African Crop Science Conference Proceedings, Vol. 11. pp. 101 - 104
Printed in Uganda.
ISSN 1023-070X/2013 $ 4.00

Effect of plant density on seed cotton yield

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Abstract Cotton (*Gossypium hirsutum* L.) is an important cash crop for small-scale farmers in Mozambique. The yield is dependent on various factors of plant management, and this can be affected by variations in plant density. In Mozambique the cotton crop is mainly growed in plant and row space arrangement corresponding to 50,000 plants per hectare, which is considered low resulting in low cotton yielding.The goal of this study, was to evaluate the effect of plant density in cotton yield, *Gossypium hirsutum* L. The experiment was conducted in Namialo village, in a randomized complete block design with four replications in a split-plot, where the main plot was distance between the plants within the rows (15, 20, 25, 30 cm) and distance between the rows (50, 75, 100 cm) as subplots randomized in each plot, making plant from 33000 to 133000 plants per hectare. Results of this experiment showed no significant interaction between the distance between the rows and plants on cotton yield, number of bolls per plant and plant height. In addition, as the distance between the plants increased, the number of bolls per plant also increased. This experiment empathize that the combination of 70 cm between the rows and 20 cm between the plants, with a total density of about 71400 plants per hectare resulted in a highest yield.

Key words: *Gossypium hirsutum*, Mozambique, smallscale farmers

Introduction

Cotton is a natural fiber, plant-derived, and is considered the most important textile fiber balance with man-made and syntactic fiber, its main advantage is the comfort of their made items.

Mozambique has good agro-ecologic conditions for cotton cultivate. North region has high potential, which include Niassa, Cabo-Delgado and Nampula province. However, cotton yield is considered low. As the productivity is influenced by many factors among which the number of plant per area unit and its respective spacing. It has being observed that the use of inadequate population of plants may cause serious problems as non uniforms maturation and lows yields.

The propose of spacing and planting density for crops in general and for cotton in particular, has tried to meet the specifics needs of cultivating methods and productivity improvement (Souza, 1996).

The accord with (Lamas, 1997), the increase of plant population in the same are, affect the development of individuals after achieve such point which each plant begin compete for growth factors, such us light, water and nutrients. After competition between plant start, the yields per individual decrease. However, if populations increase, in order to overcome the reduction the yield per plant, the use of bigger density will increase the yield.

The fact of being important adequate the plants population (combination of different spacing) for good yields, was what inspired the present work, in the interest of productivity improvement, search of better framing, such as generate news information about plants populations for our actual conditions of soils.

The present study is to evaluate the effect of plant density on seed cotton yield in cotton (*Gossypium hirsutum* L.).

Materials and methods

The trial was conducted in Agrarian Research Institute of Mozambique in Namialo, during season 2012/13. Was used Albar SZ 93 14 variety which is mostly propagate in region. Region which is, according to the (MAE, 2005), characterize by presenting climate like Aw, sub-humid dry, where the annual average rainfall is between 800 to 1000 mm and annual average temperature is 26°C.The classification of soils can be sandy soil to loam clayish. The treatments was allocated in a randomized complete block design with four replications in a split-plot, where the main plot was distance between the plants within the rows (15, 20, 25, 30 cm) and distance between the rows (50, 75, 100 cm) as subplots randomized in each plot, making plant from 33000 to 133000 plants per hectare.

For the sowing in day 5/01/12 was used treated seed and the good condition of temperature and humidity, enabled the confirmation of emergence between 5 and 10 days according to (Wanjura & Buxton, 1972a, 1972b). The second event was thinning in 13 days after emergence, with the purpose of to reduce the excess of plants that emerge per hole.

Weeds control was done manually in number of 5 during all cycle of crop. The pests was controlled with 5 spraying with ZAKANAKA TOP and PRO followed by counting, starting in February 16 and finished in April 14 of 2012.

The agronomics characteristics such us, plants high, number of capsule per plant, cotton yield and fiber, was esteemed in 15 plants random selection in each usable area of each sub-plot. Manual harvest in usable of 18 m2 was realized in June 12.

Results and discussion

Analysis of variance (Table 1) shows that there were not significant interactions between plant spacing in the row (Factor 1) and row spacing (Factor 2), rather, these factors were independent from each other for all variables under study. Nevertheless, there was a significant difference when analysis of variance was carried out for different plant spacing in the row for yield of cotton seed and for plant height. On the other hand, row spacing significantly influenced the number of cotton balls (capsules) per plant and yield of cotton seed.

This study comprised three different row spacing, namely plant rows placed at 50cm, 80cm and 100 cm apart. Figure 1 shows that cotton yield was the highest when row spacing was of 80 cm; the worst performance for this variable being observed when distance between plant rows was placed at 100 cm apart. Solar radiation penetrating crop canopy varies with plant spacing arrangements, decreasing as plant population increases (Larcher, 2000), this in turn influences production components and plant characteristics (Heitholt *et al*., 1992). Thus, it is likely that the influence of plant space arrangement on cotton seed yield is partly due to the variation of solar radiation penetrating crop canopy. It could also be suggested that row spacing at 100 cm is too wide to make optimal use of this resource, the number of plants per unity area not allowing fully interception of solar radiation, while at 50 cm spacing, low solar radiation penetration and thus, plant shading may have negatively influenced crop performance.

Figure 2 shows the variation of cotton seed yields with different plant spacing within a row. The figure shows that seeds planted at 20 cm apart provided the highest cotton seed yield, while planting 15 cm apart ranked second, the lowest crop yield being observed when plants within a row were planted 25 cm apart. Oostherhuis (1992) put forward that the fall of reproductive strictures depends on the balance between the content of ethylene and sugar on the tissue. Thus, factors which decrease photosynthesis or increase metabolism are likely to cause fall of reproductive structures, as for instance when there is plant shading or frequent cloudy days, or still, when factor as high temperatures or drought occur at flowering stage. Thus, it is likely that the narrow spacing within the rows at 15 cm has made it difficult the penetration of solar radiation and resulted in plant etiolating due to plant shading which affected photosynthesis and contributed

Table 1. Analysis of Variance for yield of cotton seed, number o cotton balls (capsules) per plant and plant height.

FV	Mean Square (MS)			
	Degree of freedom (DF)	Cotton seed yield	Number of capsules/plant	Plant height
Factor 1	2	79394.93*	51.53	436.56*
Factor 2	3	127766.20*	7.88*	165.70
Block	3	477037.04	0.42	163.85
Factor 1 x Factor 2	6	67964.41	2.78	116.84
Error	33	157452.98	0.52	92.18
Total	47			
CV (%)		20.23	10.00	7.86
Mean		1960	6.68	122.18

** Significant at 1%. * Significaant a 5%. NS Not significant.

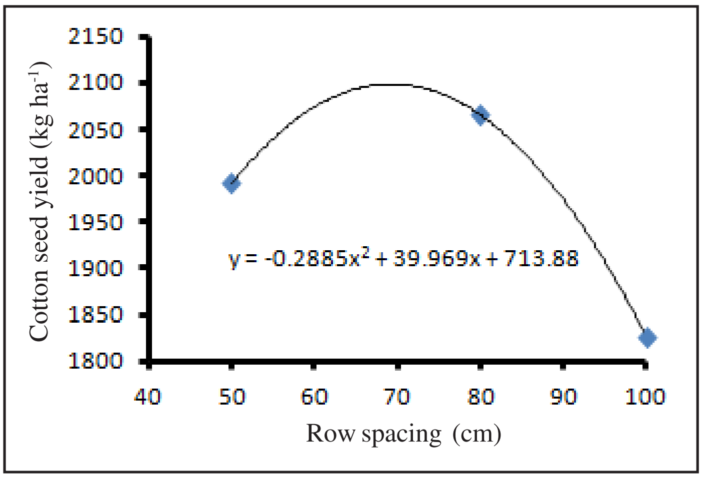

Figure 1. Variation of cotton seed yield with row spacing.

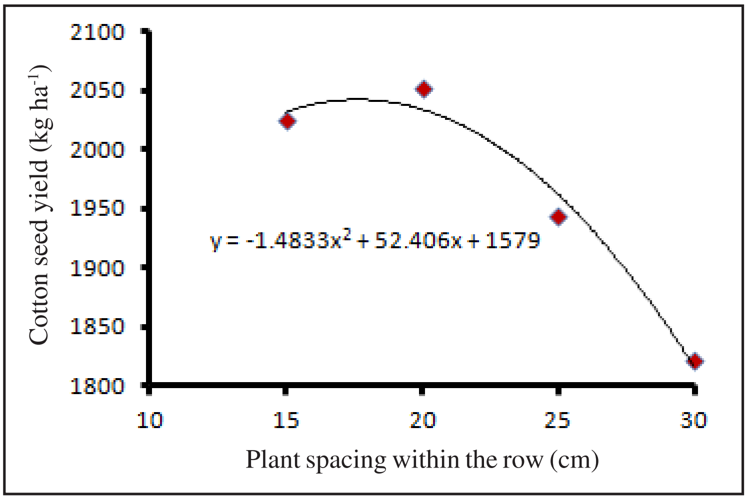

Figure 2. Variation of cotton seed yield with different plant spacing within the row.

to the fall of plant reproductive structures with implication for crop yield.

Brito *et al*. (2005) stated that increasing plant spacing in a row associated with a decrease in row spacing promoted an increase in cotton seed yield. Although there was no significant interaction, results shown in Figure 3 tends to support this finding. As shown in this figure, decreasing row spacing from 100 to 80 cm and increasing the distance between plants within the row from 15 to 20 cm and from 25 to 30 cm, cotton yield has increased. Similarly, decreasing row spacing to 50 cm, cotton yield only increased as the distance between plants within the row increased. This preliminary result may suggest that the narrower the row spacing it is likely that an increase in the distance between plants within the row will minimize the effect of plant shading and as an aftermath, crop yield will improve.

Studies carried out by Kerby & Hake (1993) point out a straight relationship between the number of cotton bolls per plant and plant population to plateaux of 140.000 plants ha^{-1}, provided that there is not excessive rainfall and too low relative air humidity. Figure 4 indicates that as space between plants within the row is widened, the number of cotton balls per plant increases. This result may be associated to the fact that high population density gives rise to a high humidity environment within the canopy which causes rot and thus, decrease in the number of cotton balls per plant.

Conclusion

Results of this study has shown that higher cotton seed yield is reached when row spacing was placed at 80 cm apart, but further research is needed to confirm that yield plateaux is achieved at row spacing placed at intervals of 70 cm. Plant spacing within rows placed at 20 cm interval provided the highest cotton seed yield. Although significant interactions were not observed, the best cotton seed yield could be achieved through combining row spacing of 70-80 cm with plant spacing within rows placed 15 to 20 cm apart. Plant spacing within rows at 30 cm interval has provided the highest cotton balls per plant.

Recommendations

Some recommendations for the improvement of cotton seed yields include:

(i) Improvement of soil chemic and physic characteristics; phytosanitary control of pests and diseases; appropriate planting dates in order to overlap the cotton growth stage where moisture is most needed with the highest likelihood period that moisture in the soil is available;

(ii) Planting with high quality, vigorous and chemical coated/treated cotton seeds;

(iii) Adequate plant spacing and plant population which need to be properly adjusted to suit environmental conditions with emphasis to the prevailing rainfall pattern and relative humidity to avoid losses due to cotton balls rot; and

(iv) Crop uniformity through an even distribution of cotton seeds placed at adequate soil depth

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