DOI: 10.15740/HAS/AU/13.4/396-404 *Agriculture Update*
Volume **13** | Issue 4 | November, 2018 | 396-404
Visit us : *www.researchjournal.co.in*
ISSN-0973-1520

RESEARCH ARTICLE :

Adoption of improved mandarin production technologies among mandarin growers of Darjeeling hills

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ARTICLE CHRONICLE :
Received :
21.08.2018;
Revised :
20.09.2018;
Accepted :
05.10.2018

KEY WORDS :
Adoption, Darjeeling Mandarin, Improved production technologies, Socio-economic

SUMMARY : The study was undertaken with the objective to assess adoption behaviour of improved mandarin production technologies among mandarin orange growers. The study was purposively conducted in the hill region of Darjeeling district in West Bengal where mandarin orange is the pride fruit of the region. In all, 150 respondents were considered for the study and personal interview method was applied for collection of data using semi-structure interview schedule and farm visit. The socio-economic profile of the mandarin orange growers shows that mean age of the respondents was 50 years with mean education upto class 6 and agriculture as primary occupation. Mean land holding was 2.3 hectares with 15 numbers of plants and having 28 years of farm experience. Annual income from mandarin production was about 0.99 lakhs. Majority of the respondents had no social participation and had training exposure among 20 per cent of the respondents. The study shows that adoption of improved mandarin production technologies was low among the mandarin growers. Total Rank Order Score (TROS) shows that proper harvesting time and methods was highly adopted. St aking and supporting was highly adopted by the respondents. The study shows low adoption of soil treatment, seedling preparation, practices of scientific intercropping. The study also shows low adoption of other improved mandarin production technologies like application of manures, application of micronutrient, water treatment, fruit drop control measures and plant protection measures. The study further shows that age ($p<0.01$) of the mandarin growers was negatively correlated and education ($p<0.01$) of the respondents, number of plants ($p<0.05$) and training received ($p<0.05$) by the respondents was positively correlated with adoption of mandarin production technologies. The study reveals that education of the respondents and the numbers of plants in the orchard were the main contributing factors for adoption of improved mandarin technologies.

How to cite this article : Roy, Rakesh, Kharga, Basu Deo and Moktan, Mendel Wangchuk (2018). Adoption of improved mandarin production technologies among mandarin growers of Darjeeling hills. *Agric. Update*, **13**(4): 396-404; **DOI : 10.15740/HAS/AU/13.4/396-404.**

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BACKGROUND AND OBJECTIVES

Mandarin (*Citrus reticulata*) is one of the premier commercial citrus grown in India. 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). 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. In spite of all these, there is a large gap between the productions of mandarin orchard at the research farm at farmers' 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 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 affecting adoption of recommended technologies of mandarin cultivation.

Under such conditions it is very important 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. Therefore, the study was under taken with the objective to study adoption behaviour of scientific mandarin production technologies among mandarin orange growers.

RESOURCES AND METHODS

Study location :

The study was conducted in the hill region of Darjeeling district in West Bengal which is located between latitude 27° 13' N to 26° 27' N and longitude 88°53' E to 87°59' E. Undivided Darjeeling district was spread over 3149 square kilometers. The terrain in the district is both hilly and plain. The temperature ranges between 24°C to 14°C in summer, and between 8°C to 5°C in winter. The hill areas get heavy rainfall in the monsoons. Average rainfall is 2831.9 millimeter and average numbers of rainy days are 106 days (Anonymous, 2012). The altitude of Darjeeling town is 2134 meters above sea level.

Study design :

The study was purposively conducted at Takdah, Mirik and Kurseong block of Darjeeling district due to its high production and area under cultivation of Darjeeling Mandar in. Respondents (50 per blocks) were randomly selected for the study. Thus, the total sample size was 150 respondents for the study. Personal interview method was applied for collection of data using semi-structure interview schedule and farm visit. For assessment of extent of adoption, the response were collected against each of the practice on three point continuum representing fully adopted (2), partially adopted (1) and not adopted (0) and Total Rank Order Score (TROS) were calculated by summing up the total score for the practices.

Data analysis :

Data were coded and entered into excel spread sheets and simple statistical analysis such as frequency, percentage, mean, mode and standard deviation was performed using SPSS 20 software.

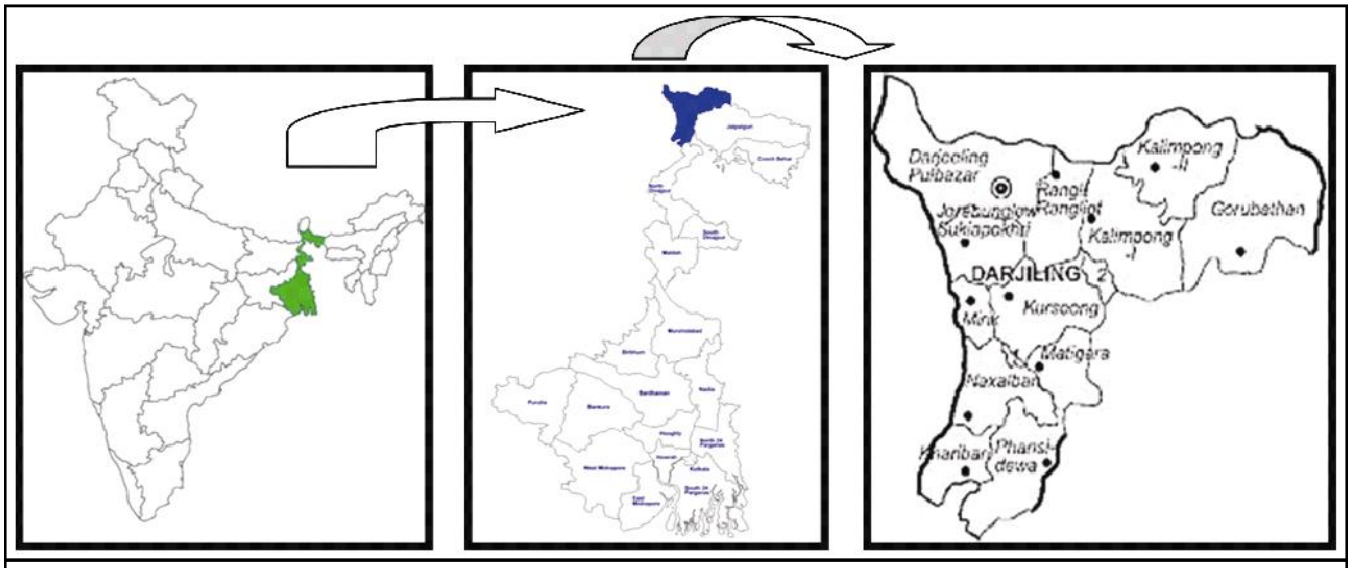

Fig. A : Map showing the study area

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Socio-economic characteristics of the mandarin growers :

The study shows that mean age of respondents was 50 years (Table 1). The modal family size of respondents was 6 members. Mean education level of respondents was upto class 6. Family education status of respondents was 3.97 which mean that other members of the family were educated. Primary occupation for majority of respondents was agriculture (58.67%) followed by labour (17.33%). Majority (44%) of respondents were Hindu followed by Christian (37.33%) and belong to general caste (40%) followed by schedule tribe (38.67%) and schedule caste (14%). Meena *et al.* (2017) reported that majority of respondents (59.17%) were middle age, followed by old (21.67%) and young age (19.17%) category and education of majority (65%) of respondents was medium level. Khan *et al.* (2007) found higher percentage of respondents (44%) belonged from middle age group and were educated upto middle standard (46%).

Mean land holding of mandarin growers was 2.30 ha where majority of respondents had small land holding (36%) followed by marginal (26.67%) and large (20%). Mahanta and Konwar (2014) reported that maximum respondents of orange growers held 10-15 bighas of area under cultivation. Meena *et al.* (2017) reported that majority (60%) of the mandarin growers in Jhalawar district of Rajasthan state were in small farmers while 40 per cent were marginal farmers.

Mean number of plant of the respondents was about 15 in numbers where majority (78.67%) of the grower had small plants size (≤20 plants). Mean age of orchards was about 38 years but majority (42%) of the orchards falls under old age category followed by medium age (35.33%) and young age (22.67%) category. Farm experience of mandarin growers was more than 28 years but majority (35.33%) of respondents fell under low farm experience followed by medium (30%) and high (25.33%) farm experience.

Annual income from mandarin production was about Rs. 99 thousand but majority (48.67%) of respondents was found having low income in mandarin production (*i.e.*, Rs. ≤50000). Mahanta and Konwar (2014) reported that income from orange cultivation was between Rs. 1-5 lakh in Doomdooma region of Tinsukia district of Assam. The annual family income of the mandarin growers was about Rs. 2.23 lakhs and majority (32%) of the mandarin growers had high family income between Rs. 2-3 lakhs.

No social participation was found among majority (46.67%) of respondents followed by members in one organization (36%). Meena *et al.* (2017) found that majority (73.33%) of the respondents were having no membership of any social organization.

Training exposure of the respondents was about 20 per cent who had received training either from the departments of Agriculture, Horticulture, Krishi Vigyan Kendra or NGOs working in the study area. Meena *et al.* (2012) reported that KVK, Department of Agriculture and NGOs were considered as the most creditable sources by the respondent for collecting the information.

Activities of mandarin growers round the year:

Table 2 describes in details the annual calendar of mandarin orange's growth cycle, management regime and major farming challenges where it was found that the problems of disease pest is one of the most serious. Pests like aphid, citrus dog, leaf miner, trunk borer and fruit fly outbreaks from the month of February and last upto November. The incidence of diseases like foot and root rot (Gummosis), powdery mildew starts from the month of June to August. Mandarin growers have to be cautious about management of these pest and diseases during these months. Irrigation must be given during the critical stages of the crop like root and leaf development stage, flowering and fruit development stage. The nutrients of the mandarin orange depletes every year. The plant nutrients like nitrogen, phosphate and potash must be applied to the plant according to their age.

Extent of adoption of mandarin production technologies :

The study shows that majority (78.67%) of respondents did not test soil of their orchard for proper nutrient management. Only 6.67 per cent had fully adopted soil testing techniques and 14.67 per cent had partially adopted this practice. Majority of respondent did not follow soil testing at the time of planting as well as in bearing stage (Phuse *et al.*, 2007 and Meena *et al.*,

Table 1 : Socio-economic characteristics of mandarin orange grower

Sr. No.	Socio-economic characteristics		Total
1.	Age	Young (≤ 35 years)	24 (16.00)
		Middle (36-50 years)	42 (28.00)
		Old(≥ 51 years)	84 (56.00)
		Mean ± SD	50.02± 14.27
2.	Family size	Small (≤5 members)	69 (46.00)
		Medium (5-7 members)	49 (32.67)
		Large(≥ 8-9 members)	32 (21.33)
		Mode	6
3.	Education (Year of Schooling)	Illiterate	19 (12.67)
		Primary	46 (30.67)
		Junior	54 (36.00)
		High	13 (8.67)
		Intermediate	6 (4.00)
		Graduate	12 (8.00)
		Mean ± SD	5.74±4.14
4.	Family education status	Small (≤3)	52 (34.67)
		Medium (3.1-4)	62 (41.33)
		Large(≥ 4.1)	36 (24.00)
		Mean ± SD	3.97±2.78
5.	Primary occupation	Agriculture	68 (58.67)
		Animal husbandry	12 (8.00)
		Labour	23 (17.33)
		Business	9(6.67)
		Service	14 (9.33)
6.	Religion	Hindu	66 (44.00)
		Christian	56 (37.33)
		Buddhist	14 (9.33)
		Other	14 (9.33)
7.	Caste	General	60 (40.00)
		Other Backward Caste	11 (7.33)
		Schedule Caste	21 (14.00)
		Schedule Tribe	58 (38.67)
8.	Land holding	Marginal (≤ 1 ha)	40 (26.67)
		Small (1.1-2 ha)	54 (36.00)
		Medium (2.1-3ha)	26 (17.33)
		Large (≥3ha)	30 (20.00)
		Mean ± SD	2.30±1.07
9.	No. of plants	Small (≤ 20 plants)	118 (78.67)
		Medium (21-40 plants)	22 (14.67)
		High (≥41 plants)	10 (6.67)
		Mean ± SD	14.94±9.91
10.	Orchard age	Young(≤ 20 years)	34 (22.67)
		Medium (21-40 years)	53 (35.33)
		Old (≥ 41 years)	63 (42.00)
		Mean ± SD	38.22±10.13

Contd… Table 1

Table 1 contd..

11.	Farm experience	Low (≤ 20 years)	53 (35.33)
		Medium (21-35 years)	45 (30.00)
		High (36-50 years)	38 (25.33)
		Very high (≥ 51 years)	14 (9.33)
		Mean ± SD	28.77±13.64
12.	Annual income in mandarin production (Rs.)	Low (≤50000)	73 (48.67)
		Medium (50001-100000)	14 (9.33)
		High (100001-200000)	45 (30.00)
		Very high (≥ 200001)	18 (12.00)
		Mean ± SD	98984±114451
13.	Annual family income (Rs.)	Low (≤100000)	21 (14.00)
		Medium (100001-200000)	41 (27.33)
		High (200001-300000)	48 (32.00)
		Very high (≥ 300001)	40 (26.67)
		Mean ± SD	223497±129347
14.	Social participation	No participation	70 (46.67)
		Member in one organization	54 (36.00)
		Member in more than one organization	12 (8.00)
		Office bearer of any organization	14 (9.33)
		Mean ± SD	1.46±1.05
15.	Training exposure	Received	31 (20.67)
		Not received	119 (79.33)

Figures in parenthesis indicate percentage

2012). This might be due to unawareness of the importance of soil testing.

Majority (92.67%) of respondents did not grow disease resistant root stock for grafting. Only 3.33 per cent had fully and partially (4.67%) adopted the technique of grafting. Most (86.67%) of respondents were not getting quality planting materials. This might be due to the fact that resistant root stock seedlings were not available in the region and there was no certified nursery producing quality planting materials.

Majority (92.67%) of respondents had not adopted proper spacing in their orchard and majority (94%) of respondents did not plant their seedling by making proper pit. The reason for not adopting proper spacing might be due to that fact that farmers in the region are small and marginal having small holding and planted more plant in small area of land and very reluctant to make proper pit for planting.

Majority (92.67%) of respondents had not adopted inter-cropping practices in their orchard. Only 2.67 per cent had fully and partially (4.67%) adopted inter-cropping practices in their orchard. It was found in the study that the respondents usually intercropped mandarin orange with nutrient exhaustive crop like ginger, turmeric and maize which were also effecting production of mandarin orange.

The study shows that majority (88%) of respondents did not apply recommended doses of FYM in mandarin orange orchard and even most of respondents did not know proper time and method of application.

Majority (94.67%) of respondents did not apply any fertilizer in their mandarin orchard and even most of the respondents were not aware about proper time and method of application. Meena *et al.* (2012) reported that as regard to time and method of fertilizer application 30 per cent and 22.22 per cent respondents, respectively were adopting these as per requirements. In the study, it was found that the majority of respondents were unaware of importance of doses, time of application and method of application fertilizer in their mandarin orchard.

The study also shows that majority (94.67%) of respondents did not apply or spray any micronutrient in their mandarin orchard. Phuse *et al.* (2007) reported that majority of the respondents did not apply any micronutrient in their mandarin orchard.

The study shows that majority (62%) of respondents

Table 2 : Annual calendar of mandarin orange growth cycle and its management regime

Months	Crop development	Plantation management	Pest and disease outbreak
January	After fruit harvest	– Pruning of dead wood, twigs water suckers and application of copper oxychloride @ 2g/lit of water – Application of FYM @ 40-50 kg/ tree along with N:P:K as per age of treeleaving 1 ft. from the main trunk following ring method – Irrigation after application of FYM followed by mulching for keeping the soil moisture	
February-March	Initiation of new leaves	– Irrigate the field in 10 days interval – Application of micronutrient @ 1g/lit of water – Spraying the tree with Dimethoate@ 2ml/lit of water	Aphid Citrus dog Leaf miner
April-May	Flowering stage	– Irrigate the field in 7 days interval – Spraying the tree with Dichlorvos@ 2ml / lit of water before flowering – Collection and killing of adult trunk borer manually – Hand picking of eggs / larvae from trunk of the tree – Preparation of pit for new plantation	Appearance of adult trunk borer and fruit fly
June-July	Fruit setting	– Stop irrigation with the onset of monsoon – Plugging the borer holes with the application of Dichlorvos – Painting of trunk with copper oxychloride @ 2g/lit of water – Spraying the plant with dimethoate@ 2ml/lit of water – Planting of new plants – Spraying the plant with wetable sulphur@2ml/lit of water – Waterstagnation in orchard should be avoided by proper drainage	Trunk and root rot (Gummosis) Powdery mildew Trunk borer Aphid
August-September	Fruit setting	– Installation of fruit fly trapafter 7 days interval – Spraying the plant with carbendazim@ 2ml/lit of water – Application of FYM @ 40-50 kg/ tree leaving 1 ft. from the main trunk following ring method – Application of micronutrient @ 1g/lit of water for controlling the fruit drop	Fruit fly
October - November	Fruit ripening stage	– Collection and destruction fruit fly attacked fruit in concrete pit – Staking of fruiting plants with bamboo	Fruit fly
December	Harvesting stage	– Harvesting of ripen fruits – Pruning of dead wood and water shoots and application copper oxychloride @ 2g/lit of water	

had not adopted any irrigation in orchard. Only 20.67 per cent of respondents had fully and partially (17.33%) adopted irrigation in orchard. Majority (88%) of respondents did not use any micro irrigation system in their mandarin orchard. Meena *et al.* (2012) reported that 52.22 per cent of respondents did not use drip irrigation. The reasons for no irrigation might be due to the scarcity of water.

Majority (80.67%) of respondents had not adopted any control measure for fruit drop. Only 6 per cent and 8.67 per cent of respondents had fully and partially adopted control measure for fruit drop, respectively.

The study shows that majority (76%) of respondents had not adopted any control measure for various insect and pest. Only 10 per cent and 21 per cent of respondents had fully and partially adopted control measure for various insect and pest, respectively. Phuse *et al.* (2007) reported that majority of the respondents did not adopt any control measures for fruit drop. Mahanta and Konwar (2014) reported that problems in production of orange faced by growers were insect and pest problems.

Majority (93.33%) of respondents had not adopted any control measure for the management of various diseases. This might be due to the fact that the majority of respondents had poor knowledge about management and control measures of pests and diseases.

Majority (96%) of respondents did not prune and train their mandarin orange plants which might be the sources of diseases and reduced production. Non adoption might be due to unawareness of their respondents.

Cent per cent of respondents were supporting or staking to mandarin orange fruiting plant. Respondents use bamboo poles for staking at the time fruiting to protect the plant from breakage due to heavy fruit load. Meena *et al.* (2012) reported that out of standard recommended package of practices, the highest adoption was recorded in case of staking.

Majority (90.67) of respondents harvest mandarin

Table 3 : Extent of adoption of improved production technologies among mandarin grower

Sr. No.	Practices	FA	PA	NA	TROS
		f (%)	f (%)	f (%)	
1.	**Soil treatment**				
	$CaCO_3$	9 (6.00)	11(7.33)	130 (86.67)	29
	Soil testing	10 (6.67)	22 (14.67)	118 (78.67)	42
2.	**Seedling for**				
	Root stock use	5 (3.33)	7 (4.67)	138 (92.00)	17
	Quality seedling	7 (4.67)	13 (8.67)	130 (86.67)	27
3.	**Spacing**				
	Required spacing	4 (2.67)	7 (4.67)	139 (92.67)	15
	Pit size	3 (2.00)	6 (4.00)	141 (94.00)	12
4.	Scientific inter cropping	4 (2.67)	9 (4.67)	137 (92.67)	17
5.	**Application of manures**				
	Doses	8 (5.33)	10 (6.67)	132 (88.00)	26
	Time of application	19 (12.67)	34 (22.67)	97 (64.67)	72
	Method of application	12 (8.00)	16 (10.67)	122 (81.33)	40
6.	**Application of fertilizer**				
	Doses	2 (1.33)	6 (4.00)	142 (94.67)	10
	Time of application	3 (2.00)	5 (3.33)	142 (94.67)	11
	Method of application	6 (4.00)	2 (1.33)	142 (94.67)	14
7.	Application of micronutrient	3 (2.00)	5 (3.33)	142 (94.67)	11
8.	Treatment at blooming stage	3 (2.00)	5 (3.33)	142 (94.67)	11
9.	**Water treatment**				
	Practice of irrigation	31 (20.67)	26 (17.33)	93 (62.00)	88
	Sprinker	7 (4.67)	11 (7.33)	132 (88.00)	25
	Drip from Jhora	6 (4.00)	11 (7.33)	133 (88.67)	23
	Picher	8 (5.33)	5 (3.33)	137 (92.67)	26
10.	Fruit drop				
	Control of disease	9 (6.00)	13 (8.67)	138 (92.00)	31
	Control of pest	12 (8.00)	17 (11.33)	121 (80.67)	41
11.	**Plant protection**				
	Various pest	15 (10.00)	21 (14.00)	114 (76.00)	51
	Control measure over diseases	2 (1.33)	8 (5.33)	140 (93.33)	12
	IPM schedule	0 (0.00)	6 (4.00)	144 (96.00)	6
12.	Time of training and pruning	0 (0.00)	3 (2.00)	147 (98.00)	6
13.	Supporting/ Staking	121 (80.66)	29 (19.33)	0 (0.00)	271
14.	**Harvesting**				
	Time	136 (90.67)	14 (9.33)	0 (0.00)	286
	Methods	24 (16.00)	58 (38.67)	68 (45.33)	106

FA= Full Adoption, PA= Partial Adoption, NA= No Adoption, TROS= Total Rank Order Score; Figures in parenthesis indicate percentage

timely but about 45 per cent of respondents did not know proper method of harvesting. Meena *et al.* (2012) reported that majority of respondents were following proper method of harvesting but Phuse *et al.* (2007) had reported that majority of the respondents had not adopted proper timing of harvesting. Farmer harvests their fruits simply by plucking the fruit manually when its ripening colour appears which fetch them good market price.

The study shows that adoption behaviour of improved mandarin production technologies was low among the mandarin growers. Total Rank Order Score (TROS) shows that harvesting time and methods was highly adopted. Adoption rate of staking and supporting

was highly adopted by the respondents. The study shows low adoption of soil treatment, seedling preparation, practices of scientific intercropping. The study also shows low adoption of other improved mandarin production technologies like application of manures, application of micronutrient, water treatment, fruit drop control measures and plant protection measures but this has to be mentioned that medium aged farmers who were exposed to training had adopted some of the improved mandarin production technologies and had higher income in mandarin orange production. Majority of orange growers had adopted recommended cultivation practices of orange to medium extent (Thakare *et al*., 1996 and Bhople *et al*., 1996).

Correlation of socio-economic factors with adoption behaviour :

Table 4 shows that age ($p<0.01$) of the mandarin growers was negatively correlated with adoption of mandarin production technologies. The study also shows that education ($p<0.01$) of the respondents, number of plants ($p<0.05$) and training received ($p<0.05$) was positively correlated with adoption of mandarin production technologies. Yadav *et al.* (2013) found that extent of adoption of improved production technology of mandarin cultivation by the farmers was

Table 4 : Correlation co-efficient of adoption behaviour with independent variables

Sr. No.	Variables	Correlation
1.	Age	-0.236**
2.	Family size	-0.071
3.	Education	0.370**
4.	Family education status	0.014
5.	Land holding	-0.104
6.	No. of plants	0.200*
7.	Orchard age	-0.035
8.	Farm experience	0.089
9.	Income in mandarin orange	0.026
10.	Annual income	0.037
11.	Social participation	0.137
12.	Training	0.057*

* and ** indicates significance of values at P<0.05 and 0.01, respectively

Table 5 : Multiple regression of adoption of improved production technologies with selected independent variables

Model	Unstandardized co-efficient		Standardized co-efficient	t	Sig.
	B	Std error	Beta		
(Constant)	5.479	3.810		1.438	0.153
Age	-0.037	0.037	-0.086	-1.014	0.312
Family size	-0.368	0.264	-0.105	-1.395	0.165
Education	0.574	0.130	0.383	4,418	0.000
Family education status	-0.018	0.056	-0.025	-0.313	0.755
Land holding	-0.584	0.439	-0.101	-1.331	0.185
No. of plants	0.203	0.051	0.324	3.946	0.000
Orchard age	-0.009	0.047	-0.014	-0.190	0.850
Farm experience	0.068	0.035	0.149	1.911	0.058
Income in mandarin orange	-6.203	0.000	-0.114	-1.274	0.205
Annual income	2.857	0.000	0.060	0.705	0.482
Social participation	0.407	0.445	0.069	0.916	0.361
Training	0.870	1.161	0.057	0.749	0.455

R^2= 0.720

positively and significantly related with caste, occupation, educational level, irrigation potentiality, source of information utilized and knowledge about mandarin cultivation.

Multiple regression of adoption behaviour of improved mandarin production technologies with selected independent variables :

Table 5 shows that the multiple regression of adoption behaviour of improved mandarin technologies with selected independent variables. The study shows that education of the respondents and the numbers of plants in the orchard were the main contributing factors for adoption behaviour of improved mandarin production technologies. It means that if the education and number of plants of the mandarin grower increases adoption of improved mandarin production technologies also increases. Here R^2 value is 0.720, meaning 72 per cent of the variance of adoption of improved mandarin technologies is explained by the independent variables. Yadav *et al.* (2013) reported 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 (Anavrat, 2015).

Conclusion :

The study has also pointed out that adoption of improved mandarin production technologies among mandarin growers was low with high orchard age which was unable to produce at its best. The study has also pointed age of mandarin growers was negatively correlated and education of respondents, number of plants and training was positively correlated with the adoption of mandarin production technologies. Therefore, policy makers and extension agencies working in the study area should come up with more appropriate production technologies addressing the problems and constraints of the farmers in the region so that the pride fruit of the region may regain its production and productivity to its maximum.

Acknowledgement :

The authors are thankful to the mandarin orange growers who had spared their time for the interview and field visit.

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