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# Influence of Topping, Side Branch Pruning and Hill Spacing on Growth and Development of Cotton (*Gossypium barbadense* L.) in the Southern Guinea Savanna Location of Nigeria

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**Abstract**

Two field experiments were carried out at the Teaching and Research Farm, University of Agriculture, Makurdi, Nigeria, during 2000 and 2001 seasons on Pima S2 cotton cultivar, to study the effects of hill spacing of 30, 35 and 40cm (plant population) and plant growth alteration treatments i.e. topping, side branch pruning at 120cm height, topping + pruning at 100cm height, topping + pruning at 120cm height on some vegetative and fruiting habits, earliness and seed cotton yield and its components.

Generally the combined data clarified that wider hill spacing increased number of monopodia, main stem internodes, sympodia, additional fruiting branch bolls, retended bolls, fruiting sites, percentage of bolls on vegetative branches, open bolls, boll weight and seed cotton yield. While it decreased final plant height, number of aborted sites, days to first open boll, earliness percentage and number of unopen bolls. However, plant alteration treatments had a positive effect on most studied traits and reversely depressed number of monopodia, aborted sites and earliness percentage compared with the control. Within plant alteration treatments, there were significant divergences. The results indicated that topping plants at 120cm height increased number of retended bolls, fruiting sites, days to first open boll, open boll, unopen bolls and seed cotton yield. Side branch pruning at 120cm height increased final plant height, monopodia, main stem internodes, sympodia, earliness percentage and boll weight. Topping + pruning at 100cm height only decreased number of aborted sites. Topping + pruning at 120cm height increased additional fruiting branch bolls, percentage of bolls on vegetative branches, boll weight and seed cotton yield. Topping at 120cm height and 40cm hill spacing resulted in the highest number of retended bolls and seed cotton yield.

**Keywords:** cotton, Gossypium barbadense, hill spacing, topping, side branch pruning, Nigeria

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## 1 Introduction

Lodging in cotton plant is known to vary according to nature of varietal growth, nutritional and environmental conditions. In this respect, removing the terminal main stem bud (topping) and side pruning of branches are considered as important adjustment for plant geometry of cotton plants grown on fertile soils of high nitrogen rates whether under dense or low plant population to eliminate lodging. Hosny *et al.* (1995) reported that lint yield increased due to topping of cotton plants. Naguib *et al.* (1987) found that topping of Pima cotton at 15 days intervals (starting from mid July) decreased plant height and number of main stem nodes, increased boll set on top sympodia and caused additional branch nodes and bolls on top of fruiting branches. However, topping did not affect boll weight, lint yield and days to boll maturity, and was less effective when applied later in the season. El-Ganayni *et al.* (1984) found that topping at 15 days intervals later in the season produced the highest seed cotton yield while boll weight was not affected by topping. Roy *et al.* (1989) topped cotton plants after 45, 60 and 75 days from emergence at different plant populations. Their results indicated that one plant per hill at spacing of 60 x 30cm produced the highest seed cotton yield whereas the topping at 60 days produced the highest yield. The interaction effect showed that two plants per hill spaced 60 x 20cm and topped at 45 days gave the highest seed cotton yield whereas the lowest one was 89obtained by two plants per hill at spacing of 63 x 20cm and topped at 75 days after emergence.

Considerable data have been collected on the effects of fruit structure removal on growth and yield of cotton. Kennedy *et al.* (1991) indicated that prolonged removal of fruiting structures (i.e. flower buds or young bolls) increased plant size, plant height, number of sympodial branches and fruit set. Ahmed and Abdel-Al (1990) deflowered cotton plants cv. Giza 81 (leaving one flower every 2, 3, 4, 5 or 7 days) which showed positive response for plant height, number of inter-nodes and boll weight but negative response with number of open bolls and seed cotton yield per plant. The basal 3, 5 or 7 fruiting branches of cotton plants were removed at square stage by Gu Benkang *et al.* (1990) and forty days after treatment they found that the number of sympodia per plant gradually decreased in the three treatments compared with the control. However, seed cotton yield was increased particularly when 3 fruiting branches were removed. Also, the number of fruiting nodes was not affected, while the squares and young bolls shedding were decreased and boll number per plant was increased by the treatments. Kennedy *et al.* (1991) observed that removal of early squares delayed the initiation of fruiting and crop maturity whereas fruiting occurred more rapidly with prolonged fruiting period in the growing season. Thus, the effect of square removal on seed cotton yield was variable from year to year. Pettigrew (1994) applied partial fruit pruning and found 16% greater boll mass than the control. The objective of this study was to characterize the growth and development of the plants of cotton cultivar Pima - S2 topped and pruned at different plant populations; plant height and under higher nitrogen level of 200kg $ha^{-1}$ at Makurdi, Nigeria.

## 2 Materials and Methods

### 2.1 Experimental Design and Treatments

Two field experiments were conducted on Pima-S2 cotton cultivar (*Gossypium barbadense* L.) in 2000 and 2001 seasons at the Teaching and Research farm of the University of Agriculture, Makurdi, located at Lat. 7.41°N and long. 8.37°E and 97m above mean sea level. The location falls within the southern guinea savanna agroecological zone of Nigeria. The experiment was set up in split plot design with four replications. The main plots were assigned to plant population in the term of hill spacing, i.e. 30, 35 and 40cm, while the subplots were occupied with plant alteration treatments as: topping at 120cm height, side branch pruning when plants reached 120cm height; topping + side branch pruning when plants reached 100cm height, and topping + side branch pruning when plants reached 120cm height besides the control (normal plants). Topping as well as side branch pruning were made by hand cutting of the terminal bud of main stem and monopodia or squares of sympodia along the plant up to the determined height, respectively. The plot size was 38.25m$^2$, including 5 ridges 65cm apart and 5m long.

### 2.2 Cultural Practices

Four cotton seeds were sown per hill on 25$^{th}$ May 2000 and 1$^{st}$ June 2001. Calcium ammonium nitrate at 200kg $\mathrm{N}$ ha$^{-1}$ was applied split at 3 and 8 weeks after sowing. Boronated superphosphate at 140kg $\mathrm{P_2O_5}$ ha$^{-1}$ was added during land preparation without $\mathrm{K}$ fertilizer in order to create imbalanced fertilization which may induce more vegetative growth. Thinning to two seedlings per stand was done three weeks after sowing. The cotton plots were weeded manually twice before the second fertilizer application and at 50% of split boll. The plants were sprayed forthnightly with carbaryl (1-naphthyl methylcarbamate) insecticide at the rate of 1.1kg chemical per 225 litres of water per hectare starting from 9 weeks after sowing to minimize insect damage by bollworms, boll weevils, leaf rollers, stainers, grasshoppers and aphids.

### 2.3 Measurements

Ten guarded plants from the three inner ridges of each plot were randomly chosen at the end of the season to determine the following criteria:

(1) **Vegetative growth habits:** final plant height (cm); number of monopodia and number of main stem internodes per plant.

(2) **Fruiting growth habits:** number of sympodia, additional fruiting branch bolls, number of aborted sites, number of retended bolls (additional fruiting branches: bolls + opened + unopened bolls) and number of fruiting sites (aborted sites + bolls retended).

(3) **Earliness measurements:** days to first open boll; percentage of bolls on vegetative branches (number of bolls produced on fruiting branches arising from vegetative side branches, expressed as a percentage of total number of bolls produced) and earliness percentage $= \frac{\text{firstpicking}}{\text{first+secondpicking}\times 100}$

(4) **Seed yield and its components:** number of open bolls, number of unopen bolls; boll weight and seed cotton yield (t $ha^{-1}$).

The interaction effects between plant population and plant alteration treatments on the above mentioned traits were also studied.

### 2.4 Statistical analysis

All data collected were analysed statistically using the analysis of variance procedure described by STEEL and TORRIE (1980). The mean values were compared at the 5% level of significance (SNEDECOR and COCHRAN, 1967).

## 3 Results and Discussion

### 3.1 Influence of Plant Population (hill spacing)

Data presented in Tables 1 - 4 exhibited pronounced effect of plant population (hill spacing) on both vegetative and fruiting habits; earliness measurements and seed cotton yield and its components for the combined data. Final plant characteristics indicated that wide hill spacing significantly increased final plant height, number of monopodia, main stem internodes, sympodia additional fruiting branch bolls, retended bolls, fruiting sites, percentage of bolls on vegetative branches, number of open bolls, boll weight and seed cotton yield (t $ha^{-1}$). On the other hand, narrow hill spacing markedly increased number of aborted sites, days to first open boll, earliness percentage and number of unopen bolls. These results could be ascribed to the basis that dense stands (narrow hill spacing) increase between-plant and within-plant competition resulting to more susceptible plants with more demand for sunlight, water and nutrients. So, the end result of this competition is taller plants with more boll infestation and more shedding of reproductive forms and this is accompanied by the lack of boll formation and opening, predisposing it to delay in maturation and finally yield reduction. These results are in agreement to those obtained by GUTHRIE and MCCARTY (1993) and MAKRAM *et al.* (1994) for plant height, number of main stem internodes: NIKOLOV (1980) for number of monopodia; ABDEL-MALIK *et al.* (1995) for number of sympodia, number of bolls retended, aborted sites, fruiting sites, percentage of bolls on vegetative branches and earliness percentage and RISHA (1993) for number of open and unopen bolls, boll weight and seed cotton yield.

### 3.2 Influence of Plant Growth Alteration Treatment (Topping) and Side Branch Pruning

#### 3.2.1 Vegetative growth habits

The combined data presented in Table 1 showed that topping and side branch pruning had a highly significant effect on this group of characters. It is obvious that topping cotton plants at a certain height i.e. 100cm or 120cm ceased plant height up to this limit of growth. On the other hand, side branch pruning only enhanced cotton plants for growth continuity resulting in tallest plants with highest main stem node number followed descendingly by the control and both topping + side branch pruning at 120cm respectively. Number of monopodia was depressed as topping, side branch pruning or

**Table 1:** Effect of hill spacing and plant growth alteration treatments and their interaction on vegetative growth habits of Pima S2 cotton cultivar (combined data of 2000 and 2001 seasons).

| *Vegetative growth habits* | *Season* | *Plant Density (D) (hill spacing)* | | | *Plant growth alteration (A)* | | | | | D × A *interact.* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *30cm* | *35cm* | *40cm* | *Control* | *T* 120cm* | *SBP† 120cm* | *T+SBP 100cm* | *T+SBP 120cm* | |
| Final plant height (cm) | 2000 | 127.21 | 127.01 | 125.88b | 141.57b | 120.00c | 148.90a | 100.00d | 120.00c | * |
| | 2001 | 128.08 | 127.28 | 126.48b | 143.01b | 120.00c | 150.34a | 100.00d | 120.00c | ** |
| | comb. | 127.65 | 127.15 | 126.18b | 142.29b | 120.00c | 149.62a | 100.00d | 120.00c | ** |
| Number of monopodia | 2000 | 0.31c | 0.46b | 1.04a | 0.91a | 0.55c | 0.68b | 0.41e | 0.48d | ** |
| | 2001 | 0.37c | 0.60b | 1.37a | 1.09a | 0.73c | 0.84b | 0.57d | 0.68c | ** |
| | comb. | 0.34c | 0.53b | 1.21a | 1.00a | 0.64c | 0.76b | 0.49d | 0.58c | ** |
| Number of main stem internodes | 2000 | 24.54b | 24.54b | 25.94a | 27.57b | 23.57c | 29.34a | 21.01d | 23.57c | NS |
| | 2001 | 25.41b | 25.34b | 27.01a | 28.79b | 24.12c | 30.90a | 21.45d | 24.34c | NS |
| | comb. | 24.98b | 24.94b | 26.48a | 28.18b | 23.85c | 30.12a | 21.23d | 23.96c | NS |

* T 120cm: topping at 120cm height
† SBP 120cm: side branch pruning at 120cm height
**,* and NS indicate $P < 0.01, 0.05$ and not significant, respectively.
Means followed by the same letter are not significantly different at 0.05 level according to L.S.D. test.

both were applied compared with the control. Irrespective to the control, side branch pruning at 120cm had the highest monopodia while topping + side branch pruning at 100cm gained the lowest one leaving topping at 120cm height in between values. These results could be ascribed to the basis that topping cotton plants usually ultimates plant height at a specific or a required height bases on determining vertical growth as apical dominance is intercepted while fruiting capacity is enhanced, modifying plant geometry into cone shape. As side branch pruning was applied, plant geometry was also modified but into arrow-like shape, whereas the unpruned top sympodial branches (above 120cm height) grew vertically and horizontally up to the end of season. Similar results were obtained by Ahmed and Abdel-Al (1990) for plant height and main stem nodes and Kennedy *et al.* (1991) for plant size and plant height.

### 3.2.2 Fruiting growth habits

Results presented in Table 2 revealed that cotton plants pruned to plant growth alteration treatments significantly exceeded those of control plants concerning this group of traits except for number of aborted sites whereas the superiority was assigned to the check plants. Cotton plants exposed to side branch pruning significantly surpassed those of both topping + side branch pruning at 120cm and topping at 120cm and topping + side branch pruning at 100cm height in descending order. Concerning additional fruiting branch bolls which arise besides the principal or on the bottom of sympodial branches, were significantly higher on plants pruned to topping + side branch pruning at 120cm followed descendingly by those exposed to topping + side branch pruning at 100cm and topping at 120cm height. Cotton plants topped and pruned at 100cm height had the

**Table 2:** Effect of hill spacing and plant growth alteration treatments and their interaction on fruiting growth habits of Pima S2 cotton cultivar (combined data of 2000 and 2001 seasons).

| *Fruiting growth habits* | *Season* | *Plant Density (D) (hill spacing)* | | | *Plant growth alteration (A)* | | | | | D × A *interact.* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *30cm* | *35cm* | *40cm* | *Control* | *T* 120cm* | *SBP† 120cm* | *T+SBP 100cm* | *T+SBP 120cm* | |
| Number of sympodia | 2000 | 15.68c | 17.74b | 19.94a | 20.23b | 16.12c | 22.34a | 13.79d | 16.45c | NS |
| | 2001 | 16.41c | 18.34b | 20.94a | 21.45b | 16.79c | 23.57a | 14.12d | 16.90c | NS |
| | comb. | 16.05c | 18.04b | 20.44a | 20.84b | 16.46c | 22.96a | 13.96d | 16.68c | NS |
| Additional branch nodes | 2000 | 3.10c | 4.14b | 5.58a | 2.74e | 3.69d | 4.61c | 4.93b | 5.40a | NS |
| | 2001 | 3.28c | 4.29b | 5.79a | 2.93e | 3.84d | 4.80c | 5.09b | 5.60a | NS |
| | comb. | 3.19c | 4.22b | 5.69a | 2.84e | 3.77d | 4.71c | 5.01b | 5.50a | NS |
| Number of fruiting sites | 2000 | 47.15c | 51.32b | 59.95a | 52.47b | 56.70a | 52.34b | 49.30c | 53.22b | NS |
| | 2001 | 48.04c | 51.99b | 60.07a | 52.98b | 57.52a | 52.95b | 49.90c | 53.48b | NS |
| | comb. | 47.60c | 51.66b | 60.01a | 52.73b | 57.11a | 52.65b | 49.60c | 53.45b | NS |
| Number of aborted sites | 2000 | 12.74a | 12.47ab | 12.31b | 21.51a | 10.93b | 10.51b | 8.98c | 10.61b | NS |
| | 2001 | 13.28a | 12.68b | 12.88c | 21.34a | 11.23b | 10.68b | 9.12c | 10.68b | NS |
| | comb. | 13.01a | 12.58ab | 12.60b | 21.43a | 11.08b | 10.60b | 9.05c | 10.65b | NS |
| Number of retended bolls | 2000 | 33.32c | 36.73b | 44.08a | 30.23d | 44.10a | 39.24b | 37.41c | 39.23 | ** |
| | 2001 | 33.70c | 37.04b | 44.42a | 30.72d | 44.47a | 39.50b | 37.71c | 39.55 | ** |
| | comb. | 33.51c | 36.89b | 44.25a | 30.48d | 44.29a | 39.37b | 37.56c | 39.39 | ** |

* T 120cm: topping at 120cm height
† SBP 120cm: side branch pruning at 120cm height
**,* and NS indicate $P < 0.01, 0.05$ and not significant, respectively.
Means followed by the same letter are not significantly different at 0.05 level according to L.S.D. test.

highest aborted sites followed descendingly by topping at 120cm, side branch pruning at 120cm and topping + side branch pruning at 120cm.

Regarding number of retended bolls and fruiting sites, the superiority was valued for plants pruned to topping at 120cm followed by both side branch pruning at 120cm and topping + side branch pruning at 120cm and topping + side branch pruning at 100cm in descending order. From the above mentioned results, one of the most interesting observations was that the removal of the apical bud resulted in a large accumulation of assimilates in the root system, which suggests that there is an increase in the flow of nutrients to the sinks and consequently more assimilates towards the old fruits or for initiating new and additional fruits (El-Debaby *et al.*, 1995). Also, a combination of topping and pruning or pruning alone was probably involved including: better light penetration into plant canopy, increased air circulation among plants resulting in an improved $CO_2$ supply for photosynthesis (Waggoner and Moss, 1963), lower humidity, and a reduction in the amount of boll infestation on early set fruit (Bennett *et al.*, 1965). Such results were obtained by Kittock and Fry (1977) for boll set and additional branch bolls, by Kennedy *et al.* (1991) for number of sympodia and fruit set and Gu Benkang *et al.* (1990) for aborted sites and fruiting sites.

**Table 3:** Effect of hill spacing and plant growth alteration treatments and their interaction on earliness traits of Pima S2 cotton cultivar (combined data of 2000 and 2001 seasons).

| *Earliness traits* | *Season* | *Plant Density (D) (hill spacing)* | | | *Plant growth alteration (A)* | | | | | D × A *interact.* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *30cm* | *35cm* | *40cm* | *Control* | *T* 120cm* | *SBP† 120cm* | *T+SBP 100cm* | *T+SBP 120cm* | |
| Days to first open boll | 2000 | 124.4a | 123.5b | 123.1b | 126.4a | 123.5b | 123.0c | 122.3d | 123.0c | NS |
| | 2001 | 124.6a | 123.8b | 123.4b | 126.7b | 123.7b | 123.3c | 122.6a | 123.3c | NS |
| | comb. | 124.5a | 123.7b | 123.3b | 123.6b | 123.6b | 123.2c | 122.5d | 123.2c | NS |
| Percentage of bolls on vegetative branches | 2000 | 6.52c | 7.72b | 17.19a | 7.40d | 11.67b | 9.69c | 11.67b | 12.32a | ** |
| | 2001 | 6.86c | 8.00b | 17.98a | 7.82d | 12.16b | 9.99c | 11.94b | 12.68a | ** |
| | comb. | 6.69c | 7.86b | 17.59a | 7.61d | 11.92b | 9.84c | 11.81b | 12.50a | ** |
| Earliness percentage | 2000 | 70.95a | 69.26b | 60.92b | 73.21a | 64.96c | 67.36b | 66.53b | 63.52d | ** |
| | 2001 | 69.13a | 68.03a | 59.98b | 70.97a | 64.38c | 66.39b | 64.88c | 62.32d | ** |
| | comb. | 70.04a | 68.65a | 60.45b | 72.09a | 64.67c | 66.88b | 65.71c | 62.92e | ** |

* T 120cm: topping at 120cm height
† SBP 120cm: side branch pruning at 120cm height
**,* and NS indicate $P < 0.01, 0.05$ and not significant, respectively.
Means followed by the same letter are not significantly different at 0.05 level according to L.S.D. test.

**Table 4:** Effect of hill spacing and plant growth alteration treatments and their interaction on seed cotton yield and yield components of Pima S2 cotton cultivar (combined data of 2000 and 2001 seasons).

| *Fruiting growth habits* | *Season* | *Plant Density (D) (hill spacing)* | | | *Plant growth alteration (A)* | | | | | D × A *interact.* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *30cm* | *35cm* | *40cm* | *Control* | *T* 120cm* | *SBP† 120cm* | *T+SBP 100cm* | *T+SBP 120cm* | |
| Number of open bolls | 2000 | 17.62c | 22.55b | 30.99a | 20.79d | 26.92a | 23.99c | 21.40d | 25.49b | ** |
| | 2001 | 18.15c | 23.06b | 31.55a | 21.41d | 27.43a | 24.49c | 21.80d | 26.01b | ** |
| | comb. | 17.89c | 22.81b | 31.27a | 21.10d | 27.18a | 24.24c | 21.60d | 25.75b | ** |
| Number of unopen bolls | 2000 | 16.95a | 15.37b | 14.28b | 10.72d | 18.37a | 16.44b | 17.20b | 14.93c | ** |
| | 2001 | 16.75a | 15.17b | 14.13c | 10.61d | 18.22a | 16.20b | 16.99b | 14.73c | * |
| | comb. | 16.85a | 15.27b | 14.21b | 10.67d | 18.30a | 16.32b | 17.10b | 14.83c | * |
| Boll weight (g) | 2000 | 3.31b | 3.47a | 3.41a | 3.30b | 3.31b | 3.47a | 3.44a | 3.46a | ** |
| | 2001 | 3.38b | 3.54a | 3.50a | 3.38b | 3.40b | 3.53a | 3.52a | 3.53a | * |
| | comb. | 3.35b | 3.51a | 3.46a | 3.34b | 3.36b | 3.50a | 3.48a | 3.50a | * |
| Seed cotton yield ($t\ ha^{-1}$) | 2000 | 1.279c | 1.413b | 1.651a | 1.220d | 1.581ab | 1.500b | 1.341c | 1.595a | ** |
| | 2001 | 1.353c | 1.479b | 1.734a | 1.289d | 1.664a | 1.572b | 1.415c | 1.671a | ** |
| | comb. | 1.316c | 1.446b | 1.693a | 1.255d | 1.623a | 1.536b | 1.378c | 1.633a | ** |

* T 120cm: topping at 120cm height
† SBP 120cm: side branch pruning at 120cm height
**,* and NS indicate $P < 0.01, 0.05$ and not significant, respectively.
Means followed by the same letter are not significantly different at 0.05 level according to L.S.D. test.

### 3.2.3 Earliness measurements

In general, earliness measurements indicated by days to first open boll, percentage of bolls on vegetative branches and earliness percentage were significantly different with plant growth alteration treatments (Table 3). It is well noticed that the control plants were more late for opening of the first boll than the treated plants. Reversely, based on higher percentage of bolls on vegetative branches and lower earliness percentage, topped, pruned or both plants markedly tended to be later in maturation than the control plants. These results could be ascribed to the basis that altering plant growth with topping and pruning increased fruiting attributes (Table 2), so boll production period was prolonged although boll opening was accelerated. Bennett *et al.* (1965) found that topping did not affect days to boll maturity.

### 3.2.4 Seed cotton yield and its components

Data presented in Table 4 showed that altering plant growth by topping, pruning or its combination significantly increased seed cotton yield and some yield components compared with the control. Cotton plants topped at 120cm height alone surpassed those pruned at 120cm, topped + side branch pruning at 120cm height concerning number of open and unopen bolls per plants, while it had the lowest magnitude regarding boll weight. Cotton plants topped at 120cm or topped and pruned at 120cm height resulted in the highest seed cotton yield followed descendingly by those pruned at 120cm alone and topped + pruned at 100cm height. Such results could be explained on the basis that topping the apical bud of cotton plant particularly later in the season usually resulted in limited sympodial branches carrying more bolls on top ones which utilizes more assimilates. However, side branch pruning either alone or combined with topping lead to removing terminal squares of sympodia which may move excess flow of assimilates towards the remaining fruit forms that allow more and heavier bolls as well as it minimize boll infestation and maximize boll set. Such findings were obtained by Bennett *et al.* (1965) and Gu Benkang *et al.* (1990) for seed cotton yield; Ahmed and Abdel-Al (1990) for boll weight, but reversely with number of open bolls and yield, Gu Benkang *et al.* (1990) for number of open bolls, Pettigrew (1994) for boll weight.

### 3.2.5 Influence of the Interaction between plant population and plant growth alteration treatments

Data presented in Table 5 revealed noticeable effects for this factor on most traits studied except for number of main stem internodes, sympodia, additional fruiting branch boll, aborted sites, fruiting sites and days to first open boll per plant indicating the independent response of the later criteria for these factors. The remaining data could be summarized as follows:

(1) Pruning at 120cm height and 40cm hill spacing gave the highest plant height while lowest one was obtained with topping + side branch pruning at 100cm height for the three hill spacings used.

(2) The control plants of 40cm hill spacing gave the highest monopodia while the lowest one was gained with topping + side branch pruning at 100cm height and 30cm hill spacing.

**Table 5:** Means of some traits of Pima S2 cotton cultivar significantly affected by the interaction between hill spacing and plant growth alteration treatments (combined data of both 2000 and 2001 Seasons).

| *Hill Spacing* | *Control* | *T 120cm** | *SBP 120cm†* | *T+SBP 100cm* | *T+SBP 120cm* |
|---|---|---|---|---|---|
| | | | *Final plant height* | | |
| 30cm | 144.34b | 120.00d | 150.85a | 100.00a | 120.00d |
| 35cm | 141.68c | 120.00d | 146.18b | 100.00a | 120.00d |
| 40cm | 140.84c | 120.00d | 151.85a | 100.00a | 120.00d |
| | | | *Number of monopodia* | | |
| 30cm | 0.38gh | 0.33gh | 0.41fg | 0.25h | 0.35gh |
| 35cm | 0.66de | 0.49fg | 0.58ef | 0.45fg | 0.50fg |
| 40cm | 1.96a | 1.11c | 1.29b | 0.78de | 0.90cd |
| | | | *Number of retended bolls* | | |
| 30cm | 24.23j | 39.81d | 34.78g | 32.76h | 36.00fg |
| 35cm | 27.66i | 42.90c | 37.81e | 37.76ef | 38.31de |
| 40cm | 39.55de | 50.14a | 45.53b | 42.16c | 43.88bc |
| | | | *Percentage of bolls on vegetative branches* | | |
| 30cm | 5.11i | 7.47f | 5.72h | 7.65f | 7.87f |
| 35cm | 6.43g | 8.90e | 7.27f | 7.90f | 9.17e |
| 40cm | 11.30d | 19.37b | 16.54c | 19.87a | 20.47a |
| | | | *Earliness percentage* | | |
| 30cm | 74.10a | 67.22ef | 69.97cd | 71.92bc | 67.22ef |
| 35cm | 73.13ab | 66.97f | 68.80de | 68.07ef | 66.60f |
| 40cm | 69.00de | 59.79h | 61.77g | 57.09i | 54.92j |
| | | | *Number of open bolls* | | |
| 30cm | 14.49m | 19.87ij | 17.97 | 16.57l | 20.54hi |
| 35cm | 18.39jk | 25.77de | 23.52 | 22.17gh | 24.22ef |
| 40cm | 30.44c | 35.90a | 31.24 | 26.27d | 32.50b |
| | | | *Number of unopen bolls* | | |
| 30cm | 11.07ef | 21.14a | 18.00bc | 17.38bc | 16.65cd |
| 35cm | 10.47f | 18.32b | 15.48d | 16.82bcd | 15.29d |
| 40cm | 10.47f | 15.43d | 15.49d | 17.07bc | 12.57e |
| | | | *Boll weight (g)* | | |
| 30cm | 3.20e | 3.22e | 3.40d | 3.44cd | 3.47bcd |
| 35cm | 3.42d | 3.44cd | 3.65a | 3.50bc | 3.54b |
| 40cm | 3.40d | 3.42d | 3.45cd | 3.52bc | 3.48bcd |
| | | | *Seed cotton yield (t* $ha^{-1}$*)* | | |
| 30cm | 1.009i | 1.380fg | 1.349fg | 1.263gh | 1.577cde |
| 35cm | 1.132h | 1.580cd | 1.569cde | 1.403f | 1.548de |
| 40cm | 1.622cd | 1.908a | 1.690bc | 1.469ef | 1.775b |

* T 120cm: topping at 120cm height; † SBP 120cm: side branch pruning at 120cm height
Means followed by the same letter are not significantly different at 0.05 level according to L.S.D. test.

(3) Topping plants at 120cm height and 40cm hill spacing resulted in the highest number of retended bolls, open bolls and seed cotton yield while the lowest ones were obtained with control plants and 30cm hill spacing.

(4) Topped and pruned plants at 120cm height and 40cm hill spacing produced the highest percentage of bolls on vegetative branches while the lowest one was obtained with the control plants and 30cm hill spacing.

(5) Control plants and 30cm hill spacing gave the highest earliness percentage while the lowest one was obtained with topping + side branch pruning at 120cm height and 40cm hill spacing.

(6) Cotton plants topped at 120cm height and 30cm hill spacing induced the highest number of open bolls while the lowest one resulted from the control plants and 30cm hill spacing.

(7) Pruned plants at 120cm height and 35cm hill spacing gave the highest boll weight while the lowest one was obtained with the control plants and 30cm hill spacing.

Roy *et al.* (1989) observed that the interaction effect of two plants per hill having spacing 60 x 20cm and topping at 45 days gave the highest seed cotton yield whereas the lowest one was obtained by two plants per hill having spacing 63 x 20cm and topping at 75 days after emergence.

## 4 Conclusions

The study has demonstrated that wider hill spacing and plant alteration treatments had beneficial influence on some vegetative and fruiting growth habits, seed cotton yield and its component. Topping at 120cm height increased the number of fruiting sites and retended bolls. Hill spacing of 40cm reduced final plant height but increased number of fruiting sites, retended bolls and seed cotton yield. Topping at 120cm height and 40cm hill spacing gave the highest number of open bolls, retended bolls and highest seed cotton yield.

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