International Journal of Advanced Research in Biological Sciences
ISSN : 2348-8069
www.ijarbs.com

Research Article

Demonstration and evaluation of the effect of different irrigation frequencies on the growth and yield of wheat in standing cotton.

Muhammad Aslam[1], Dr. Muhammad Anjam Ali[2], Masood Qadir Waqar[3], Ashiq Hussain Sangi[4], and Laila Khalid[5]

[1]Senior Subject Matter Specialist (Agronomy) Department of Adaptive Research Farm, Rahim Yar Khan Punjab Pakistan
[2] Director General Agriculture (Ext.) Punjab Pakistan
[3] Director Adaptive Research Punjab Pakistan
[4]Senior Subject Matter Specialist (Plant Protection) Department of Adaptive Research Farm, Rahim Yar Khan Punjab Pakistan
[5] Research Officer Bahawalnagar, Department of Adaptive Research
*Corresponding author: *Laila_kld@yahoo.com*

Abstract

Wheat is the staple food of Pakistan. Wheat planting is delayed due to late picking of cotton. A field experiment was conducted during winter seasons 2012-13 and 2013-14. The effect of different irrigation frequencies on the yield of wheat as relay crop sown in standing cotton was evaluated at Adaptive Research Farm Rahim Yar Khan. Three different irrigation frequencies of wheat sown in standing cotton were evaluated in a three replicated RCBD method. In 1st treatment three irrigations at (crown root, booting and milking stage), in 2nd one four irrigations at (crown root, after stem elongation, booting and milking stage) and in 3rd treatment five irrigations at (crown root, stem elongation, booting, early milking and early dough stage) were checked out. Results revealed that all the yield and yield parameters were significantly affected by the different irrigations frequencies of wheat in standing cotton. The average of two years result revealed that significant maximum plant germination i.e 170.52 m^{-2}, fertile tillers i.e 317.90 m^{-2}, height 105.66 cm, 1000 grain weight i.e 40 (g) and grain yield of 4490 kg ha^{-1} was obtained when four irrigations at (crown root, after stem elongation, booting and milking stage) was applied to wheat crop sown in standing cotton as relay crop. Different irrigations frequencies were economical for all wheat varieties when sown in standing cotton.

Keywords: wheat, irrigation, relay sowing.

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop of Pakistan. Punjab is the major contributor of wheat in Pakistan where most of the area under wheat comes after cotton crop. At present very low yield of wheat crop is the main cause of poor productivity of cotton wheat based cropping systems in Pakistan. The low productivity is ascribed to very late sowing after harvest of cotton. Cotton is the most important cash crop of Pakistan and its early picking for timely sowing of wheat seems impossible (Government of Pakistan, 2004). Pakistan is an agriculture country that has variable climate and almost two third of the regions show arid type of climate. Only a narrow belt of sub mountainous regions show humid climate. Most of the areas in the central and southern Pakistan are highly arid; while the northern part of the country is humid except the extreme northern mountains which are relatively dry (Chaudhry and Rasul, 2004). Areas that are moist and warm are not suited for wheat crop. Higher precipitation causes lodging and diseases and interferes with field operations of planting to harvesting, Late planting of wheat can be done up to the middle of December, after which further delay in sowing reduces yield drastically. Wheat sowing in last decade of November can cause a reduction of 15-20 kg per acre yield during each subsequent day. There are two critical periods, during which water stress reduces yield greatly; the period from the development of adventitious roots to the start of tillering, and the period from anthesis to the milk maturity stage. Well-drained clay loams, loams and sandy loams are the best soils for wheat (Khan and Hanif, 2007). Wheat responds to supplemental irrigation, but careful irrigation management is important to produce consistently high yields with minimum costs. Water use by the wheat crop primarily depends on the location, planting date, variety, and weather during the growing season. Water use for wheat is about 22 inches for a grain crop (Fulton *et al.* 2006). Irrigations can be scheduled using predetermined calendar or days between irrigations, methods that directly measure soil moisture or crop stress, or the soil water balance method using evapotranspiration data. Predetermined dates or days between irrigations can be useful for scheduling irrigations under average conditions, but requires adjustment for weather conditions that vary from normal. Soil moisture and crop water stress can be measured in a variety of ways (Hanson *et al.* 2004) and calibrated at certain critical levels to trigger irrigation. The crop water requirement measured for the period from emergence to wax maturity. This shows that after wax ripens practically there is no need of irrigation because the hot and dry conditions are desirable to achieve rapid hard maturity. As the wheat growing areas are located at different altitudes which affect the length of the growing season, due to variations in temperature. The wheat in areas at or above 1000 meters above sea level ready for harvest during May as compared to March/April at most of the agriculture plains of the country. The sowing of wheat generally starts from mid of October and continues up to end of December (Rasul, 1993). Water logging also hinder nitrogen uptake from the soil since plant roots need oxygen to take up nitrogen. The plant symptoms of waterlogged soil conditions are yellowing and lack of growth of the plants. Plant wilting is a sign the first irrigation should have been applied sometime earlier. Delaying the 1st irrigation as long as possible with the intention of promoting root development and improving the ability of the crop to extract deep moisture in the future (Ottman *et al.* 1987).

Wheat sowing under these two cropping systems especially cotton-wheat cropping system is delayed which causes significant yield reduction. Usually low yields are obtained by conventional methods of wheat planting. Wheat cultivation on raised beds has been investigated for its suitability in rice-wheat and other cropping systems (cotton-wheat) of the Indo Genetic Plains (Hobbs and Gupta, 2003).Sowing of wheat is delayed due to late harvest of the preceding kharif crops like cotton, rice, maize, sunflower etc and additional time required for intensive cultivation for conventional seedbed preparation. According to an estimate, wheat yields under farmer's condition decline on an average @ 30-40 kg ha^{-1} day^{-1} when planted after 20 November (Anonymous, 1999). Planting method, time and removal of cotton sticks has a significant effect on water, nitrogen and phosphorus economy, energy savings and soil compaction (Toredson *et al.* 1989). Relay cropping of wheat at zero tillage has been reported to produce wheat yields comparable to those obtained from wheat raised on conventionally prepared seedbed (Verma *et al.* 1989; Akram, 1992). In that case two potential problems associated with the relaying surface seeding of wheat at zero tillage that are poor plant stand establishment and greater weed infestation. Pre sowing soaking of the wheat seed can alleviate the former problem. This occurs because wheat planting is often delayed by 20-44 days due to late picking of cotton, and subsequent tillage and field preparation operations for wheat planting. Stapper and Fisher (1990) have also pointed out that wheat planted after cotton harvest in general faces an unfavorable temperature regime and smaller window for growth and development by the standing cotton sticks in the field, leading to lower yields.

The raised beds for wheat production facilitates double cropping and offer significant advantages in controlling soil moisture, both irrigation and drainage, and are amendable to narrow row spacing (Mascagni *et al.* 2010). Wheat could be grown successfully on beds, with the advantage of reduced irrigation water requirement, seed rate, lodging and low population of *Phalaris minor* (Quanqi *et al.* 2008).

Materials and Methods

The experiment was conducted at Adaptive Research Farm Rahim Yar Khan during two consecutive years 2012-13 and 2013-14. The objective of this study was to check the effect of different irrigation frequencies on the yield of wheat as relay crop sown in standing cotton. The experiment was laid out in Randomized Complete Block design (RCBD) with three replications. In 1st treatment three irrigations at (crown root, booting and milking stage), in 2nd one four irrigations at (crown root, after stem elongation, booting and milking stage) and in 3rd treatment five irrigations at (crown root, stem elongation, booting, early milking and early dough stage) were checked out on wheat variety Faisalabad-2008 as mention in table 1. 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 dry seed was broadcasted in the 1st week of November in both experimental years. The previous crop was cotton in this field which was sown on 2nd fortnight of May. Cotton picking was done from the month of October to December. Field was irrigated and after four hours immediately wheat seed was broadcasted carefully. When dry seed used in the field it required some moisture to germinate, while in case of soaked seed the seed have moisture to grow if the soil don't have enough moisture for seed germination. In case of soaking less seed rate used to fill the gaps. Weedicides were used for the control of narrow and broad leaved weeds during mid January and February. Harvesting was done during 1st 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).

Treat ments	Different irrigation frequencies
T_1	Three irrigations at (crown root, booting and milking)
T_2	Four irrigations at (crown root, after stem elongation, booting and milking)
T_3	Five irrigations at (crown root, stem elongation, booting, early milking and early dough)

Table 1- Different seeding techniques of wheat in standing cotton as relay cropping system.

Results and Discussion

All the treatments showed significant effect on the growth and yield parameters during two years of experiment. During 2012-13 as mentioned in table 2 plant germination was maximum (168.67 m^{-2}) when four irrigations was applied to wheat crop sown in standing cotton at crown root, after stem elongation, booting and at milking stage followed by five irrigations at crown root, stem elongation, booting, early milking and early dough stage (157.35 m^{-2}). The minimum plant germination (144.20 m^{-2}) was obtained when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. 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 (310.50 m^{-2}) when four irrigations was applied to wheat crop sown in standing cotton at crown root, after stem elongation, booting and at milking stage followed by five irrigations at crown root, stem elongation, booting, early milking and early dough stage (298.30 m^{-2}). The minimum fertile tillers m^{-2} (286.10m^{-2}) was obtained when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. The effect of different irrigations three, four and five to wheat in standing cotton as relay crop was non significant for the height (cm) in all above three treatments. The height observed in T_2 was 104.33 followed by 98.07 for the treatment T_3. The height 93.87 was observed in T_1 which is less than all other treatments. The maximum 1000 grain weight was recorded as (38g) for the treatment T_2 followed by (35g) for the treatment T_3. The lowest (31g) grain weight was observed for the treatment T_1 when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. The data regarding grain yield ha^{-1} as mentioned in table 2 during 2012-13 envisaged that yield was affected significantly by different irrigation frequencies as applied in standing cotton. The highest grain yield (4500 kg ha^{-1}) was obtained for treatment when four irrigations was applied to wheat crop sown in standing cotton at crown root, after stem elongation, booting and at milking stage followed by (3910kg ha^{-1}) for the treatment T_3 when five irrigations at crown root, stem elongation, booting, early milking and early dough stage was applied to wheat crop. The lowest yield (3390kg ha^{-1}) was observed for the T_1 when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. Water use by the wheat crop primarily depends on the location, planting date, variety, and weather during the growing season. Water use for wheat is about 22 inches for a grain crop (Fulton *et al*. 2006). Khan and Salim (1986) reported that early planted wheat crop resulted in higher yields as compared with late planting crop.

Table 2 Effect of different irrigation frequencies on the yield of wheat in standing cotton during 2012-13

Treatments	**Plant germination (m^{-2})**	**Fertile tillers (m^{-2})**	**Height (cm)**	**1000 grain wt. (g)**	**Yield (kg ha^{-1})**
Seeding techniques					
T_1 Three irrigations at (crown root, booting and milking)	144.20c	286.10c	93.87	31c	3390c
T_2 Four irrigations at (crown root, after stem elongation, booting and milking)	168.67a	310.50a	104.33	38a	4500a
T_3 Five irrigations at (crown root, stem elongation, booting, early milking and early dough)	157.35b	298.30b	98.07	35b	3910b
LSD (0.05)	**9.23**	**7.42**	**N.S**	**2.49**	**375.83**

During 2013-14 as mentioned in table 3 plant germination was maximum (172.37 m^{-2}) when four irrigations was applied to wheat crop sown in standing cotton at crown root, after stem elongation, booting and at milking stage followed by five irrigations at crown root, stem elongation, booting, early milking and early dough stage (163.21 m^{-2}). The minimum plant germination (145.24 m^{-2}) was obtained when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. 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 (325.30 m^{-2}) when four irrigations was applied to wheat crop sown in standing cotton at crown root, after stem elongation, booting and at milking stage followed by five irrigations at crown root, stem elongation, booting, early milking and early dough stage (310.70 m^{-2}). The minimum fertile tillers m^{-2} (290.20m^{-2}) was obtained when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. The effect of different irrigations three, four and five to wheat in standing cotton as relay crop was non significant for the height (cm) in all above three treatments. The height observed in T_2 was 107 followed by 102 for the treatment T_3. The height 98 was observed in T_1 which is less than all other treatments. The maximum 1000 grain weight was recorded as (42g) for the treatment T_2 followed by (38g) for the treatment T_3. The lowest (34g) grain weight was observed for the treatment T_1 when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. The data regarding grain yield ha^{-1} as mentioned in table 3 during 2013-14 envisaged that yield was affected significantly by different irrigation frequencies as applied in standing cotton. The highest grain yield (4480 kg ha^{-1}) was obtained for treatment when four irrigations was applied to wheat crop sown in standing cotton at crown root, after stem elongation, booting and at milking stage followed by (4120kg ha^{-1}) for the treatment T_3 when five irrigations at crown root, stem elongation, booting, early milking and early dough stage was applied to wheat crop. The lowest yield (3860kg ha^{-1}) was observed for the T_1 when three irrigations was applied to wheat crop at crown root, booting and milking stage sown in standing cotton. Similar findings were also reported by carver (2005), Ahuja *et al*. (1996), Raj *et al*. (1992) and Serma and Medhy (1995).

Table 3 Effect of different irrigation frequencies on the yield of wheat in standing cotton during 2013-14

Treatments Seeding techniques	Plant germination (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield (kg ha^{-1})
T_1 Three irrigations at (crown root, booting and milking)	145.24c	290.20c	98	34c	3860c
T_2 Four irrigations at (crown root, after stem elongation, booting and milking)	172.37a	325.39a	107	42a	4480a
T_3 Five irrigations at (crown root, stem elongation, booting, early milking and early dough)	163.21b	310.70b	102	38b	4120b
LSD (0.05)	**7.57**	**13.04**	**N.S**	**3.25**	**225.20**

From the two years average (pooled) data 2012-14 in table 4, it was concluded that maximum grain yield (4490 kg ha^{-1}), plant germination (170.52 m^{-2}), fertile tillers m^{-2} (317.90 m^{-2}), height (105.66cm) and 1000 grain weight (40g) were observed when four irrigations at (crown root, after stem elongation, booting and milking stage) was applied to wheat crop sown in standing cotton as relay crop.

Table 4 Effect of different irrigation frequencies on the yield of wheat in standing cotton average of two years (2012-13 & 2013-14)

Treatments Seeding techniques	Plant germination (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield (kg ha^{-1})
T_1 Three irrigations at (crown root, booting and milking)	144.72c	288.15c	95.93	32.5c	3625c
T_2 Four irrigations at (crown root, after stem elongation, booting and milking)	170.52a	317.90a	105.66	40a	4490a
T_3 Five irrigations at (crown root, stem elongation, booting, early milking and early dough)	160.28b	304.50b	100.03	36.5c	4015b
LSD (0.05)	**8.40**	**10.23**	**N.S**	**2.89**	**300.51**

Conclusion

It was concluded that four irrigations at (crown root, after stem elongation, booting and milking stage of wheat produced maximum grain yield (4490 kg ha^{-1}), plant germination (170.52m^{-2}), fertile tillers (317.90m^{-2}), height (105.66cm) and 1000 grain weight (40g) in standing cotton as relay crop.

References

1. Ahuja, K.N., R.B. Lal and A. Kumar (1996). Effect of seed rate, date and method of sowing on growth and yield of wheat. Annals of Agricultural Res.; 17 (2): 190-192.
2. Akram, M., (1992). Relay versus sequence cropping of wheat in cotton wheat cropping system. AARI, Ann. Report. Directorate of Agronomy, Faisalabad, pp: 26–7.
3. Anonymous, (1999). Report on status of wheat crop in Punjab. Wheat Research Institute, AARI, Faisalabad.
4. Carver, M.F.F. (2005). The influence of different establishment methods on performance of early drilled winter wheat. HGCA- Project Report; 375:24.
5. Chaudhry, Q. Z., G. Rasul, (2004). Agro climatic Classification of Pakistan, Science Vision (Vol.9, No.1-2&3-4), (July-Dec, 2003 & Jan-Jun, 2004), Page.59.

6. Fulton, Allan, Khaled Bali, Zazk Mousli, and Lee Jackson (2006). Small grains production manual, Part 5: Irrigation and water relations. UC Davis.
7. Government of Pakistan, (2004). Economic Survey of Pakistan. Finance Division, Economic Wing, Islamabad, Pakistan.
8. Hanson, Blaine, Larry Schwankl, and Allan Fulton (2004). Scheduling irrigations: When and how much water to apply. UC Davis.
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.
10. Khan, I., M. Hanif., (2007). Weather and Wheat Development in Faisalabad Region Rabi Season (2006 – 2007).
11. Hobbs, P.R. and R.K. Gupta (2003). Resource-conserving technologies for wheat in the rice-wheat system. American Society of Agronomy Special Publication No. 65. ASA, CSSA, SSSA, Madison, Wisconsin, USA.
12. Mascagni, R., S. Harrison, K. Arceneaux and B. Bell (2010). Influence of raised beds, row spacing and seeding rate on production of wheat on alluvial soil. Winter issue of Magazine Louisiana Agriculture, Louisiana, USA
13. Ottman, M., P. Brown, and J. Harper (1987). Yield and water use of wheat as influenced by early irrigation at Maricopa, p. 140-145. Forage and Grain. Univ. Ariz. Coll. Agric. Coop. Ext. Report Series P-71. Univ. Ariz., Tucson.
14. Quanqi L., Y. Chen, M. Liu, Xunbo, S. Yu and B. Dong (2008). Effects of irrigation and planting patterns radiation use efficiency and yield of winter wheat in North China. Agric. Water Manag., 95: 469-476.
15. Raj, S, D. Singh and V.U. Rao (1992). Effect of date of sowing and row spacing on the yield of wheat (*Triticum aestivum* L.). Crop Research (Hissar): 5 (2): 199-206.
16. Rasul, G., (1993). Water requirement of wheat crop in Pakistan. Journals of energy and applied sciences, Vol.12, No.2, July-Dec.
17. Serma, N.N. and D.N. Medhy (1995). Response of rain fed wheat to seeding methods and fertility levels. Annals of Agricultural Res., 16(2): 260-261.
18. Stapper M, Fischer R. A. (1990). Genotype, sowing and plant spacing influence on high yielding irrigated wheat in Southern New South wales, Australian Journal of Agricultural Research, 41, 1021-1041.
19. Troedson, R. J., R. J, Law, K. F, Byth and G. L, Wiloon (1989). Response of field grown wheat to saturated soil culture. Field Crop Res. 21: 171-187.
20. Verma, U.N., V.C. Srivastava and R. B. Prasad (1989). Effect of zero tillage on wheat (*Triticum aestivum L.*) with rice (*Oryza sativa L.*) stubble mulching. *Ind. J. Agri. Sci.*, 59: 669–71.
21. 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.