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Research Article

Demonstration and evaluation of the effect of different dates of removal of cotton sticks on the yield of wheat in standing cotton.

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Abstract

Wheat (*Triticum aestivum* L.) is the staple food of Pakistan. Planting of wheat after 20th of November reduces its productivity. Wheat planting is delayed due to late picking of cotton. A field experiment was conducted during winter seasons 2011-12 and 2012-13. The effect of different dates of removal of cotton sticks on the yield of wheat as relay crop sown in standing cotton was evaluated at Adaptive Research Farm Rahim Yar Khan. Four different dates (removal of cotton sticks 40 days after sowing wheat i.e 20th December, after 50 days i.e 30th December, after 60 days i.e 10th January and after 70 days i.e 20th January of 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 the removal of cotton sticks of wheat in standing cotton. The average of two years result revealed that significant maximum plant germination i.e 156.70 m^{-2}, fertile tillers i.e 321.43 m^{-2}, height 105.15 cm, 1000 grain weight i.e 39 (g) and grain yield of 4240 kg ha^{-1} was obtained when dry wheat seed was broadcasted immediately after irrigation. Different seeding methods were economical for all wheat varieties when sown in standing cotton.

Keywords: Wheat (*Triticum aestivum* L.), removal of cotton sticks plant germination.

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop that responds differently to various agro management practices especially planting methods and time of sowing alone or in standing cotton field. Punjab is a 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). 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-Gangetic 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 Trodson *et al.* (1989). Absorption of photo synthetically active radiations has also been found to be influenced by planting methods and cotton sticks removal Lal *et al.* (1991).

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. Sowing wheat after 20th November in this region reduces the productivity at the rate of 1.0-1.5 % per day Nasrullah *et al.* (2010), reducing average yield after cotton by > 0.5 t ha^{-1}. 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.

Carver, (2005) investigated the impact of different crop establishment methods, i.e. conventional drilling, precision drilling and broadcasting in winter wheat. Broadcasting method produced the most effective spatial arrangements. 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).

The maximum grain yield in broadcast method and by removal of cotton sticks immediately after irrigation in standing cotton field can be described to higher number of spikelets $spike^{-1}$, number of grains $spike^{-1}$ and 1000-grain weight, which was favored because of better growing condition in broadcast method. Similar findings were also reported by carver (2005), Ahuja *et al*. (1996), Raj *et al*. (1992) and Serma and Medhy (1995). Dawelbeit and and Babiker (1997) have reported maximum yield for seed drilling and ridging after broadcasting than broadcasting alone. The results indicate that proper seed rate, sowing method and timely removal of cotton sticks increased plant vitality and yield. It encourages nutrient availability, proper sun light penetration for photosynthesis Chang *et al.* (1991).

Materials and Methods

The experiment was conducted at Adaptive Research Farm Rahim Yar Khan during two consecutive years 2011-12 and 2012-13. The objective of this study was to check the effect of different dates of removal of cotton sticks 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. Wheat variety Faisalabad-2008 was used to check four different dates of removal of cotton sticks as mention in table 1. In 1st case cotton sticks was removed 40 days after sowing i.e 20th December in standing cotton as relay crop. While in 2nd case cotton sticks removed 50 days i.e 30th December and in 3rd case cotton sticks was removed 60 days i.e 10 January and in last case cotton sticks was removed 70 days i.e 20 January. 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. During wheat season four irrigations were applied. 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).

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

Treatments	Different seeding techniques
T_1	Removal of cotton sticks 40 days after sowing wheat i.e 20th December
T_2	Removal of cotton sticks 50 days after sowing wheat i.e 30th December
T_3	Removal of cotton sticks 60 days after sowing wheat i.e 10th January
T_4	Removal of cotton sticks 70 days after sowing wheat i.e 20th January

Results and Discussion

All the treatments showed significant effect on the growth and yield parameters during two years of experiment. During 2011-12 as mentioned in table 2 plant germination was maximum (137.54 m^{-2}) when cotton sticks was removed at 40 days on 20th December followed by 50 days after sowing wheat i.e 30th December i.e (125.34 m^{-2}), followed by 60 days after sowing wheat i.e 10th January (119.11 m^{-2}). The minimum plant germination (110.08m^{-2}) was obtained when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. 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 (313.33) when cotton sticks was removed at 40 days on 20th December followed by 50 days after sowing wheat i.e 30th December and 60 days after sowing wheat i.e 10th January i.e (294.23) and (280.67). The minimum fertile tillers m^{-2} (245.93m^{-2}) was obtained when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. The effect of different dates of removal of cotton sticks on 40, 50, 60 and 70 days after sowing of wheat was non significant for the height (cm) of wheat crop in all above four treatments. The height observed in T_1 was 104.87 followed by 100.60 and 97.93 for the treatments T_2 and T_3. The height 94.53 was observed in T_4 which is less than all others treatments. The maximum 1000 grain weight was recorded as (39g) for the treatment T_1 followed by (37g) for the treatment when cotton sticks was removed on 50 days after sowing wheat i.e 30th December. Then it was observed for the treatments T_3 (35g) as when cotton sticks was removed on 60 days after sowing wheat i.e 10th January. The lowest (31g) was observed for the treatment T_4 when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. The data regarding grain yield ha^{-1} as mentioned in table 2 during 2011-12 envisaged that yield was affected significantly by different dates of removal of cotton sticks as applied in standing cotton zero tillage stage. The highest grain yield (4200 kg ha^{-1}) was obtained for treatment when cotton sticks was removed at 40 days on 20th December followed by (3890kg ha^{-1}) for the treatment T_2 when cotton sticks was removed on 50 days after sowing wheat i.e 10th January. A yield of (3550kg ha^{-1}) was observed for T_3 when cotton sticks was removed on 60 days after sowing wheat i.e 10th January. The lowest yield (3200kg ha^{-1}) was observed for the T_4 when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. Khan and Salim (1986) reported that early planted wheat crop resulted in higher yields as compared with late planting crop.

During 2012-13 as mentioned in table 3 plant germination was maximum (175.87 m^{-2}) when cotton sticks was removed at 40 days on 20th December followed by 50 days after sowing wheat i.e 30th December i.e (161.65 m^{-2}), followed by 60 days after sowing wheat i.e 10th January (153.09 m^{-2}). The minimum plant germination (139.34m^{-2}) was obtained when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. 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).

Table 2 Effect of different dates of removal of cotton sticks on the yield of wheat in standing cotton during 2011-12

Treatments	Plant germination (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield (kg ha^{-1})
Seeding techniques					
T_1 Removal of cotton sticks 40 days after sowing wheat (20th December)		137.54a	313.33a	104.87	39a 4200a
T_2 Removal of cotton sticks 50 days after sowing wheat (30th December)		125.34b	294.23b	100.60	37b 3890b
T_3 Removal of cotton sticks 60 days after sowing wheat (10th January)		119.11c	280.67c	97.93	35c 3550c
T_4 Removal of cotton sticks 70 days after sowing wheat (20th January)		110.08d	245.93d	94.53	31d 3200d
LSD (0.05)	**5.246**	**12.41**	**N.S**	**1.752**	**249.08**

Important parameter which directly affected economic yield was fertile tillers m^{-2}. The maximum fertile tillers m^{-2} were observed (329.54) when cotton sticks was removed at 40 days on 20th December followed by 50 days after sowing wheat i.e 30th December and 60 days after sowing wheat i.e 10th January i.e (302.75) and (290.99). The minimum fertile tillers m^{-2} ($279.11m^{-2}$) was obtained when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. The effect of different dates of removal of cotton sticks on 40, 50, 60 and 70 days after sowing of wheat was non significant for the height (cm) of wheat crop in all above four treatments. The height observed in T_1 was 105.44 followed by 103.22 and 99.64 for the treatments T_2 and T_3. The height 96.88 was observed in T_4 which is less than all others treatments. The maximum 1000 grain weight was recorded as (40g) for the treatment T_1 followed by (37g) for the treatment when cotton sticks was removed on 50 days after sowing wheat i.e 30th December. Then it was observed for the treatments T_3 (34g) as when cotton sticks was removed on 60 days after sowing wheat i.e 10th January. The lowest (30g) was observed for the treatment T_4 when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. The data regarding grain yield ha^{-1} as mentioned in table 3 during 2012-13 envisaged that yield was affected significantly by different dates of removal of cotton sticks as applied in standing cotton zero tillage stage. The highest grain yield (4280 kg ha^{-1}) was obtained for treatment when cotton sticks was removed at 40 days on 20th December followed by (3990kg ha^{-1}) for the treatment T_2 when cotton sticks was removed on 50 days after sowing wheat i.e 10th January. A yield of (3660kg ha^{-1}) was observed for T_3 when cotton sticks was removed on 60 days after sowing wheat i.e 10th January. The lowest yield (3170kg ha^{-1}) was observed for the T_4 when cotton sticks was removed on 70 days after sowing wheat i.e 20th January. 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 dates of removal of cotton sticks 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 Removal of cotton sticks 40 days after sowing wheat (20th December)		175.87a	329.54	105.44a	40a 4280a
T_2 Removal of cotton sticks 50 days after sowing wheat (30th December)		161.65b	302.75b	103.22b	37b 3990b
T_3 Removal of cotton sticks 60 days after sowing wheat (10th January)		153.09c	290.99c	99.64c	34c 3660c
T_4 Removal of cotton sticks 70 days after sowing wheat (20th January)		139.34d	279.11d	96.88d	30d 3170d
LSD (0.05)	**7.25**	**10.49**	**N.S**	**2.125**	**275.48**

From the two years average (pooled) data 2011-13 in table 4, it was concluded that maximum grain yield (4240 kg ha^{-1}), plant germination (156.70 m^{-2}), fertile tillers m^{-2} (321.43 m^{-2}), height (105.15cm) and 1000 grain weight (39g) were observed when cotton sticks was removed at 40 days on 20th December in standing cotton as relay crop.

Table 4 Effect of different dates of removal of cotton sticks on the yield of wheat in standing cotton average of two years (2011-12 & 2012-13)

Treatments	Plant population (m^{-2})	Fertile tillers (m^{-2})	Height (cm)	1000 grain wt. (g)	Yield ($kg\ ha^{-1}$)
Seeding techniques					
T_1 Removal of cotton sticks 40 days after sowing wheat (20th December)		156.70a	321.43a	105.15a	39a 4240a
T_2 Removal of cotton sticks 50 days after sowing wheat (30th December)		143.49b	298.49b	101.91b	37b 3940b
T_3 Removal of cotton sticks 60 days after sowing wheat (10th January)		136.01c	285.83c	99.78c	34c 3605c
T_4 Removal of cotton sticks 70 days after sowing wheat (20th January)		124.71d	262.52d	95.70d	30d 3185d
LSD (0.05)	**6.24**	**11.45**	**N.S**	**1.93**	**262.28**

Conclusion

It was concluded that cotton sticks when removed on 40 days at 30th December in wheat after sowing produced maximum grain yield (4240 kg ha^{-1}), plant germination (156.70m^{-2}), fertile tillers (321.43m^{-2}), height (105.15cm) and 1000 grain weight (39g) in standing cotton as relay crop.

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