Effect of method of planting and crop geometry on productivity of rainfed upland cotton (*Gossypium hirsutum*) grown in lowland rice (*Oryza sativa*) fallows

R.K. SARKAR AND G.C. MALIK

Department of Agronomy, Institute of Agricultural Science, Calcutta University, Kolkata, West Bengal 700 019

Received: February 2003

**ABSTRACT**

A field experiment was conducted during late winter (*rabi*) season of 1998–99 and 1999–2000 at Nimpith, to study the effect of planting method and crop geometry on productivity of rainfed upland cotton (*Gossypium hirsutum* L.) in lowland rice fallows. Transplanting of cotton performed better than direct sowing when the crop was sown during the second fortnight of December after harvest of winter rice (*Oryza sativa* L.). Transplanting of cotton improved the growth, yield attributes, and gave 16.5 and 12.7% higher seed-cotton and lint yield, respectively, compared to direct seeding of cotton. Transplanting of cotton increased net returns and per day productivity by 22.5 and 16.9%, respectively, over the direct seeding. Crop geometry showed significant impact on productivity of cotton. Intermediate inter-row spacing of 60 cm gave higher values of growth and yield attributes and recorded 7.9 and 11.1% higher seed-cotton yield over both the narrower and wider inter-row spacing of 45 cm and 75 cm respectively. Similarly, intermediate plant-to-plant spacing of 45 cm improved the growth and yield attributes and yield of cotton; and resulted in higher seed-cotton yield by 5.6 and 18.9% over the narrower and wider spacing of 30 and 60 cm respectively. Intermediate inter- and intra-row spacing of 60 and 45 cm, respectively, proved most beneficial for cotton cultivation in terms of monetary returns as well.

**Key words**: *Gossypium hirsutum*, Transplanting, Upland cotton, Rice-fallow, Crop geometry, Crop establishment method

The coastal alluvial land of West Bengal is typically a monocropped tract where a single crop of long duration traditional rainfed aman (photoperiodically season bound) rice is grown in lowlying lands from June-July to November-December every year. Majority of these lands remain fallow for 6 to 7 months, i.e. till the next rice crop in the following year, due to a large number of agro-economic factors. There is acute shortage of irrigation facilities in this area. However, recently attempts are being made to explore the possibilities of utilizing such vast rice fallow lands for growing a second crop. Cotton being a deep-rooted and drought-tolerant crop, growing of cotton in rice fallows, may be possible as this crop has an inherent capacity to draw moisture from the receding moisture regime, from deeper zones with the help of its long tap root-system (Grimes and El-Zik, 1990). Moreover, cotton being a fairly salt-tolerant crop (Fageria et al., 1991), it is likely to be more adaptable in coastal lands where soil salinity may pose a problem for the salt-susceptible crops. However, late harvest of rice and late receding of water from low lying rice fields, do not permit timely sowing of cotton crop in rice fallows. Under such situations, transplanting may increase the yield and also mitigate the ill-effects and compensate the yield of delayed sowing.

To exploit yield potential of cotton under given set of environmental complexes, determination of optimum crop geometry is an important consideration for successful introduction and production of cotton. Planting geometry of cotton influences dry-matter production and also nutrient uptake (Wali and Koraddi, 1990) and, thereby, affects the yield of cotton. Manipulation of plant spacing between and within rows plays a significant role in boosting up of the crop yield (Virk et al., 1984). With a view to examine critically to achieve maximum yield under the above-referred to situation, the present experiment was planned.

**MATERIALS AND METHODS**

The field experiment was conducted during late winter (*rabi*) season of 1998–99 and 1999–2000 at Krishit Vigyan Kendra, Ramkrishna Ashram, Nimpith, West Bengal, on coastal alluvial land having 0.86% organic carbon, 22 kg/ha available P and 260 kg/ha available K, pH 7.5 and electrical conductivity 4.0 dS/m. Treatments comprising 2 planting methods, viz. direct sowing and transplanting, in the main plots, 3 inter-row spacings, viz. 45 cm, 60 cm and 75 cm in the sub-plots, 3 intra-row spacings, viz. 30...
cm, 45 cm and 60 cm in sub-subplots, were tried in split-plot design replicated thrice. Cotton variety 'LRA 5166' was used. In transplanting method, cotton seedlings were raised in polythene packets of 75 cm diameter and 15 cm length made up of 150 gauge thick polythene tubes. The polythene packets were filled up with pot mixture composed of organic and inorganic fertilizers. Two pre-germinated seeds were dibbled in polythene packets at a depth of 3–4 cm in pot mixture during the third week of November.

Water was applied at an interval of 4–5 days by garden-can for germination and emergence of the seedlings. The seedlings thus raised in polythene packets when became 4 weeks old were transplanted in furrows opened at a depth of 7–8 cm with desired planting design. The polythene bags at transplanting were given a cut across the length in any one side and at the bottom of the polythene packets by means of a sharp blade. Both direct sowing and transplanting were done in the third week of December during both the years.

Uniform dose of 80 kg N, 40 kg P₂O₅ and 20 kg K₂O/ha was applied to the crop. Two-thirds dose of N was applied as basal and remaining N was top-dressed at square-formation stage. In transplanting, all the fertilizers were applied in furrows. The total rains received during the crop period was 543 and 650 mm in 1998–99 and 1999–2000 respectively. The crop was harvested by picking bolls 5–6 times within June every year before the onset of full monsoon. Since error variances for growth, yield parameters and yield of respective treatments during 2 years were found homogeneous and, therefore, pooling of data was done.

### RESULTS AND DISCUSSION

#### Planting method

The transplanting of cotton seedling increased the plant height, dry-matter production/ha compared to direct sowing. Transplanting with 30 days old seedlings appreciably and significantly increased sympodia/plant (Table 1) over direct sowing. The difference in seed cotton and lint yields (Table 2) were found significant due to methods of planting. Transplanting method proved significantly superior to direct sowing in increasing yield of cotton. Transplanting increased the seed-cotton and lint yield by 16.5 and 12.7%, respectively, over direct sowing on pooled basis. The higher yield under transplanting method was attributable to more bolls/plant, boll weight/plant, owing to early and enhanced vegetative growth and eventually more fruiting points of transplanted seedlings. Similar results were also reported by Pundarikashuddu et al. (1992) and these results establish the superiority of adopting transplanting as technically sound and economically feasible, practical approach for growing cotton during the winter season in fields vacated by harvest of rice grown in flooded land.

#### Inter-row spacing

Inter-row spacing showed pronounced effect on growth and yield attributes and yield of cotton, irrespective of the planting method. Intermediate inter-row spacing of 60 cm showed appreciable and significant improvement in growth, ancillary characters (Table 1) of yield of cotton compared with narrower and wider inter-row spacings of 45 cm and 75 cm respectively. Wide inter-row spacing caused a depressive effect on dry-matter production (Table 1). Reduction in dry matter under wider in-
ter-row spacing was attributable to inefficient use of solar radiation because under wider spacing much of radiation may even be wasted by falling on ground during major part of growing period. Wider inter-row spacing decreased plant density which might have resulted in reduction of dry matter/ha. Intermediate inter-row spacing of 60 cm increased the seed-cotton yield by 7.9 and 11.1% over narrower, inter-row spacing of 45 cm and wider inter-row spacing of 75 cm respectively. Such an increase in seed-cotton yield with intermediate inter-row spacing is attributed to balancing of plant row spacing, leading to efficient interception of solar radiation and hence the resultant greater bolls and weight of boll/plant. The increase in lint yield at 60 cm over 45 cm and 75 cm inter-row spacing was 13.5 and 9.0%, respectively, owing to increased seed-cotton yield under intermediate inter-row spacing. The closer inter-row spacing of 45 cm resulted in greater competition leading to lowered yield attributes. While the wider inter-row spacing of 75 cm failed to compensate the loss in yield due to lower plant population. The results thus indicate that a plant of intermediate growth habit of this type of cultivar of cotton, is likely to be benefitted more by moderately closer spacing as this encourages the fullest and efficient interception of solar radiation and utilization of soil nutrients, moisture and space.

Intra-row spacing

Growth and ancillary growth and yield attributes of cotton were appreciably and significantly affected by different intra-row spacings (Table 1). Intermediate intra-row spacing of 45 cm improved growth and yield attributes of cotton over closer and wider intra-row spacing of 30 and 60 cm respectively. The reduction in dry matter/ha of cotton under wider intra-row spacing of 60 cm may be ascribed to comparatively poor growth and development of individual plants owing to inefficient use of solar radiation, and decreased plant density. Intermediate intra-row spacing of 45 cm gave significantly higher seed-cotton and lint yield compared with the closer and wider intra-row spacing of 30 cm and 60 cm respectively (Table 2). The increase in seed-cotton yield with intermediate intra-row spacing of 45 cm was 5.2 and 18.9% respectively. Such an increase in yield with intermediate intra-row spacing was attributed to improvement in ancillary characters/plant of cotton (Table 1) owing to optimum utilization of space, soil and environmental resources available for the individual plant coupled with optimization of population stand. Reduction in yield with closer intra-row spacing of 30 cm may be ascribed to comparatively poor growth and sub-optimal expression and development of yield attributes, due to greater intra-plant competition for growth resources. The yield of cotton decreased significantly with wider intra-row spacing of 60 cm over closer and intermediate intra-row spacing due to lesser number and weight of bolls/plant as well as lower plant population per unit area. The widely spaced plants probably could not utilize fully the available moisture and nutrients from the inter-vening large gaps between the hills. Tomar et al. (2000) reported lower cotton yield at relatively wide plant spacing.

Interaction effect

The interaction effect on seed cotton and lint yield between planting methods, inter-row and intra-row spacings was significant (Table 2). Transplanting of cotton at closer inter-row spacing of 45 cm with intermediate intra-row
spacing of 45 cm gave the maximum seed-cotton yield (25.2 q/ha) over remaining combinations of planting method and inter-row and intra-row spacings. Transplanting at wider inter-row spacing of 75 cm or intermediate inter-row spacing of 60 cm, both with only intermediate intra-row spacing of 45 cm being at par increased lint yield over other combination of planting method and inter-row and intra-row spacings. This indicates that transplanting of cotton with optimum spacing results in higher productivity owing to early establishment and better growth of the crop with efficient utilization of growth resources.

Economics

Transplanting of cotton led to incurring of higher cost of cultivation than direct seeding (Table 2). Raising seedlings in polythene tubes and transplanting in main field increased the cost of cultivation, raising the seedlings and transplanting were labour-intensive. Transplanting system of cotton, however, still gave higher net returns, and per day productivity, than the direct-seeded cotton (Table 2). This was made possible due to higher income from the transplanted cotton despite slightly higher costs of cultivation.

Planting cotton in intermediate inter-row spacing of 60 cm appeared to be more remunerative with the highest net returns (Rs 16,900/ha) and per day productivity (Rs 187/day/ha) compared with those obtained under the narrower and wider inter-row spacing of 45 cm and 75 cm respectively.

Similarly, planting cotton in intermediate intra-row spacing of 45 cm gave the highest net returns (Rs 17,500/ha), and per day productivity (Rs 190/day/ha) compared with narrower (30 cm) and wider (60 cm) intra-row spacing. Relatively higher yields of cotton raised with intermediate inter-row and intra-row spacing resulted in higher monetary returns over closer and wider spacings.

It was concluded that for growing cotton successfully and to realise better returns from cotton on the lowlands coming after rice, it may be advisable to grow cotton with inter-and intra-row spacing of 60 cm x 45 cm and hence it is recommended that it may be practiced for higher productivity and profit in cotton production on these lowlying coastal land of West Bengal.

REFERENCES


