Vishal Nath, Sanjay Kumar Singh*,
Jyoti Singh and S D Pandey

Doubling productivity of litchi through hedge row system of planting

Doubling the productivity of litchi by employing knowledge of plant geometry, row orientation, canopy architecture management and good agricultural practices along with integration of mechanization to harness the abundance of solar radiation in effective fruit producing canopy in litchi production zone has demonstrated higher yield over normal spacing. The new technology of hedge row planting system in rectangular pattern at spacing of 8 × 4 m has been able to double the productivity in litchi plants. In this technology, each plant requires an area of 32 m² instead of 64 m² under conventional square system (8 × 8 m). With the orientation of rows from east to west and developing stereo fruiting by enabling canopy architecture through open centre pruning to harness the maximum photo-synthetically active radiation (PAR) on both sides of the hedge-row, it virtually creates four fruiting surfaces. This technology has enabled an experimental yield of 20.33 MT/ha in comparison to 8-9 MT/ha under traditional system of planting.

LITCHI (*Litchi chinensis* Sonn.) is commonly known as *Queen of fruits,* and belongs to family Sapindaceae. Due to its attractive colour and fragrant juicy aril, it is one of the most popular table fruit liked by every age group of the society. Litchi is crop of Chinese origin but occupies substantial area in India with annual production of more than 7.0 lakh tonnes from an area of about 1.0 lakh ha. The average productivity of litchi in the India varies from 7-10 tonnes per ha mainly due to widely-spaced plantations (8 × 8 m or 10 × 10 m in square system of planting) and unscientific management of orchards. With continuous rise in population there is continuous rise in pressure on cultivable land to be expanded for litchi orchard and it is very difficult to put additional area under litchi orcharding.

To fulfil the increasing demand, it is necessary to produce more fruits per unit area. High density planting with appropriate planting system has played a crucial role in enhancing orchard productivity in many crops. Litchi trees are wide canopied evergreen crop; they are usually planted in a square system at spacing of 8-10 m apart. However, in high density planting, the spacing of 5 m × 5 m and above is also followed. The light penetration and distribution is affected at later stage if proper canopy is not managed and plants overcrowd, resulting in reduced yield and quality. To increase the litchi production and optimize fruit quality, it is very important to choose the correct planting system and optimum plant spacing to obtain good light interception and to exploit photosynthetic area. This combination tends to increase profitability by improving yield and fruit quality. By changing the geometry from square (5 × 5 m or 6 × 6 m) to rectangular hedge row (8 × 4 m or 6 × 4 m) system of planting, the higher productivity can be ensured up to 100% and 50% more in comparison to traditional planting system, by reducing 4-10% land area on per tree basis with better interception of light (under and above canopy), as seen in the result obtained at ICAR-NRC on Litchi, Muzaffarpur, Bihar. Thus, the

Pruning for canopy architecture

Flowering and bearing in hedge row (6 m × 4 m) system of planting

Bearing of fruits in litchi planted at 8 m × 4 m

new technology of hedge row planting under rectangular system accommodates more plants per unit area, gives more yield and better quality than square system practiced traditionally in major litchi growing areas. Hedge row system of planting also allows more interception and uniformity in distribution of light on most of the arboreal branches, i.e. under and above canopy. This permits easy cultural operation in the orchard. Rather due to this system of planting, only inclined sunlight fall on most of the branches during 11.00-14.00 hrs when PAR valued crosses >800 nm (it would have caused photo oxidation of chlorophyll, that led to reduction in yield. As in this system, the direct sunlight falling in morning (8.00-11.00 hrs and 14.00-17.00 hrs) on rows and at side branches, it is better for photosynthesis (as maximum intensity of red and blue wave length). In this system of planting, the light falling on floor of the orchard/or on side branches, during morning and in the afternoon hours, leads to reduced [canopy] humidity, partial soil solarisation and overall reduction in built up of insect pests and diseases which ultimately curtails the total input cost on plant protection measures.

Technique

The orchard layout should aim to accommodate maximum number of trees per hectare, adequate space for proper canopy development and ensuring convenience in cultural practices of the orchard. In rectangular system, trees are planted on each corner of a rectangle in single hedge row and the distance between any two rows is more than the distance between any two trees in a row. The wider row spaces permit easy intercultural and mechanical operations. The orientation of rows from east to west enables to harness maximum photosynthetically active radiation (PAR) (600–800 nm) which exist between 8.00 to 11.00 hrs and 15.00 to 17.00 hrs when the sun has an appropriate angle with row length and the canopy receive maximum PAR.

The status of rows and trees over the years needs to be maintained through proper annual pruning and clearing the duct and centre spaces of plants every year after harvesting. For this, the tree frame needs to be developed on two primaries orienting towards wide space and subsequent secondary and tertiary branches may be allowed. In litchi, hedge row (rectangular system) planted at 8 m × 4 m and 6 m × 4 m in litchi cultivar '*Shahi*' at ICAR-NRCL, Muzaffarpur produces significantly superior yield per hectare than traditionally planted orchard (in square system) at 8 m × 8 m. Quality of fruits has also been found better in hedge row (in rectangular system) planted at 8 m × 4 m and 6 m × 4 m than square system due to higher light interception (below and above part of canopy), moisture retention near root zone (due to shade during mid day hrs) and air circulation between duct

Fruiting in hedge row (6 m × 4 m) system of planting

Hedge row system of planting at 8 m × 4 m

Table 1. Performance of litchi in different plant geometry

Planting system	No. of plant/ ha	Space allocation per plant (m^2)	Yield (kg/ tree)	Yield (tonnes/ha)	TSS (°B)	Titratable acidity (%)
6 × 4 m (Rectangular system)	417	24	33.38	15.87	20.86	0.77
8 × 4 m (Rectangular system)	312	32	42.35	20.33	21.17	0.64
8 × 8 m (Square system)	157	64	50.05	8.22	20.19	0.73

Fruit quality in tree spaced at 8 m × 4 m in hedge row system

spaces in rectangular system. In grown up plants of 8 m × 8 m, the full tree canopy get light for photosynthesis during Mid-day when the wavelength of radiation crosses over 800 nm (effective PAR is 600-800 nm) and the photosynthetic efficiency of the plant reduced. At the same time when the sun is vertical, only outer surface of the plant canopy received light and inner canopy remains in shade and not able to contribute efficiently for light harvesting and performance of the plant declines.

Canopy management in rectangular system

The training and pruning are important techniques for development of canopy, ideal trees and to get higher yield. Selection of two branches with wider crotch angle orienting towards north and south at 50-60 cm above ground with clear and vertical stem which will later develop into main trunk of tree is necessary. Allowing secondary (two on each primary) and tertiary (two on each secondary) will make skeleton frame of eight branches with open centre of nearly 'V' or 'Y' shaped on which whole canopy of tree develops. Hedging and centre opening should be done (during July and August) regularly in rectangular system. Open-centre system of litchi plant helps in the development of low spreading tree canopy. This also allows maximum light penetration, and uniform distribution of fruit and fruit colour. While opening up the canopy, the care is to be taken to make a balanced and healthy canopy by removing all unwanted, dried and diseased branches which generally do not contribute to yield.

Conclusion

To produce higher yield and quality fruits in litchi from less area, the hedge row planting system has been identified as important option for litchi orchardists. In our investigation the hedge row system of planting at 8 m × 4 m (row × plant) occupying 32 m^2 land space produced a yield of 20.33 tonnes per ha, with better quality fruits after 17 years of orchard establishment of litchi cv. *Shahi*. Therefore for litchi, the rectangular system of planting with spacing of 8 m × 4 m under hedge row system is best for the farmers to harvest higher yield of 18-20 tonnes per ha against 8-10 tonnes per ha in normal square system of planting (i.e. 8 × 8 m or 10 × 10 m).

For further interaction, please write to:
Sanjay Kumar Singh (Senior Scientist), ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar 842 002. *Corresponding author's email: sanjay.singh3@icar.gov.in; sanjayhor@rediffmail.com