International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 21, No. 4, p. 1-5, 2022

RESEARCH PAPER OPEN ACCESS

Impact of conservation agriculture on cotton productivity

F. Baya*, W. Mubvekeri

Cotton Research Institute, Kadoma, Zimbabwe

Article published on October 03, 2022

Key words: Conservation, Technology, Adoption, Moisture stress, Cotton

Abstract

A study was carried out to investigate the possibility of adopting conservation agriculture in cotton production and determine its impact on seed cotton yield. The experiment was carried out in Zimbabwe at Cotton Research Institute, Umguza, Kuwirirana, Wozhele, Shamva and Dande communal areas. This new technology is also to fuse with the new Pfumvudza cotton program, a drive which Zimbabwean government is trying to implement. The experimental design used was a randomised complete block design (RCBD) with five replications. The treatments used were as follows: conventional tillage practice, conservation agriculture with basins, conservation agriculture with ripped rows and conservation agriculture with dibber made holes. The data was collected on the average boll mass, plant height and seed cotton yield. The data was analysed using GenStat 18th version and the means were separated using Fisher's LSD test at a 5% probability level. Based on the outcome of the results, it showed that high significant differences were realised at sites for all the treatments in terms of seed cotton yield with conservation agriculture with basins yielding the most at 1337kg ha $^{-1}$. The other two conservation practices also produced better yields. This showed that conservation agriculture practices are a promising technology that can be used in cotton production with benefits being significant with time.

* **Corresponding Author:** F. Baya ✉ fbaya80@gmail.com

Introduction

Cotton production is mainly dependent on conventional tillage system in Zimbabwe which exposes the soil to degradation at a wide scale due to the slow growing nature of the crop during the first six weeks (Cotton handbook, 1998). Unless concerted measures are undertaken to address soil degradation resulting from overworking the soil in conventional tillage systems, arable land shortages will seriously become a problem in the major cotton growing areas. Furthermore, poor season quality experienced now and then significantly affect productivity of cotton amongst other crops. Most cropping seasons are characterized by mid-season dry spells which seriously reduce yield potential, making water the greatest limitation to crop productivity (Nyagumbo, 2010).

In recent years, in order to mitigate the impact of climate variability, manifesting themselves in the form of droughts and increased temperatures, technologies including diversification to drought tolerant crops, conservation agriculture and moisture conservation techniques have been developed. In cotton, little have been done in terms of technologies pertaining to conservation agriculture. It is known that conservation agriculture (CA) is premised on the principles of reduced or no-soil disturbance, provision of soil cover through live or dead mulch (Nhamo, 2007). The benefits derived from CA provides a feasible option for redressing declining productivity in Zimbabwe's cotton under small holder farming and its advantages with respect to reducing soil degradation have been well documented (Nyagumbo, 2008). However, effectiveness of such technologies gets enhanced when crop residues are applied as surface mulch. The retention of crop residues as soil cover and the manual work involved in the operations remain a major bottleneck to CA adoption by farmers in Zimbabwe (Mazvimavi and Twomlow, 2008; Giller *et al.,* 2009).

The proposed project therefore seeks to address the research gaps in cotton production on the benefits of conservation agriculture. Implementation of the proposed project is envisaged to address a priority research gap in Zimbabwe which should help address the question of how crop residues, water, and fertility management options can be integrated for maximum synergy to improve cotton productivity in drought prone regions under rain-fed conditions.

Therefore the study conducted to evaluate the benefits of conservation tillage technologies on seed cotton yield under Zimbabwean conditions.

Materials and methods

The study was conducted at Cotton Research Institute, Umguza, Kuwirirana, Wozhele, Shamva and Dande communal areas for three successive seasons. The experimental design used was randomised complete block design with five replication and four treatments. Conservation basins of 15cm depth were installed manually and on planting 10cm of soil was returned in the hole and planting done in the upper 5 cm of the basin and covered by about 2cm of soil to leave a depression of about 3cm to retain water. Seed drilling was done in holes of 5cm depth where fertilizer was first applied and 1cm of soil returned into the hole and then seed placement done before covering with a 2cm layer of soil. Locally recommended plant spacing of 1m x 0.3m was used in all treatments and fertilizer rates of 250kg ha $^{-1}$ Compound L and 100kg ha $^{-1}$ ammonium nitrate was applied. Trash content estimation was done using visual assessment at each site. The data was collected on average boll mass, plant height and seed cotton yield, was analysed using GenStat 18th version and separation of means was done using Fishers' Protected L.S.D.

Treatments

Table 1. The list of treatments used in the study.

Treatments
Conventional tillage practice - control
Conservation agriculture with basins
Conservation agriculture ripped rows
Conservation agriculture with dibble made holes

Results and discussion

Average boll mass

Average boll mass did not vary under different tillage systems at various sites as shown in Table 2 except for C.R.I and Umguza. At C.R.I all systems

that included conservation practices resulted in significantly heavier bolls which was the opposite at Umguza were heavier bolls were noticed on conventional tillage practice which somehow comparable to conservation practice with basins at planting stations.

Table 2. Effect of conservation agriculture on average boll mass (g).

Treatment	C.R.I	Kuwirirana	Dande	Shamva	Umguza	Wozhele
Conventional tillage practice	5.7a	6.0	4.6	6.4	5.9b	6.4
Conservation with basins	7.2b	6.1	4.3	6.4	5.7ab	6.5
Conservation with ripped rows	6.8b	6.2	3.8	6.4	5.3a	6.2
Conservation with dibble made holes	7.0b	6.3	4.4	6.2	5.3a	6.6
Mean	6.7	6.2	4.3	6.4	5.6	6.4
P -value	<0.001	0.144	0.349	0.865	0.028	0.051
LSD	0.39	0.26	0.99	0.6	0.44	0.24
CV (%)	4.3	3.1	16.7	6.8	5.7	2.7

Means followed by the same letter are not significantly different at p = 0.05 and means were separated by the Fishers' LSD

Plant height

Results indicated no significant differences on plant height among the different tillage systems at most of the sites as shown in Table 3 except for CRI, Shamva and Wozhele. This was attributed to the unfavourable climate conditions experienced in the season at most of the sites which resulted in the plants not growing to their full potential optimum height. However, it shows that different heights were recorded on different treatments. At CRI, only conventional tillage practice had least height, whereas other three treatments had comparable results. At Shamva, conservation with dibber holes recorded tallest plants whereas other three treatment had comparable heights. At Shamva, the least plant height was recorded on conservation with basins.

Table 3. Effect of conservation agriculture on plant height (cm) at Cotton Research Institute, Chitekete, Wozhele, Dande, Shamva and Umguza.

Treatment	C.R.I	Kuwirirana	Dande	Shamva	Umguza	Wozhele
Conventional tillage practice	67.0a	110.6	93.8	102.8b	83.8	129.2b
Conservation with basins	123.0b	110.0	88.4	101.0b	81.4	122.0a
Conservation with ripped rows	116.0b	102.0	89.4	101.0b	72.8	125.4ab
Conservation with dibble made holes	123.6b	105.8	89.4	90.4a	73.8	129.8b
Mean	107.4	107.1	90.2	98.8	78.0	126.6
P -value	<0.001	0.604	0.741	0.034	0.234	0.039
LSD	10.74	15.47	11.45	8.70	13.20	5.73
CV (%)	7.3	10.5	9.2	6.4	12.3	3.3

Means followed by the same letter are not significantly different at p = 0.05 and means were separated by the Fishers' LSD

Seed cotton yield

Results indicated high statistical significant differences (P<0.001) in seed cotton yield among the tillage systems at C.R.I, whereas Kuwirirana had (P<0.004) and Umguza (P<0.03) whilest no significant differences at the other sites as shown in Table 4**.** Conservation practices performed better at the first two sites although at Umguza we could not substantiate the claim as conventional tillage performed better in terms of yield. This shows the feasibility of using the conservation agriculture technology in cotton production. According to literature, the apparent results of conservation tillage are evident after one season of practicing conservation agriculture on a piece of land (Nyagumbo, 2008), so that is the reason why there are some apparent differences with the conventional practice being started to be realised.

Multi location analysis

The across site analysis showed that different conventional tillage and conservation agriculture

practices used in different agro-ecological conditions were highly significant as shown in Table 5 in terms of seed cotton yield. Conservation agriculture practice with basins in cotton production performed better than other treatments across all the sites with a yield of 1337kg ha $^{-1}$. Conservation with dibble made holes produced the second-best cotton seed yield of 1254kg ha $^{-1}$ though comparable to the yield of conservation with ripped rows.

Table 4. Effect of conservation agriculture on seed cotton yield (kg ha $^{-1}$) at Cotton Research Institute, Wozhele, Chitekete, Dande, Shamva and Umguza.

Treatment	C.R.I	Kuwirirana	Dande	Shamva	Umguza	Wozhele
Conventional tillage practice	983a	574a	733	1820	797b	851
Conservation with basins	3002b	1006b	523	2174	649ab	667
Conservation with ripped rows	2821b	1291b	526	1648	555a	666
Conservation with dibble made holes	2762b	1338b	539	1640	511a	733
Mean	2392	1052	580	1820	628	729
P -value	<0.001	0.004	0.344	0.171	0.031	0.164
LSD	277.9	393.4	301.5	547.0	191.3	188.2
CV (%)	8.4	27.1	6.3	21.8	22.1	18.7

Means followed by the same letter are not significantly different at p = 0.05 and means were separated by the Fishers' LSD.

Table 5. Across site analysis of the effect of conservation agriculture in different locations on seed cotton yield (kg ha $^{-1}$).

	Treatments				
Site	Conventional tillage practice	Conservation with basins	Conservation with ripped rows	Conservation with dibble made holes	Grand Mean
CRI	983cde	3002j	2821j	2762j	2392d
Dande	733abcd	523a	526a	539ab	580a
Kuwirirana	574ab	1006de	1291ef	1338fg	1052b
Shamva	1820h	2174i	1648gh	1640gh	1821c
Umguza	797abcd	649ab	555ab	511a	628a
Wozhele	851bcd	667abc	666abc	733abcd	729a
Grand Mean	960	1337	1251	1254	1201
Site x Trt Interaction			<0.001		
LSD			318.2		
CV (%)			21.1		

Means followed by the same letter are not significantly different at p = 0.05 and means were separated by the Fishers' LSD, Trt - treatment

Conclusion

There is need to mitigate the impact of climate variability, manifesting themselves in the form of droughts and increased temperatures, technologies including diversification to drought tolerant crops, conservation agriculture and moisture conservation techniques have been developed. In cotton, little have been done in terms of technologies pertaining to conservation agriculture. The proposed project therefore seeks to address the research gaps in cotton production on the benefits of conservation agriculture. Basing on the findings, there is overwhelming evidence which shows that conservation agriculture on cotton production can reap fruitful results if its principles are adopted correctly. Cotton production under conservation with basins proved to yield better results with time and that can increase cotton productivity. According to the results, two other conservation practices also proved to be realising better yields and by doing so the objective of the project has been met. This research will go a long in increasing cotton productivity if this conservation practice is put in good use. The only limitation to this practice is that of labour challenges on installation of basins.

Acknowledgements

I would like to express my deepest appreciation to my colleagues at Cotton Research Institute, especially my other co-research officers for their editing help,

late-night feedback sessions, and moral support. Compliments should also go to the research assistants, and above all my head of institute, who impacted and inspired me. Lastly, I would like to thank the farmers in all five communal areas where the research work was done, their contribution had a positive impact on the success of this project. I would also like to thank my family for their emotional support.

References

Cotton handbook. 1998. Cotton Growers Association Publication

Mazvimavi, Twomlow. 2008. Conservation Farming for Agricultural Relief and Development in Zimbabwe. In No till Farming Systems WASWC Special Publication No. **3,** 169-178

Nhamo. 2007. The contribution of different fauna communities to improved soil health. A case of Zimbabwean soils under conservation agriculture. University of Bonn Ecology and Development Series **56,** 131

Nyagumbo. 2008. A Review of Experiences and Developments towards Conservation Agriculture and Related Systems in Zimbabwe. In "*No-Till Farming Systems*" (T Goddard, MA Zoebisch, YT Gan, W Ellis, A Watson and S Sombatpanit, eds.), Special Publication No. **3,** 345-372.

Nyagumbo. 2010. Evaluating the effects of conservation agriculture and related technologies on soil biodiversity, crop and labour productivity in semi-arid Zimbabwe. Second RUFORUM Biennial Meeting 20-24 September 2010, Entebbbe, Uganda.