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Review

Adoption of improved production technology of Mandarin in Rajasthan, India: A review

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Fruits are of great importance in the field of human nutrition. Citrus is one of the most important fruit crop in India. In India common citrus fruits are mandarin, sweet orange and lime. India also earns foreign exchange by exporting orange to Iran, Bahrin, Singapore etc. The demand for mandarin fruit is very high because of its nutritive value. Citrus fruits have a special place in Indian diet as they are rich source of vitamin C, vitamin A and B and fruit sugars. In some part of Rajasthan such as Jhalawar, Kota, Sikar and Ganganagar districts, citrus is the leading fruit crop. Nagpuri mandarin is quite important and produced commercially at large scale of the various types of citrus. Majority of the farmers (69.00%) were found to have medium level of knowledge about improved production technology. The study shows farmers possessed maximum knowledge about "varieties" and "plantation" while minimum knowledge was reported in "manure and fertilizer" and "plant protection measure". Majority of farmers (64.00%) were found to have medium level of adoption of mandarin production technology. The study indicates that farmers had high adoption level for the practices viz., varieties and plantation and low adoption practices viz., manure and fertilizer and plant protection measures. The knowledge of the farmers about improved production technology of mandarin cultivation was positively and significantly associated with their caste, occupation, educational level, social participation, size land holding while their market distance and irrigation potentiality were negatively and non significantly co-related with their knowledge level.

Key words: Citrus, mandarin, improved production technology, farmers.

INTRODUCTION

Fruits are of great importance in human diet. India is the second largest producer of fruits in the world. Its share in world's fruit production is 11%. The major fruits grown in India are mango, banana, citrus, guava, pineapple, grape and papaya in tropics and subtropics and apple in the temperate region. Apart from these, sapota, aonla ber, pomegranate, litchi, peach, pear plum and walnut are grown on a sizable area. A number of other fruits such as jack-fruit, lasoda, phalsa, mulberry, beal, fig, datepalm etc, are also grown in different regions. Major fruit growing states are Uttar Pradesh, Andhra Pradesh, Bihar, Karnataka, Tamil Nadu, Maharashtra, Kerla and West Bengal. The other states which have substantial area are Gujarat, Assam, Madhya Pradesh and Orissa. The per capita availability of fruits in the country is only 46 g per day against to the requirement of 92 g as prescribed by the Indian Council of Medical Research, this may be due to very low productivity of the large unproductive old orchard, small size of land holding and poor management of the orchards, especially in the

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Figure 1. Fruit bearing tree and fruits of mandarin.

rainfed area which constitute area over 60% of the total areas under fruits. Besides this, lack of quality of planting material of improved varieties and several production constraints also contribute to this low productivity (Anonymous, 2004).

Citrus (Linnaeus) is one of the most economically important fruit crops of India, belonging to the subtribe Citrinae, tribe Citreae, subfamily Aurantioideae of the family Rutaceae. It is widely distributed throughout the tropical and subtropical regions of the world and believed to be originated in Southeast Asia, particularly, in the regions extending from North-east India eastward through the Malay archipelago; North into China and Japan, and South to Australia (Swingle and Reece, 1967; Moore, 2001). Mandarin (*Citrus reticulata* Blanco) is one of the premier commercial citrus grown in central India. It is grown in 92.2 thousand hectare with a total production of 11.2 lack tonnes and an average productivity 11.5 tonnes per hectare, Nagpuri mandarin was introduced in 1894 by late Shri Rahuji Raje Bhonsale in Central India (Shrivastva and Singh, 2003). Citrus is world's leading fruit crop. It is also known as fancy fruits and is eaten as desert fruit. It is originated in all probability in Cochin, China and has been cultivated in China and Japan over long period. Citrus plant is characterized by the following diagnostic characters: shrubs or small to large trees; stem usually angular and spiny, leaves unifoliolate, usually with narrow to broadly winged petiole and pellucid dots (oil glands) on leaf surface, hesperidium fruit (a type of berry with a leathery adherent pericarp), spongy or fibrous mesocarp and fleshy endocarp filled with pulp vesicles containing sour or sweet juice. *Citrus* species have diploid chromosome number, 2n = 18, but some species show polyploidy, that is, 27 and 36 chromosomes (Cameron and Frost, 1968; Guerra, 1984).

Thus there is a great scope of increasing the fruit production by increasing the productivity besides bringing more area under fruits crops. According to the national commission on agriculture, the total production in the country should be increased to 52 million tonnes to provide enough fruits for a population of about one billion people by the turn of the century. Another significant factor which contributes to low availability of fruits to the people is the considerably high post-harvest losses; almost 20 to 30% of the fruits are lost at the post harvest stages which could be saved by adoption of improved harvesting, packaging, handling and storage techniques. Development of processing industry should result in sustained fruit production by ensuring strong sink for disposal. However, at present, only about 0.3% of the fruits are used for processing against a demand of about 0.5%, there is considerably scope of increasing the supply of fruits in processed form.

Utilization of fruits has been inherent in the Indian way of life from ancient times, medicinal uses of fruits like aonla, beal, citrus, ber, karronda, lemon, lime, fig, jamun, mango, orange, banana, pomegranate, almond etc. have been mentioned in charak samhita and sushrut samhita, mango, banana, beal, aonla and coconut have been associated with the festival and ritual in India. The several fruits like mango, banana, fig, grape and date palm were the most favorite. The mandarin group includes all type of loose jacket oranges commonly called by the Indian name santra such as Nagpuri santra, khasi orange and desi type orange.

India has an enormous diversity of citrus genetic resources, both cultivated and wild. Citrus occupies the second position in terms of area (5, 02,800 ha) and third position in terms of production, that is, 4,396,700 million tonnes (mt) of fruit crops in India (NHB database, 2012). Being the second most important fruit crop of the world trade for fresh fruits, more than fifty countries are growing citrus fruits commercially in different agroclimatic conditions for its diversified use and increasing demand worldwide. The rich genetic diversity particularly in mandarins, sweet oranges, lemons and limes immensely contributed to improvement of citrus cultivation and industry in India.

At present mandarin are commercially grown in India. The tree is small, spiny with a dense top (Figure 1). The

leaves are long, lanceolate, petiole slightly, margined, articulated, flower white, solitarily, perfect. The size of fruit is medium to large, flattened or depressed globose. The colour of fruit is yellow, reddish orange (Figure 1). The core is hollow. The rind is thin, rind and segments are easily separated. The number of segment is 10 to 14. The pulp quality is exceptionally fine. The seeds are small beaked, cotyledon green, highly polyembryonic.

The mandarin is locally knows as “Nagpuri santra” has reputation and it is the best of its kind grown in India. The regular excessive bearing in the shallow soil exhaust “Nagpuri mandarin” plants, earlier than those in the deep soil. If not managed properly and timely, the plant starts declining their vigour and yield potential whereas, the mandarin plants respond well to regular and timely supply of fertilizers with proper irrigation schedule in shallow soils. The demands for mandarin are very high because of its nutritive value. It is very rich in vitamin C (ascorbic acid), fruit sugars and in addition to this it also contains vitamin A and B. Juice content is abundant, yellow in colour with excellent flavour, sweet in taste. The number of seeds per fruit is 6 to 7. It provides vitamin P which keeps the small blood vessels in healthy condition in body. Mandarin is the most important of citrus fruits alone occupy 40% of the land under citrus cultivation. Citrus cultivation is of major economic importance. India earns foreign exchange by exporting oranges to Iran, Bahrin, Singapore, Nepal, Switzerland etc.

In Rajasthan, kinnow occupies 5522 ha area under cultivation (Anonymous, 2008, 2009). The mandarin is being grown in different districts of which important are Jhalawar, Kota, Sikar, Baran, Bhilwara and Rajsamand. Jhalawar district has highest area (5693.12 ha) and production (4784.66 qtl.) (Revenue office, Jhalawar). Citrus fruits are good sources of citric acid, flavonoids, phenolics, pectins, limonoids, ascorbic acid, etc. (Dugo and DiGiacomo, 2002). The dietary, nutritional, medicinal and cosmetic properties of citrus fruits are well documented (Swingle and Reece, 1967; Dugo and Digiacomo, 2002). Recent pharmacological studies support the traditional medical applications of citrus fruits in scurvy, obesity, cancer, HIV/AIDS, contraception, cough, and reducing blood pressure (Mabberley, 2004). Oranges are used for treatment of cold, fever, liver disorders, gall bladder problems, acne, and ringworm (Imbesi and Pasquale, 2002; Mabberley, 2004; Arias and Laca, 2005). During last few years, the urgent need for undertaking the basic and strategic research work has been done in the country on various aspects such as varieties, propagation, irrigation and pruning for stabilizing and increasing the production, productivity and quality of mandarin fruits. The production of poor quality of mandarin fruit is due to lack of knowledge in the mandarin growers about mandarin production technology.

Despite the availability of improved varieties, improved package of practices, scientific technology and poor management of the mandarin orchard, it is a large gap between the yield of mandarin orchard recorded at the research farm and its production at farmer’s field. The low production of mandarin fruits may be due to the non adoption or poor adoption of recommended technology of mandarin by the farmers which may be due to their being unaware of about latest recommended technology and they may be facing some problems in its adoption at their own farm and there may be certain factors which may be affect adoption of recommended technology of mandarin cultivation.

Purpose statement

Mandarin is most suitable fruit crop for India, but when we look to the productivity of mandarin, it stands very low productivity as compared to other countries. This is a challenging task for the scientists and the farmers. The scientists have evolved latest technologies but the farmers have not adopted latest technologies due to the fact of low knowledge and awareness, about new technologies. Under such conditions it is quite imperative that reasons for the technological gap in mandarin should be identified and studied critically in order to face the existing challenge of low adoption of improved technology. It is true that improved practices are not only the things, which cause adoption or rejection, but certainly other factors are also directly or indirectly responsible for technological gap.

Some enthusiastic farmers in Jhalawar district planted a few saplings of loose skinned range after importing from Nagpur in fifties. These plants started bearing in 1955. The growers found it similar in quality and better in yield than the original place of it. Which was motivated the farmers to extend area under orange plantation. At the end of 1960, its production was for marketing. The first attempt to orange plantation was made in Jhalawar district during 1972 with the financial assistance of NABARD. This area is known as “Nagpur of Rajasthan” for orange production. Jhalarapatan, pirawa and pachpahad are the main basis in Jhalawar district where orange (mandarin) is produced on large scale.

IMPROVED PRODUCTION TECHNOLOGY

Adoption of improved production technology of mandarin cultivation is directly or indirectly related to knowledge of mandarin growers. Hence, it was considered necessary to assess the knowledge of the farmers about improved production technology of mandarin cultivation while the knowledge about the technology had influence on the decision making about its adoption with this view in mind the knowledge test was applied on the farmers to test their knowledge about improved production technology of mandarin cultivation.

Phuse et al. (2007) found that the progressive farmers of the village were found to be the most credible source of information for the orange growers. The soil type and use of planting; recommended rootstock use; application of fertilizer doses and irrigation practice; total no of irrigation, method of application for manures were the practices partially adopted by more than half of the respondents. However, it could further be seen that majority of the respondents did not adopt the important improved cultivation practices such as; proper harvesting time for fruit (T.S.S: Acidity ratio) was (81.50%) and up to 44% respondent did not adopt the proper time of harvesting. It is due to they cannot take the risk in market, as well as lack of awareness but they are totally dependent up on mediator. It is also seen that (54.50%) respondent's did not follow soil testing at the time of planting as well as at bearing stage. So, there is a need to adopt the full-improved recommended package of practices for increasing the productivity with quality in mandarin orange.

Improved production technology has revolutionized the fruits cultivation and India has a reputed position in the field of fruit production. The increasing demand of fruits clearly indicates that the production is an urgent need to boost up the production of mandarin fruit to cater the demands of growing population. Some of the factors responsible for non adoption of latest technology by farmers may be lack of awareness, low technical know-how and less knowledge regarding resources of information factors such as credit, storage and marketing etc. The knowledge level of farmers about improved production technology of mandarin cultivation was measured by a knowledge test developed by the Mohammad (2000). The adoption level of farmers about improved production technology of mandarin cultivation was measured by scale developed by Mohammad (2000) with slight modification. Whereas, the constraints faced by the farmers in adoption of improved production technology of mandarin cultivation as measured by schedule prepared by the investigator in light of suggestion of the experts, the independent variables like caste, occupation, educational level, social participation, size of land holding, market distance and irrigation potentiality were measured by modified scale of Trivedi (1963). The source of information was measured by scale of Ramchandarn (1974) with slight modification as per need of the study.

The majority of kinnow growers belonged to medium adoption category for the recommended kinnow production technology such as 'application of N', 'application of potash', 'planting pit size' and 'filling the pit'. The least adoption was for the practices such as 'plant protection measure' and 'application of growth regulators' and high adoption for the practices such as 'plant population', 'irrigation intervals', 'application of FYM', 'plantation depth', 'recommended method of propagation' and 'application of phosphorus'. The knowledge level, education level, size of land holding and occupation were positively and significantly associated where as their market distance was negatively and significantly associated, while social participation and irrigation potentiality were positively and non-significantly related with the adoption level of farmers about recommended kinnow production technology (Choudhary et al., 2011).

Nainawat (1990) found that majority of farmers have moderate knowledge about recommended ber production technology. Nimje et al. (1991) observed that there is a need to transfer the ber cultivation techniques to the ber growers. About 25% ber growers did not have sufficient knowledge of various aspects of ber cultivation. Very simple aspects like digging pits, selection of bud grafts, selection of buds, grafting methods etc. were not known to the ber growers. Mohammad and Punjabi (1997) reported that majority of mandarin growers (80%) were having medium level of knowledge of mandarin production technology while 20% of them had low level of knowledge. In case of non mandarin growers, 70% medium level of knowledge and about 30% possessed low level of knowledge. Sharma and Bangarwa (1997) concluded that majority of the respondents (about 60%) had medium knowledge level about tree plantation, followed by 26.66% who had moderate knowledge level. Only 8 and 6% of respondent had low and high knowledge level about tree plantation respectively.

Deshmukh et al. (1998) found that 93.33% of the respondent had knowledge about the varieties and time of harvesting of custard apple. As much 92.90% of the respondents had knowledge of recommended soil type for custard apple cultivation. Similarly the knowledge about the importance of digging pit and size of pit was possessed by 81.66 and 65.85% respondent, respectively. Devi and Agarwal (2000) reported that majority of the farmers had medium level of knowledge about improved technology of pea cultivation. Dayama (2000) concluded that majority of farmers has medium knowledge level (68%) about improved practices of aonla plantation. Mohammad (2000) observed that guava orchard owners had maximum knowledge about fruit varieties (100%). It was followed by planting (67.22%), cultural practices (66.66%), harvesting and marketing (65.33%) and propagation (55.55%). Comparatively less knowledge was reported in plant protection measures (47.91%) among the guava orchard owners. Jangid (2001) reported that 68% farmers were categorized in medium knowledge level, 22% farmers were in low knowledge level and 10% farmers were in high knowledge about adoption of recommended cultivation practices of chilli.

Meena (2001) found that there exists a significant knowledge difference with regards to all the practices of onion production technology between trained and untrained respondents. Pandaria et al. (2002) revealed that the potential of crop regulation technology in orchard growers but also highlighted the useful implications.

Table 1. Distribution of farmers under different knowledge levels about improved production technology of mandarin cultivation (N = 100).

S/N	Categories of knowledge level	No of farmers	Percentage of farmers
1	Low knowledge (Score upto 26.10)	11	11
2	Medium knowledge (score from 26.11 to 34.08)	69	69
3	High knowledge (score above 34.08)	20	20
	Total	**100**	**100**

X = 30.09 σ3.99.

Firstly, participating in trials, growers gained knowledge about the technology which they can adopt and disseminate among fallow growers. Secondly, the participatory trials at different locations provided opportunity for the growers to develop their capability for on farm experimentation and also build up their confidence in designing, implementing and evaluating the on farm experimentation along with scientists. Poonia (2002) found that majority of respondents (65.00%) had medium level of knowledge of improved kinnow cultivation practices. However, respondents found in high and low knowledge category were (18.33%) and (16.67%), respectively. Srivastava et al. (2002) it was concluded that majority of chilli growers were having over all medium level of knowledge regarding S-49 chilli cultivation technology. In case of practice wise level of knowledge, nearly 14.00 to 24.00% of chilli growers had high level of knowledge while in case of low possession of knowledge of chilli growers varies from nearly 14.00 to 22.00% regarding different agronomic practices of chilli cultivation technology.

Arneja and Khangura (2003) it was concluded that the pea growers were also categorized into three different categories according to their overall performance of knowledge score that 40% of farmers had low, while 32% of respondents had medium level of knowledge and only 28% of the pea growers had a high level of knowledge regarding various pea cultivation practices. Thus, it can be concluded (72.00%) had low to medium level of knowledge regarding various pea cultivation practices. Meena (2004) observed that 60.00% farmers were categories in medium knowledge level, 21.70% farmers were in high knowledge level and 18.30% farmers were in low knowledge level about improved practices of guava plantation. Jhajharia (2005) concluded that the study shows farmers possessed maximum knowledge about soil and soil preparation and spacing while minimum knowledge reported in plant protection and seed treatment about improved ber production technology.

The knowledge level of farmers about improved production technology of mandarin cultivation was measured with the help of knowledge test developed by Mohammad (2000) which was used with slight modification by the researcher for the study purpose. Eleven technologies/practices having 25 questions were included in the schedule after discussion with Horticulture scientists and extension personnel's to test the knowledge level of the respondents regarding improved production technology of mandarin cultivation. The range of knowledge score were from zero to 50. The knowledge score were assigned according to the performance of respondents in the knowledge test. One mark was given to every right answer and zero mark for every wrong answer. This range was divided into three categories based on the mean (30.09) and standard deviation (3.99) as presented below.

(1) The farmers who obtained knowledge score upto 26.10 were categorized as having low knowledge level.
(2) The farmers who obtained knowledge score from 26.11 to 34.08 were categorized under medium knowledge level.
(3) The farmers who obtained knowledge score above 34.08 were categorized under high knowledge level.

The statistical data regarding the knowledge level of farmers about improved production technology of mandarin cultivation have been presented in Table 1. The data in Table 1 concluded that the 69.00% of mandarin growers were having medium knowledge level, 20.00% of farmers having high knowledge level and 11.00% farmers having low knowledge level about improved production technology of mandarin cultivation (Yadav, 2006).

It was also evident that all the farmers were having knowledge about "varieties", this might be due to the fact that majority of the (33%) farmers were literate to highly educated in the study area and hence may know the latest varieties by reading the related literature and also they remain in contact with neighbors, friends, progressive farmers etc. Hence, they may discuss about the latest varieties with the fallow farmers. Hence they had good knowledge about the varieties of mandarin. The farmers had low knowledge about "manure and fertilizers" and "plant protection measures" this might be due to the reason that the farmers might have not understood the instruction written on the container of chemicals because of its complex language they might also not get proper technical guidance about these aspects. It might also due to fewer contacts of farmers with plant protection specialists. The findings of the study are in conformity of

Table 2. Distribution of farmers under different adoption categories towards improved production technology of mandarin cultivation.

S/N	Categories of adoption level	No of farmers	Percent of farmers
1	Low adoption (Score upto 28.51)	15	15
2	Medium adoption (Score from 28.52 to 34.59)	64	64
3	High adoption(Score above 34.59)	21	21
	Total	**100**	**100**

X 31.55, σ = 3.04.

Agarwal (2000), Jangid (2001), Meena (2004), Mohammad (2000) and Jhajharia (2005).

EXTENT OF ADOPTION OF IMPROVED PRODUCTION TECHNOLOGY OF MANDARIN CULTIVATION

Nainawat (1990) reported that 57.84, 83.43, 50.00, 58.43, 80.62, 53.31 and 4.12% of the respondents adopted the recommended improved variety, spacing, soil treatment, manure and fertilizer application, irrigation, intercultural operations and plant protection measures, respectively. Urede et al. (1991) observed that majority of respondents (87.80%) planted mango orchard followed by Indian jujuba (44.66%) on their farm. Only 4.00% farmers have planted pomegranate orchard. Chiprikar and Khuspe (1992) reported that a majority of grape growers were medium to low adopters of grape production technology.

Sen (1995) found that the maximum percentage of adoption of production technology of guava was about planting (70.37%). Manjula (1996) found that over all adoption of farm women about recommended mulberry cultivation practices revealed that 39.58% of the farm women had medium level of adoption with respect of recommended mulberry cultivation practices. Thakare et al. (1996) stated that the majority of orange growers had medium level of adoption of recommended orange cultivation practices (60.50%), while 25.50% of the respondents were in low level of adoption and only 14% of respondents were having high level of adoption. Bhople et al. (1996) found that 62% of the orange growers had adopted recommended cultivation practices of orange to medium extent. Only 16% of them were found to be higher adopters. It was also noted that 22% of orange growers were found to be low adopters. Mohammad and Punjabi (1997) found that maximum adoption gap was reported in propagation (35.56%) this was followed by plant protection measures (22.23%), planting (11.86%) and harvesting and marketing (8.19%).

Agarwal (2000) reported that adoption of improved cultivation of pea by the farmers was not upto mark in soil treatment (13.50%), fertilizer application (19.57%), weed management (31.66%) and plant protection measures (33.20%), whereas, they had high adoption regarding recommended seed rate (88.00%) and recommended spacing (66.93%). Mohammad (2000) found that maximum adoption of guava production technology was reported in varieties (100%) pit digging of recommended size plant sampling in orchard (89.44%), irrigation interval as per the suggested irrigation schedule (88.88%) and scientific method of irrigation for higher water use efficiency (83.33%). On other hand, comparatively less adoption was found in the use of plant protection measures as per the advice of experts (33.83%) grading of fruits after harvesting (36.11%) and use of suitable method of propagation (10.55%) among the guava growers. Meena (2001) observed that a significant difference was reported in adoption between trained and untrained respondents regarding all the practices of onion production technology. Meena (2002) reported that 64% tomato growers were in the medium adoption group and 21% farmers were in the high adoption group, while only 15% farmers were in the group of low adoption. Poonia (2002) found that 60% respondents had medium level of adoption and 22.50% respondent having low and 17.50% having high level of adoption of recommended kinnow production technology. Meena (2004) was found that 88.83% of guava growers found to be medium adopters and 25.00% farmers were high adopter and 16.67% of the respondents were low adopters. Jhajharia (2005) concluded that farmers had high adoption level for the practices viz., harvesting, soil and soil preparation and low adoption practices are plant protection and weed management in improved ber production technology.

Based on adoption score obtained by the farmers, the mean 31.55 and standard deviation (3.04) were computed for the purpose of classifiying the adoption level in to three categories namely low level, medium level and high level adopters. In this way the farmers were categorized into three groups as follows:

(i) Farmers who obtained adoption score upto 28.51 were categorized as low adopters.
(ii) Farmers who obtained adoption score from 28.52 to 34.59 were categorized as medium adopters.
(iii) Farmers who obtained adoption score more than 34.59 were categorized as high adopters.

The statistical data regarding the extent of adoption categories towards improved production technology of mandarin cultivation by the farmers have been presented in Table 2. About 64.00% of farmers were found to be

Table 3. Extent of adoption of improved production technology of mandarin cultivation by the farmers.

S/N	Package of practices	MPS	Rank
1	Soil and soil preparation	80.33	III
2	Varieties	88.67	I
3	Propagation	55.33	VI
4	Plantation	83.44	II
5	Hoeing and weeding management	56.33	V
6	Irrigation management	41.50	IX
7	Inter-cropping	45.67	VIII
8	Manure and fertilizers	36.33	X
9	Training and pruning	51.00	VII
10	Plant protection measures	19.67	XI
11	Harvesting and marketing	76.55	IV
	Over all	**57.43**	

medium adopter, while 15.00% farmers were low adopter and 21.00% of farmers were high adopters (Table 3). The average extent of adoption of improved production technology of mandarin was 57.43%. Out of eleven selected practices, the extent of adoption of “varieties” was 88.67 MPs which were higher than the other adopted practices of mandarin cultivation. The adoption of “plantation” (83.44 MPS) and “soil and soil preparation” (80.33 MPS) recorded second and third position, respectively after adoption of the “varieties” (Table 3). Hence, it may be inferred from the above results that the respondents were very conscious about the adoption of “varieties” of mandarin whereas, they were least bothered about the adoption of “manure and fertilizers” and “plant protection measures” due to lack of knowledge in plant protection and manure and fertilizers.

It was found that majority of the respondents 64.00% were medium adopter, 15.00% were low adopters and 21.00% of the respondents were high adopter of improved production technology of mandarin cultivation. It might be due to the fact that various extension activities like demonstration, training etc. are frequently organized by the extension field functionaries in the villages, which may have helped in convincing the farmers about the improved production technology of mandarin cultivation, which have resulted in increasing the adoption of improved production technology of mandarin cultivation, but still there is an increasing recognition of the need to convert the medium adopters into high adopters and low adopters into medium adopters, therefore, all the essential supplies and services for transfer of technology through extension activities should be made available to the farmers and intensive efforts by all concerned to convince the farmers about improved production technology of mandarin cultivation is needed. In case of extent of adoption of improved production technology of mandarin cultivation, the farmers had appropriately adopted the recommended “varieties”, “plantation”, “soil and soil preparation” and “harvesting and marketing”. Such practices were adopted by farmers as they had good return due to adoption of these technologies/practices. Also these technologies/practices neither require any extra investment, nor complicated in using the probable reason for medium adoption of “hoeing and weeding management”, “propagation”, “training and pruning”, “inter cropping”, “irrigation management” may be due to lack of knowledge about these technologies/practices and lack of proper technical guidance provided to them by the state department of Agriculture/Horticulture.

The probable reason for low adoption of “manure and fertilizer” and “plant protection measures” may be due to high cost of plant protection chemical and plant protection equipment, fertilizers and weedicides. The untimely availability of fertilizers, lack of credit facility, and lack of knowledge about irrigation management may also be the other reasons, for low adoption of these practices. The low adoption of plant protection measures might also be because of the non availabilility of latest plant protection equipment at farmer’s field, their hazardous effect on human beings and animals, harmful residual effect and lack of any subsidy provision. The findings of the present study are in line with the findings of Manjula (1996), Meena (2004) and Jhajharia (2005).

MAJOR CONSTRAINTS

Lokhande and Wangikar (1991) observed that about 79.16% respondents expressed the problem about unavailability of cuttings of improved varieties in time, 76.66% of the respondents did not receive know how about improved varieties of grape, while 70.83% respondents expressed the problems about less resistance of varieties to diseases. Urade et al. (1991) reported difficulties in successful plantation for want of

technical guidence, untimely supply of information and difficulty in procurement of bank loan, non-availability of protective irrigation and trampling by stray cattle. Difficulty in selection of dry land fruit crop, lack of knowledge of pests and their control measure were also reported as problems by them. Pandey (1993) reported that in cultivation of mango, guava, pomegranate, aonla and other fruit plants, there was a great problem of unavailability of reliable plant material. Plants were purchased indiscriminately from nearby states, from private nurseries that have no pedigree records of their mother plants. He further added that many of the plants die during transit period.

Singh (1993) reported that in case of papaya, mosaic disease had restricted the farmers for cultivation of this profitable fruit crop having tremendous potentiality. Non availability of seeds of reliable varieties to the common cultivator was a great problem. Bhople et al. (1996) found that orange growers faced marketing constraints like costly packaging material (80.00%), non availability of processing units (76.67%) and high transportation charges for transport of fruit from orchards to nearby market (54.90%). Sharma (1997) reported that provision should be made for adequate and timely supply of essential inputs such as grafted mango plants of regular bearing varieties, fertilizers etc.

He further added that timely finance and credit facilities should be provided to mango growers at low interest rate. Sutar et al. (1997) observed that the constraints in adoption of selected scientific technologies in grape cultivation are the high cost of cuttings of required varieties and fertilizers as well as non availability of improved varieties, fertilizers and credit to overcome these constraints in the adoption of modern grape cultivation.

Handiganur et al. (1998) revealed that 90% farmers expressed the problem of scarcity of water and non-availability of labour were the main problems viewed by 67.50% of the farmers expressed the problems of severity of pests and diseases. Shrestha et al. (1998) found that the lack of technical know-how was the main constraint for trying the technology followed by low production and low economic status for cellar store in mandarin orange fruit. Gomase and Patil (1998) revealed that major constraints perceived by the kagzi lime growers that inadequacy of irrigation water, irregular power supply, non availability of labour, lack of knowledge of insect pest and disease and its control measures and high wages of labour.

Devi and Monoharan (1999) revealed that low price obtained for the produce in the market, lack of quick transport facilities, lack of storage facilities, non availability of middle men where the major constraints faced by the guava cultivators that high cost of fertilizers, soil and water problems, non availability of credits and lack of input availability are the area where guava farmer requires the external agency assistance. Mohammad (2000) concluded that high intensity constraints regarding aspects of orchard development with their relative position in the hierarchy as expressed by the orchard owners were lack of technical knowhow, long juvenile period, perishable nature of commodity, a high cost of establishment of orchards, lack of storage facility in the area, malpractices of the middle men, problematic soil, erratic rainfall, sub division and fragmentation of land and lack of need based training programme.

Poonia (2002) found that lack of technical knowhow, irregular water supply from the canal, perishable nature of commodity, high cost of insecticides and pesticides, lack of storage and preservation industry in the area and unfavourable weather condition, were the constraints in the adoption of kinnow orchard by the owners. Rajput et al. (2002) reported that the major constraints felt by the most of the respondents includes non availability of soil turning plough, lack of soil treatment, im-balanced use of fertilizer, infestation of several insect and diseases and lack of good quality of pesticides. Sale of cotton (produce) through mandi may be encouraged to measure producers share in consumer rupee. Meena (2004) reported that majority of cabbage growers were experienced the constraints such as lack of knowledge, high cost of inputs and lack of skill regarding the adoption of improved cabbage cultivation practices.

Waman and Girase (2003) it was found that the present study implied that sent percent pomegranate growers had adopted grading and packing of fruits in card board boxes of standard sizes. Majority of the growers preferred to sale fruits in other states that selling of fruits in local market to fetch attractive prices. They faced many problems in marketing, it is recommended that the government may establish markets at nearly place and to create infrastructure facilities to preserve and process the fruits.

This may enable them to fetch remunerative prices, stabilize rates, to reduce transformation charges and to assure timely receipt of payments. Jhajharia (2005) it was revealed that among all the categories of constraints, technical constraints were perceived with highest intensity by the ber growers.

The constraints “no preservation industry” (97.33 MPS) was the most perceived constraints among all the constraints faced by the farmers which was responsible for the adoption of improved production technology of mandarin cultivation. Hence it was awarded first rank. The constraints “reluctance for fruit growing” (31.00 MPS) was the least perceived constraint by the farmers and was ranked at last position (Table 4). The problem “no preservation industry” might be due to the fact that the unawareness of people, no proper guidance and avoidness policy of govt. and therefore, it was not possible to establish the industry without awareness of people and economic help by Govt. and agriculture department in their operational area that’s why these constraints were reported.

Table 4. Constraints perceived by the farmers in adoption of improved production technology of mandarin cultivation in the study area, N = 100 (Multiple response).

S/N	Constraints	MPS	Rank
A	**Technical constraints**		
1	Long vegetative period	36.33	V
2	Lack of regular water supply	34.33	VI
3	Poor quality of water	33.00	VII
4	Lack of technical know how	59.67	I
5	Unsuitable soil for orcharding	38.33	IV
6	High mortality of plant during initial stages	57.00	II
7	Disease sensitive	45.33	III
B	**Economical constraints**		
1	Perishable commodity results in economic losses	95.67	I
2	Labour intensive affairs	45.33	VII
3	High cost of transportation of fruit and plant material	49.67	VI
4	Lack of credit facility in the area	52.00	V
5	High cost of establishment at the initial stage	60.33	IV
6	High cost of insecticide and pesticides	94.67	II
7	Costly plant material	92.33	III
C	Storage and marketing constraints		
1	Lack of storage facility	96.33	II
2	No preservation industry	97.33	I
3	Lack of co-operative marketing system	53.00	V
4	Lack of proper market	42.67	VI
5	Low purchasing power of the consumer	39.00	VII
6	General unawareness about mandarin in product and their nutritional importance	69.67	IV
7	High fluctuation in market prices	95.67	III
D	**General constraints**		
1	Small land holding	32.67	V
2	Undulated land	32.67	V
3	Threat from wild and stray animal	59.33	II
4	Chances of theft	61.33	I
5	No proper road	50.33	III
6	Jealously of neighbours	40.33	IV
7	Reluctance for fruit growing	31.00	VI

CONCLUSION

Majority of the farmers had medium knowledge about the improved production technology of mandarin cultivation. Among the various aspects of different improved production technology, all the farmers had knowledge about plantation, “soil and soil preparation”, “harvesting and marketing”, “hoeing and weeding management”, and propagation”. Majority of the farmer had medium adoption about the improved production technology of mandarin cultivation. The knowledge of the farmers about improved production technology of mandarin cultivation was positively and significantly associated with their caste, occupation, educational level, social participation, size land holding while their market distance and irrigation potentiality were negatively and non significantly co-related with their knowledge level about mandarin cultivation. The caste, occupation, educational level, source of information utilized, social participation and size of land holding were the important variables for predicting the knowledge level of farmers about improved production technology of mandarin cultivation. The extent of adoption of improved production technology of mandarin cultivation by the farmers was positively and significantly related with caste, occupation, educational level, irrigation potentiality, source of information utilized and knowledge about mandarin cultivation while market distance was negatively and significantly co-related and social participation and size of land holding were non significantly co-related with their extent of adoption of improved production technology of mandarin cultivation. The caste, occupation, educational level, market

distance, information source utilized and knowledge about mandarin cultivation were the important variables for predicting the extent of adoption of improved production technology of mandarin cultivation.

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