pak. J. Soil Sci. 13(1-4): 15- 18.

Lorbeer, S., J. Jacobsen, P. Bruckner, D. Wichman, and J. Berg. 2000. Capturing the genetic protein potential in winter wheat. Fertilizer Fact #23. Montana State University Extension and Agricultural Experiment Station. Bozeman, Montana.

Melaj, M.A., H.E. Echeverrya, S.C. Lopez and G. Studdert. 2003. Timing of nitrogen fertilization in wheat under conventional and no-tillage system. Agron. J. 95 (6):1525–1531.

Orvis, P.E. and Hellums, D.T. 1993. Water solubility of phosphate fertilizer: agronomic aspects- a review, Paper series P-17, International Fertilizer Development Center, Alabama, USA.

Rashid, A. 1994. Phosphorus use efficiency in soils of Pakistan. In: Proc. 4th Natl. Cong. Soil Sci., Islamabad, Pakistan. pp.115-127.

Ragheb, H.M., R.A. Dawood, and K.A. Kheiralla. 1993. Nitrogen uptake and utilization by wheat cultivars grown under saline stress. Assiut. J. Agric. Sci. 24: 97-117.

Shah, K.H., Memon, M.Y., Siddique, S.H. and Aslam, M. 2001. Response of wheat to broadcast and fertigation technique for P application. Pak. J. Biol. Sci. 4: 543-545.

Ugarte C, Calderini DF, Slafer GA. 2007. Grain weight and grain number responsiveness to pre-anthesis temperature in wheat, barley and triticale. *Field Crops Res.*, 100:240-248.

Weisz, R. 2005. Small grain production guide 2004-05. North Carolina State University Cooperative Extension. AG-580.

Westcott, M., J. Eckhoff, R. Engel, J. Jacobsen, G. Jackson and B. Stougaard.1997. Grain Yield and Protein Response to Late-Season Nitrogen in Irrigated Spring Wheat. Fertilizer Fact No. 11. Montana State University Extension, Bozeman, Montana.

Zhang L., 2007. Productivity and resource use in cotton and wheat relay intercropping. PhD thesis, Wageningen University, Wageningen, The Netherlands. 188 pp. ISBN: 978 90-8504-759-9.

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