I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

Pusa Apple Rootstock -101 Suitable for Apple Cultivation in Hilly Slopes

K. K. Pramanick, A. K. Shukla, J. Kumar and Santosh Watpade

ABSTRACT: *The area in and around Shimla in Himachal Pradesh (India), is strictly not a temperate zone region, however, because of its altitude (1900 – 2600 m ASL) it is able to support a fairly good production of temperate pome and stone fruits. Erratic winter chilling in some apple growing areas of late has raised alarming concerns about the continued sustenance of productivity of temperate fruits, particularly of apple, in the region. It will be pertinent to determine the extent of rootstocks in the region and its impact on productivity of apple trees.*

The crab apples (Malus baccata) *can play a pivotal role for the improvement of apple through proper utilization of their potentiality. A number of crab apples have been found growing wild in the Himalayas. An experiment is in progress for utilization of selection of indigenous apple root stock with Spur Type Red Delicious as scion. It is semi-vigorous in nature. It has a very good propagation potential. The chilling requirement of this species is less than that of M 9 (Malling-9) and MM 106 (Malling-Merton-106). It could be used as rootstock in high density planting of apple. The germplasm that holds promise either for using rootstock or in breeding programme for disease resistance (woolly aphid, powdery mildew, white root rot, apple scab) or as pollinizers has been identified for the improvement of apple i.e. Pusa Apple Rootstock-101. Apple planting density of 4651, 2500, 1736, 1111 and 625 trees per hectare is being evaluated to recommend an optimum planting density for apple cultivation on steep slopes. From the analysis of vegetative growth and yield, it can be concluded that the density of 1111 trees per hectare could be the optimum density for stability of yield, and sustainability of high density planting.*

Keywords: *Rootstock, Apple, Crab apple,* Malus baccata, *disease resistance, yield, high-density, M9, MM106.*

INTRODUCTION

The area in and around Shimla in Himachal Pradesh (India), is strictly not a temperate zone region, however, because of its altitude (1900 – 2600 m ASL) it is able to support a fairly good production of temperate pome and stone fruits. Erratic winter chilling in some apple growing areas of late has raised alarming concerns about the continued sustenance of productivity of temperate fruits, particularly of apple, in the region. It will be pertinent to determine the extent of rootstocks in the region and its impact on productivity of apple trees.

Since prehistoric times, wild fruits plants have been an important source of food for mankind. Domestication and use of wild plants has been closely associated with the development of man. However, over the ages conscious selection for superior edible types has systematically deprived our cultivated fruit crop varieties of qualities like resistance to diseases and pests (Ram and Randhawa,1979), winter hardiness, drought tolerance and vigour. Their importance was not realized and mechanism of their selection was not fully understood. Valuable genes and germplasm, which were available in nature thus got discarded and are now on the brink of extinction.

Data has been presented to show the extent of variability that exists in the different rootstocks (Exotic as well as indigenous). This variation is of great economic significance as it could be instrumental in introducing far reaching improvements in apple production.

The purpose of this paper is to highlight the extent and richness of the Natural Biodiversity available in India. Apple species is just an example all our fruits are similarly provided for by Mother Nature we only have to reach out and Protect our Richness.

Apple productivity is gradually declining over the years. One of the reasons for this has been attributed to the non-descript seedlings stocks that are predominantly being used as rootstocks in apple

* IARI Regional Station (Cereals & Horticultural Crops), Amartara Cottage, Cart Road, Shimla – 171004, *E-mail: Kallol_pramanick@yahoo.co.in and kallolpramanick@gmail.com*

plantations (Sharma and Kumar, 2006). It is therefore, very necessary to identify suitable rootstocks for improvement in apple cultivation.

The crab apples, botanically classified as *Malus baccata* (Lin.) Borkh, have been sometimes used a rootstock for the cultivated varieties of apple (Srivastava *et al.*, 1997). Its fruit is small sized, edible and have medicinal value in traditional therapies. Quite distinct types of the Himalayan crab apple have been found growing wild in different agro-climatic conditions. The differences observed warrant a species or variety status to these biotypes Kishore and Randhawa, 1993, Kishore *et al.*, 2005). One of these was collected from Shillong (Meghalaya) at an altitude of 1300 m ASL and has the potential of a promising rootstock for apple and suitable for high-density orcharding.

MATERIALS AND METHODS

An existing high density apple plot (48mX48m) was re-laid in 2001 with planting densities corresponding to 4651, 2500, 1736, 1111 and 625 trees per hectare. The rootstock used was Pusa Apple Rootstock-101; detailed characteristics of this root stock are presented in Table1 as compared to M-9 and MM-106. The scion variety was Spur Type Red Delicious. Each plant density plot measured 12m X 12m in three replications. Pollination was provided by cultivar Golden Delicious planted in rows in-between the high density plots. The experimental area was on a 30% steep slope. All recommended agronomic practices and plant protection measures were adopted. This evaluation was conducted in the research farm of the ICAR-IARI Regional Station (CHC), Amartara Cottage, Shimla at the elevation of 1948m amsl during three growing seasons 2010, 2011 and 2012. The data presented is the average of these three years. Yield (kg/tree), resistance to biotic factors, horticultural characters were recorded.

RESULTS

Data on horticultural characteristics of Pusa Apple rootstock-101,M-9 and MM-106 are presented in Table 1. Maximum stomatal count (10.45c) and maximum relative rate of growth (1.65) was recorded in MM-106 rootstock and the minimum stomatal count (7.15b) and minimum relative rate of growth (1.25)was recorded in M-9 rootstock where as Pusa Apple rootstock-101 recorded in between stomatal count (7.45b) and relative rate of growth (1.35) however propagation potential (95%), graft success (90%), rooting quality (Profuse) is more than M-9 and MM-106 and chilling hour requirement is less as compared to M-9 and MM-106.

Influence of planting densities on yield characteristics is presented in Fig. 1. Yield in terms of kg/tree (range 13.50 -26.64) was inversely correlated with planting density, while in terms of tons/ha (range 16.65-62.79) the yield was positively correlated with the planting density.

Apple accessions collected from Shillong (Meghalaya) i.e. *Malus baccata* (Shillong), was found completely resistant to woolly aphid (*Eriosoma lanigerum*) and the development of root rot (c.o. *Dematophora necatrix)* and powdery mildew (*Podosphora leuchotricha*) was significantly delayed as compared to well known source of resistance, *Malus zumi*. It has shown field resistance to apple scab (c.o. *Venturia inaequalis*) also (Table 2). It has a very good propagation potential. The chilling requirement of this species is less than that of M 9 and MM106. In vigour it is equivalent to MM106 and has proved adaptable for use in high density plantings (Table 1). Though leaf stomatal counts indicated that as a rootstock it might be as dwarfing as M9 yet the actual growth of grafts on this rootstock was similar to those on MM106. The test scion cultivars were Spur-Type-Red Delicious and Golden Delicious. A high density apple plantation experiment is in progress with planting densities of 4651, 2500, 1736, 1111 and 625 trees per hectare (Fig.1). The germplasm holds promise for use as rootstock for semi-dwarfing and semi-vigourness, it can also be useful in breeding programme for disease and pest resistance.

M. baccata Shillong possess the following desirable traits

- Dwarf to semi vigorous: It is semi vigorous in nature.
- Tree spread: Average tree spread varies from 300-380 cm in conventional planting distance.
- Graft compatibility: Compatible with all commercial varieties grafted.
- Precocity: Bearing starts from 4th year onward.
- Adaptability: To wider soil and agro-climatic conditions.
- Chilling unit requirement: Less than M9 and MM106 thus suitable to low elevation areas.
- Propagation: Easy to propagate through mound layers, hard wood cuttings through bottom heated technique.
- Multiplication through seeds: It is often cross pollinated and seedling raised from the seeds

collected from bagged flowers exhibit more homogeneous, semi vigorous growth.

- Productive period: No decline in the productivity of 25 year old plant in the farmers field has been recorded so far.
- Yield potentiality: More than 25 tons /ha
- Disease resistance: It showed resistance to powdery mildew, moderate resistance to apple scab and tolerance to white root rot.
- Pest resistance: Highly resistance to woolly aphid.
- High density planting: Planting distance of 3m × 3m is ideal for high density orcharding for stable and sustainable yield by optimum utilization of sunlight interception, photosynthesis and uptake of nutrient.

Based on twenty years studies at research farm and on farm research at farmer's field, *Malus baccata* Shillong has proved an ideal promising rootstock for conventional as well as high density planting. Even at 30 % slope with drip irrigation facility it yielded more than 25 tons / ha. Thus this station recommends *a* new rootstock for apple which may be christened as **"Pusa Apple Rootstock-101".** The characteristic features to be considered for ideal rootstock was also supported by Randhawa and Ram, 1977 and Randhawa and Kishre, 1981.

DISCUSSION

In any high density planting the foremost criteria is maximizing yield in terms of per unit area of orchard land, however, the high density planting should also be able to sustain such high yields for a major proportion of the fruiting life of such apple planting i.e. stability and sustainability characteristics. There is obviously a competition between the fruiting apple trees for the uptake of nutrients from the soil, even though fertilization has been done on per tree basis and not per unit land area basis (Shear and Faust, 1980). In view of this it cannot be expected that the level of observed yield can be improved upon or even sustained for any length of time. Even the commercial life of such a planting should also be expected to be considerably shortened. Keeping these parameters in view, the best planting density in the present study appears to be 111trees/ha. The rootstock "Pusa Apple rootstock-101", besides being suitable for high density plantings also has an appreciably lesser chilling requirement (Kishore and Randhawa, 1987) as compared to M-9 and MM-106 (Table 1). It has a potential, therefore, for extending apple cultivation to areas where winter chilling has been considered insufficient for apple cultivation as rootstocks have been known to influence the chilling requirement of scion variety (Young and warner, 1985). It has also multiple disease and pest resistance characteristic.

CONCLUSION

Pusa Apple rootstock-101 has been shown to be a semi-dwarfing rootstock for apple and is being evaluated for high-density plantings. In its natural habitat it is a small low-bearing tree. Though leaf stomatal counts indicated that as a rootstock it might be as dwarfing as M9 yet the actual growth of grafts on this rootstock was similar to those on MM106. The test scion cultivars were Spur-Type-Red Delicious and Golden Delicious. The winter chilling requirement of this species has been found to be comparatively much less than that required for M9 or MM 106. Its propagation by mound layering yields profusely rooted suckers and the graft success of Golden Delicious scion is good with less shoot growth than

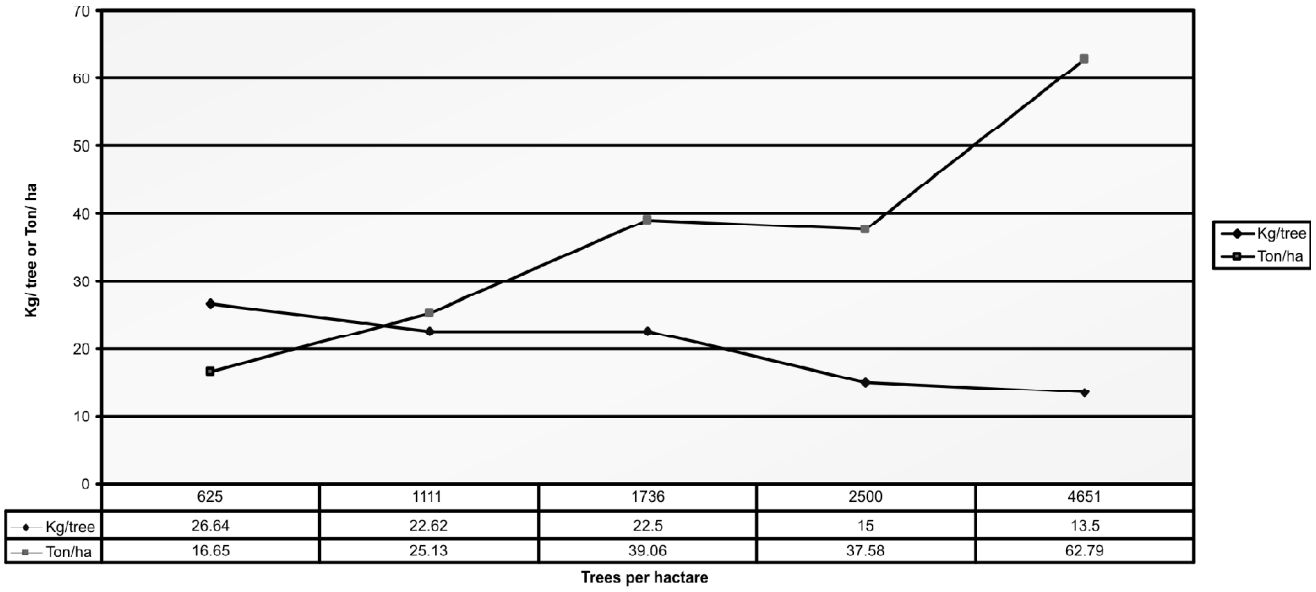
Table 1

Species	*Leaf Stomata (100X,10X)*	*Chilling Requirement*	*Propa-gation*	*Rooting Quality*	*Graft Success*	*Relative Rate of Growth*
M 9	7.15b	****	40	Good	85	1.25
MM 106	10.45c	****	75	Good	87	1.65
Pusa Apple Rootstock-101	7.45b	**	95	Profuse	90	1.35

Table 2

Species	*Reaction to Woolly Aphid*	*Reaction to Powdery Mildew*	*Reaction to Apple Scab*	*Reaction to White Root Rot*
M 9	R	S	S	S
MM 106	S	S	S	S
Pusa Apple Rootstock-101	R	R	R	S

R denotes Resistance
S denotes Susceptible



	625	1111	1736	2500	4651
Kg/tree	26.64	22.62	22.5	15	13.5
Ton/ha	16.65	25.13	39.06	37.58	62.79

Figure 1: Effect of Apple Tree Density on Yield

on MM106 rootstock. A high degree of resistances of woolly aphid and powdery mildew have been found in this species. Planting distance of 3m × 3m is ideal for high density orcharding for stable and sustainable yield by optimum utilization of sunlight interception, photosynthesis and uptake of nutrient.

REFERENCES

Kishore, D.K. and Randhawa, S.S., (1987), Comparative chilling requirement of native wild species. In Advances in Research on Temperate Fruits (Chadha, T.R. Ed.). Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, India. p 95-98.

Randhawa, S.S. and Ram, R.D., (1977), Potentiality of the indigenous germplasm in the improvement of pome and stone fruits. In Fruit Breeding in India (Nijjar, G.S. Ed.). Oxford and IBH Publishing Co., New Delhi. P 131-138.

Ram, R.D. and Randhawa, S.S., (1979), Resistance of different species of pome and stone fruits to powdery mildew incited by Podosphaera leuchotricha. Sci Cult, 45: 256.

Srivastava, R.P., Pathak, R.K., Bana, D.S. and Pandey, V.S., (1977), Utilization of some important fruit trees growing wild in the Himalayan Region. In Fruit Breeding in India (Nijjar, G.S., Ed.). Oxford and IBH Publishing Co., New Delhi. P 131-138.

Kishore, D.K., Randhawa, S.S., (1993), Wild germplasm of temperate fruits. In: Chadha, K.L., Pareek, O.P. (Eds.), Advances in Horticulture Vol. 1 – Fruit Crops Part 1. Malhotra Publishing House, New Delhi, pp. 227–241.

Kishore, D.K., Pramanick, K.K., Sharma, S.K., (2005), Significance of crab apples in the improvement of apples. In: Chauhan, J. S., Sharma, S. D., Sharma, R. C., Rehalia, A. S., Kumar, K. (Eds.), Acta Horticulturae No. 696, Part Two. ISHS, pp. 39–41.

Randhawa, S. S., Kishore, D. K., (1981), A note on graft compatibility of native wild species – I apple and pear. J. Hortic. Sci. 56, 369–371.

Sharma, S.D., Kumar, K., (2006), Temperate fruit diversity status and prospects. In: Kishore, D.K., Sharma, S.K., Pramanick, K.K. (Eds.), Temperate Horticulture: Cur-rent Scenario. New India Publishing Agency, New Delhi, pp. 27–34.

Shear, C.B., Faust, M., (1980), Nutritional ranges in deciduous tree fruits and nuts. In: Janick, J. (Ed.), Horticultural Reviews, vol. 2. AVI Publishing Company, Connecti-cut, pp. 142–163.

Young, E., Werner, D. S., (1985), Chill unit and growing degree hour requirements for vegetative bud break in six apple rootstocks. J. Am. Soc. Hortic. Sci. 110, 411–413.