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Research Note :

HIGH DENSITY PLANTING IN FRUIT CROPS

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ABSTRACT : High density orcharding is one of the recent novel concepts of increasing productivity without affecting quality of fruits. It gives earlier production and return per unit area, shortens juvenility provides efficient resources. Dwarfing root stocks play key role to accommodate more number of plants per unit area. Under HDP has been found most suitable technique for some tropical and subtropical fruits accomodating more number of plants per unit area *viz.,* Dashehari mango (1333 plants/ha), guava (5000 plants/ha), papaya (6400 plants/ha), etc.

Keywords : *Fruit crops, high density planting, dwarfing root stock, interstock, canopy.*

The high density planting (HDP) in fruit crops is one of the recent novel concepts of increasing the productivity without affecting the quality of fruits. India is the largest producer of fruits in the world after China. The average productivity and per capita availability of fruits in India is, however, low as compared to many developed countries. The main reasons for low productivity are old and senile orchards, wider spacing, low yielding varieties, poor orchard management and inadequate technological up-gradation and adoption by the growers. Presently, the continuing decline in the availability of cultivable land, rising energy and land costs together with the increased demand of fruit and fruit products, have given thrust to the concept of high density planting (HDP) in fruit crops. High density planting gives earlier production and return per unit area, shortens juvenility, eco-friendly, provides efficient land use and better use of resources like light, water and fertilizers, efficient pesticides application, besides, in this system the harvesting becomes easy. Among the factors such as cultivar, rootstock, quality of planting material and cultivation practices contribute to high yield of fruit trees, however, the number of trees-1 is the most important factor which brings about radical increase in fruit production. Therefore, high density planting has great potential for increasing productivity in fruit crops (Mishra *et al.,* 5). The success of this technology in most of the fruit crops is dependent on the use of methods to control shoot growth and maximize light interception as the trees begin to bear fruit (Menzel and Lagadec, 4). The main aim of HDP is to achieve the twin requisites of productivity by maintaining a balance between vegetative and reproductive growth without impairing the plant health and fruit quality. The underlying principle of HDP is to make the best use of vertical and horizontal space per unit time and to harness maximum possible return per unit of inputs and natural resources.

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The conceptual background of high density planting in fruit growing was pioneered in temperate fruits and first planted at the end of the nineteen sixties, since then there is rise in establishment of commercial high density orchards throughout the world. HDP system is normally understood as a system in which a higher number of plants are accommodated per unit area in comparison to the conventional planting density. However, the exact limit of plant density to be termed as HDP is not yet well defined. It varies with growing region, species, variety, rootstock, agro-techniques adopted for a particular crop and return from the orchard. In India, high density plantings have successfully been demonstrated in guava (Lal *et al.,* 3), litchi (Mishra *et al.,* 6), mango and papaya (Ram, 10)

Advantages of HDP

- ✓ It induces the precocity
- ✓ Enhanced fruit yield and quality
- ✓ Low cost per unit production
- ✓ Enables mechanization in fruit crops
- ✓ Efficient use of applied and natural resources

Disadvantages of HDP

- ✓ In long run, it results in heavy competition for space, nutrients and water.
- ✓ Overcrowded growth of canopy results in buildup of high humidity, reduced cross ventilation in the orchard, which are conducive for more incidence of pests and diseases.
- ✓ The trees in close plantings soon begin to crowd each other and yields decline
- ✓ Efforts to breed dwarfing rootstocks that can control the growth of mature trees have been largely unsuccessful.
- ✓ Effective canopy management appears to be the largest barrier to success of high density orchards.
- ✓ For restriction of growth in high density orchards growth retardants are used. There are reports that some of the growth regulators persisting in the harvested fruit and soil (Menzel and Lagadec, 4).
- ✓ Reduced fruit size and quality.

Status of high density orcharding in fruit crops

There has been much talk about the potential of high density orcharding in fruit crops, but few studies demonstrated the long-term economic benefits (Ram, 10). In some of the cases, yield was declined after few years as trees began to crowd each other. The high-density orchard provides several times (8-9) higher yields than the traditional densities as demonstrated by Ram (10) in alternate bearing Dashehari mango in north India. Dashehari mango at 2.5 m $\times$ 3 m (1,333 plants ha^{-1}) was raised under HDP with pruning and dehorning after the harvesting followed by paclobutrazol application and yield was secured every year. In an experiment at CISH, Lucknow, ultra high density system of planting in guava was standardized. The ultra high density orchard system of guava accommodates 5000 plants ha^{-1}, at a spacing of 2.0 $\times$ 1.0m and managed with regular topping and hedging during initial stages which helped in controlling tree size and getting higher yield. Pusa Nanha papaya may be planted at a distance of 1.25 $\times$ 1.25 m (6,400 plants ha^{-1}). Similar observations have been made by various workers in citrus, litchi, banana and pineapple.

Approaches for establishing high density orchards

HDP can be achieved with the suitable use of following components, they are (a) Dwarf scion varieties, (b) Dwarfing rootstocks and inter-stocks, (c) Training and pruning, (d) Use of growth regulators and (e) Suitable crop management practices. These components are harnessed in HDP which helps in attaining the goal of high yield and quality.

Use of genetically dwarf scion varieties

It is easier to establish high density orchards if the trees are naturally small. Use of genetically dwarf cultivar offers great scope for close plantings, which have the potential for higher yields and returns than traditional plantings. However, availability of dwarfing scion cultivars are meager as indicated below :

Crop	Dwarf cultivar	Desirable characters
Banana	Dwarf Cavendish	Dwarf stature with high yield
Guava	Pant Prabhat	Less spreading and high yielder
Litchi	Calcuttia, China	Upright tree growth habit
Mango	Amrapali, Arunika	Precocious and regular bearer
Papaya	Pusa Dwarf, Pusa Nanha	Bears at lower height
Sapota	PKM-1, PKM-3	Dwarf stature

Use of dwarfing root stocks

Root stocks are known to have a profound effect on the tree vigour, precocity, productivity, quality of fruits and longevity of varieties grafted on them. Dwarfing can be due to the rootstock or the scion, or both. Attempts have made to standardize dwarfing rootstocks especially in the fruit crops like ber, citrus and grape. However, much choice is not available for most of the tropical and subtropical fruit crops in comparison to the temperate fruits. Use of graft incompatible scion and rootstock induces dwarfness in the composite plant. As in case ber, if scion cultivars grafted on to the *Zizyphus rotundifolia, Z. nummularia* dwarfness may be induced due to graft incompatibility.

Crop	Dwarfing rootstocks
Ber	*Zizyphus rotundifolia, Z. nummularia*
Citrus	Troyer citrange, Flying Dragon (*Poncirus trifoliata*), Karna Khatta
Guava	*Psidium friedrchsthalianum*, *P.chinensis*, Pusa Srijan
Mango	Vellaikullamban

Use of pruning to control tree growth

Overcrowding poses a serious problem for orchard access and for adequate light interception needed for optimum photosynthesis, flowering and fruit set and quality. Attempts have been made by various workers on the use of pruning for canopy management in high density orchards (Sharma and Singh, 9; Mishra and Lal, 7; Nath *et al.,* 8). Pruning and production of new shoot was found essential to maintain continuity of vigour and to provide terminal bud for panicle emergence in Dahehari mango at Pantnagar. Pruning can be used to increase the distribution of light through the canopy, although productivity is not always restored in the same season. For instance, heavy pruning of 34 year old avocado trees inhibited production for the following two to three years (Crane *et al.,* 1).

Use of growth regulators to control tree growth

Pruning often leads to strong re-growth of shoots in mango and other fruit crops. Plant growth regulators such as Paclobutrazol, Alar, Uniconazole, prohexa-dione-calcium have been used to restrict vegetative growth. Of these Paclobutrazol treatments in mango at Pantnagar induced flowering and fruiting in new shoots produced in July after pruning without any loss in fruit quality. September to November treatment was highly effective in increasing flowering and fruiting besides reducing vegetative growth (30-35%). Thus, paclobutr-azol treatments induced flowering and fruiting and helped in reducing the vegetative growth required for high density orcharding. However, uniconazole was more effective for restricting shoot growth than paclobutrazol in avocado in South Africa (Kohne and Kremer-kohne, 2). Prohexadione-calcium sprays on five year old 'Hass' avocado trees reduced the growth of spring shoots compared with the growth achieved in control, but did not affect yield (Menzel and Lagadec, 4).

Use of new planting systems

No systematic research has been conducted to develop tree forms and planting designs for improved yield, fruit quality and profitability in tropical and subtropical fruit crops. Early production of high quality fruit and its sustainability in long run is an important factor determining the profitability of an orchard. Hence under these situations, standardization of planting system following high density principle for accommo-dating more number of plants per unit area is essential to enhance productivity without any compromise with fruit quality. High density planting systems has been successfully demonstrated for earliness, improved yield, smooth handling and cultural practices using double hedge row system of planting in litchi (Mishra *et al.,* 6), mango (Singh *et al.,* 11, Nath *et al.,* 8), aonla (Singh *et al.,* 12) and guava (Lal *et al.,* 3, Singh *et al.,* 13). Moreover, by manipulating plant spacing using different planting systems like hedge row, double hedge row, paired planting and cluster planting proved to be an important tool to achieve high quality produce and productivity.

CONCLUSION

There have been various attempts to standardize HDP in fruit crops with variable success, however, commercial adoption at farmers field is still lacking. As most of tropical and subtropical fruits crops like mango, litchi and guava are naturally vigorous. Canopy management through pruning is not well understood and in addition to this use of machinery for pruning is negligible or absolutely not available in India. Therefore, the lasting solution for this would be development of dwarfing rootstock and scion cultivars. Modern tree training systems, which have been successfully used in temperate fruit crops may tried and adopted after long term evaluation.

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