



Rejuvenation techniques for revival of the senile and old almond (*Prunus dulcis*) orchard in north western Himalaya region

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Received: 27 January 2014; Revised accepted: 22 September 2014

ABSTRACT

An experiment was conducted during 2009-11 at CITH, Srinagar, J&K to standardized the rejuvenation techniques in old and senile almond (*Prunus dulcis* (Mill) DA Webb) orchard. Highest graft success and number of laterals were recorded in P2 pruning level and the F1 fertilizer dose resulted highest linear growth of laterals and graft success. Water harvesting structure W1 resulted highest linear growth (52.25 cm), number of laterals (10.47) and graft success (27.73%). The V1 (Waris) variety resulted highest graft success among the varieties. The treatment combination P3F1W1V1 resulted highest canopy area (2.85 m²), however, the nut yield (1.94 kg/tree) was noted in P1F1W1V1 treatment combinations.

Key words: Almond, Canopy area, Rejuvenation, Pranyaj, Top grafting, Waris, Water harvesting.

Extensive benchmark surveys across the north western Himalayan almond plantations revealed that growers are not aware about the scientific rejuvenation techniques of the nut crops. The rejuvenation is a holistic approach which comprises pruning, top grafting or budding, fertilization, irrigation and overall management of disease and insect pest. Therefore, considering the foremost advantages of rejuvenation the present experiment was under taken.

MATERIALS AND METHODS

The experiment was conducted in Kashmir Valley, J&K, India, which is situated at an altitude of 1390 meters above mean sea level and between 34°75' North latitude and 74°50' East longitude. Climate is wet temperate type with severe winter temperature ranging from -15 to 3°C and the precipitation occur in form of snow and rain. Spring season also experiences heavy to light snow fall along with rain, during summer season temperature ranges from 15-35°C with cooler nights. Soil of the site is sandy loam. For this experiment old and unproductive almond trees 40-50 years old were selected. Preliminary survey was carried out to record the health, yield potential and the average production. The average productivity of dry almond recorded in the range of 0.5 to 1 kg/tree. Average annual shoot growth was in the range of 15 to 20 cm with high incidence of twig dieback, blossom blight, shot hole, gummosis and insects like stem borer, hull borer etc. The canopy of

individual tree was not in proper shape and full of criss crossed and unmanaged branches. All the almond trees selected for rejuvenation were earmarked with red paint. Three levels of pruning, i e P1 = 1st order pruning of branches, existing on main trunk, P2 = Pruning of 2nd order branches on the secondary branches and P3 = 3rd order branches pruning at the top and periphery of the tree with two levels of fertilizer dose, F1 = 0 kg FYM+500 g N + 250 g P₂O₅ + 700 g K₂O, F2 = 50 Kg FYM + 500 g N + 250 g P₂O₅ + 700 g K₂O, two water harvesting structures (W1 = cup-plate shape and W2 = Full Moon shape) and top working with two varieties (V1 = Waris and V2 = Pranyaj). Pruning treatments were employed as per methodology described by Krueger *et al.* (1996) starting from last week of January to first week of February. Major cut portion were pasted with Chaubattia paste. Over-crowded, dried and diseased branches were removed completely. Half dose of nitrogen, full dose of P₂O₅ and K₂O along with full dose of FYM were applied in January-February and remaining half dose of N was applied in the 1st week of June. Tree basins were covered with black polythene mulch having 250 micron thickness. During subsequent years, light corrective pruning was done to avoid breakage of branches. Scion wood of Waris and Pranyaj varieties were collected from healthy and certified progeny bank of Central Institute of Temperate Horticulture, Srinagar. Top grafting by cleft method was done in February-March on one year old water shoots available on scaffold branches. To prevent leaf curl and other fungal diseases Copper-oxy-chloride @ 300 g/ 100 litre of water was sprayed twice during November and December. Observations on graft success, scion growth (linear and radial growth), number of primary and secondary

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branches, nut weight, yield per tree and canopy area were recorded. Per cent canopy growth over control canopy (tree left un-rejuvenated) was calculated as per formulae:

$$\frac{\text{Canopy area of rejuvenated trees}}{\text{Canopy of control tree}} \times 100$$

The present experiment was carried out in Factorial Randomized Block Design with four factors each treatment was replicated thrice with two plants per replication. Data were statistically analyzed with the help of Minitab software and are presented in the tables for interpretation of the results.

RESULTS AND DISCUSSION

Main effect of pruning levels, fertilizer doses, water management techniques and varieties on grafting success and growth parameters in rejuvenated trees

The main effect of pruning level, fertilizer level, water conservation techniques and varieties has great influence on graft success and growth of the scion of rejuvenated trees. Significant effect of pruning level recorded on linear growth of scion, highest growth (53.54 cm) noted in P1 followed by P2 (50.45), whereas lowest in P3. However the P2 had highest number of laterals (11.41) and graft success 37.55 (37.97) per cent. The fertilizer dose had significant impact on the different growth parameters and graft success. Significantly highest linear growth (52.27 cm) and diameter of laterals (5.84 mm) were recorded in F1 and number of laterals (10.58) and graft success (29.50%) were noted in F2 level. The linear growth (52.25 cm), number of laterals (10.47), diameter of laterals (5.37) and graft success (27.73) were recorded significantly high in W1 water harvesting structure. The V1 (Waris) variety had significant effect on linear growth of scion (54.61 cm) and graft success (36.12%), however varietal difference for number of laterals and their diameter found non-significant (Table 1).

Table 1 Main effect of pruning intensities, fertilizer levels, water management techniques and varieties on growth of rejuvenated almond tree (2009)

Treatment	Linear growth of scion (cm)	No. of laterals	Diameter of laterals (mm)	Graft success (%)
P ₁	53.54	9.70	5.08	20.18 (26.11)
P ₂	50.45	11.41	4.96	37.55(37.97)
P ₃	47.79	8.33	5.45	22.19(27.57)
CD (P =.05)	1.28	0.96	0.35	2.10(1.84)
F ₁	52.27	9.13	5.84	23.78(28.36)
F ₂	48.91	10.50	4.48	29.50(32.76)
CD (P = 0.05)	1.05	0.78	0.28	1.71(1.50)
W ₁	52.25	10.47	5.37	27.73(31.39)
W ₂	48.94	9.16	4.96	25.55(29.72)
CD (P = 0.05)	1.05	0.78	0.28	1.71(1.50)
V ₁	54.61	9.63	5.15	36.12(37.13)
V ₂	46.58	10.00	5.18	17.16(23.98)
CD (P = 0.05)	1.05	0.78	0.28	1.71(1.50)

Main effect of pruning levels, fertilizer doses, water management techniques and varieties on canopy area and yield characters in rejuvenated trees

The effects of different variables were recorded on canopy area and growth, nut weight and yield/tree, 3 years after rejuvenation. Significantly highest canopy area (2.12 m²) were recorded in P1 level closely followed by P3 level. Similarly canopy growth (60.57%) over control were recorded in P1, however, nut weight and yield were found non-significant. The main effect of fertilizer dose on canopy area and growth, nut weight and yield were found non-significant. Similarly impact of water harvesting structures and varietal difference on canopy area and growth, nut weight and yield per tree were found non-significant.

Interaction effect of pruning levels, fertilizer doses, water harvesting structures and varieties on different growth parameters and yield of rejuvenated trees

Significant differences among interaction effect were noted with respect to different growth parameters and yield of rejuvenated trees. Highest canopy area (2.85 m²) and per cent growth of canopy over control (81.42%) were recorded in P3×F1 (1st level of fertilizer dose)×W1 (cup-plate type of tree basin)×V1 (Waris) variety followed (2.55 m²) and 73% in P1F1W1V1. The lowest values for canopy area and canopy growth over control (1.78 m² and 51%, respectively) were noted in treatment combination of P2F1W1V2 treatment. Nut weight was recorded highest (3.46g) in P1F1W1V1 treatment combination. However, other treatment combinations were also found to be statistically at par. Nut yield was recorded highest (1.94 kg/tree) in P1F1W1V1 followed by (1.53 kg/tree) in P1F1W2V1 treatment combination. Comparatively the lowest nut yield (0.97 kg/tree) was recorded in treatment combination of P3 (3rd level of pruning)×F2 (2nd level of fertilizer dose)×W2 (full moon shape tree basin)×V2 (Pranyaj) variety (P3F2W2V2).

The initial bud take of in top grafted varieties normally depended on genotype and method of grafting. Cleft grafting was highly successful as top working method in February-March on apple in the North Western Himalayan temperate region (Das *et al.* 2011). Variations in grafting success might be due to presence of varied amount of endogenous phytochemicals including tannins and other secondary metabolites in bud tissues of different seedling origin trees. Moreover, in the present study variety Waris gave better result which might be due to that it may have more favorable endogenous organic compounds required for graft success. Flowering and fruiting started in the second year after top grafting in rejuvenated trees. Because it is well documented that scion wood taken for grafting from adult trees had already attained physiological maturity contains Florien hormones and other essential chemicals for expression of reproductive phase in deciduous fruit trees (Bernier 1988 and Faust 1989). Better grafting success, vegetative growth and yield was recorded in cup plate type of water harvesting structure might be due to more efficient water conservation

Table 2 Main effect of pruning levels, fertilizer doses, water harvesting structures and varieties on vegetative growth and nut weight of rejuvenated almond trees (2011)

Treatment	Canopy area (m ²)	% Growth over control (C=3.5 sq m)	Nut weight (g)	Yield (kg/tree)
P1	2.12	60.57	2.82	1.38
P2	2.06	58.85	2.49	1.21
P3	2.11	60.28	2.51	1.19
CD (P=0.05)	1.06		1.92	1.50
F1	2.08	59.42	2.67	1.29
F2	2.12	60.57	2.54	1.23
CD (P=0.05)	1.03		1.57	1.22
W1	2.15	61.42	2.68	1.32
W2	2.04	58.28	2.53	1.20
CD (P=0.05)	1.06		1.57	1.22
V1	2.18	62.28	2.56	1.38
V2	2.01	57.42	2.65	1.15
CD (P=0.05)	1.06		1.57	1.22

in the trench type structure which helps in slow and long duration of moisture availability to the active root zone of the trees. This is well proven from the yield record of some of the rejuvenated trees in the second year where 400-600 nuts were harvested. High canopy volume exhibited positive relationship with nut yield of rejuvenated trees, but were negatively related with nut weight. It may be due to more number of fruits with increasing canopy area which resulted in relatively lower nut weight. These results are in conformity with Mishra *et al.* (2007), who recorded good qualities of fruits in rejuvenated aonla trees. Increased tree canopy volume, yield and quality of fruits on the rejuvenated trees are the resultant of growth of new healthy shoots and luxuriant leaves which exhibited high photosynthetic efficiency and ultimate partitioning to the fruiting portion (sink) keeping a well balance in vegetative and reproductive growth. Similarly, Mistry and Patel (2009) and Burondkar *et al.* (2000) also recorded canopy growth of rejuvenated mango trees in similar pattern. Yield of the rejuvenated almond trees can also be corroborated with the findings of Clair-Maczulajtys *et al.* (1996) in rejuvenated tree of avocado at Florida, USA.

Pruning intensity in combination with inorganic sources of N, P and K as well as organic manures had a significant effect on different parameters which are evident from the interpretation of year wise data. Pruning of 2nd order branches (P₂) had a very significant effect on grafting success, successive scion growth and numbers of newly lateral shoots on the scion. In the second year, observations on number and length of primary and secondary branches and nut yield of the top worked scion variety showed that trees which were subjected to either 2nd level of pruning (i.e. pruning of 2nd order branches on the secondary branches) or 3rd level of pruning (i.e. pruning of 3rd order branches) in the first year had positive effect on these parameters. Off course, inorganic sources of N, P and K in combination

Table 3 Interaction effect of P*F*W*V on vegetative growth and nut weight of rejuvenated almond trees (2011)

Treatment	Canopy area (m ²)	% growth over control (C=3.5 sq m) Factor = 4	Nut weight (g)	Yield (kg/tree)
P1F1W1V1	2.55	73.00	3.46	1.94
P1F1W1V2	1.93	55.00	3.33	1.39
P1F1W2V1	1.93	55.00	2.51	1.53
P1F1W2V2	1.98	57.00	2.63	1.21
P1F2W1V1	2.03	58.00	2.70	1.66
P1F2W1V2	2.31	66.00	2.66	1.19
P1F2W2V1	2.05	58.00	2.56	1.13
P1F2W2V2	2.23	63.80	2.71	1.02
P2F1W1V1	1.98	57.00	2.43	1.23
P2F1W1V2	1.78	51.00	2.73	1.06
P2F1W2V1	2.10	60.00	2.46	1.29
P2F1W2V2	2.10	60.00	2.36	1.04
P2F2W1V1	2.31	66.00	2.46	1.47
P2F2W1V2	2.16	61.71	2.63	1.15
P2F2W2V1	2.03	58.00	2.38	1.19
P2F2W2V2	2.06	58.85	2.50	1.25
P3F1W1V1	2.85	81.42	2.16	1.25
P3F1W1V2	1.98	56.57	2.60	1.10
P3F1W2V1	2.03	58.00	2.66	1.24
P3F1W2V2	1.78	50.85	2.76	1.24
P3F2W1V1	2.16	61.71	2.36	1.25
P3F2W1V2	1.81	51.71	2.70	1.15
P3F2W2V1	2.21	63.14	2.61	1.35
P3F2W2V2	2.03	58.00	2.20	0.97
CD (P = 0.05)	1.49		2.70	0.75

with organic manures interacted positively with pruning intensities. Canopy development of the top worked trees in the third year was better which were subjected to either 1st or 3rd level of pruning. However, rejuvenation done by 1st level of pruning (i.e. pruning of 1st order branches) resulted in comparatively better vegetative growth as well as yield and nut weight. The observation gives a clear idea about the physiological role of pruning in terms of optimizing relationships among shoot growth, leaf growth, leaf area, photosynthetic activity, building and partitioning of reserves like carbohydrates and ultimate realization for good yields with high quality fruit and pruning intensity is very critical to regulate vegetative and reproductive responses (Daie 1985 and Lang 2001). It is also evident in the present observation that in the initial year, pruning of 2nd order branches was significantly regulating the vegetative phase, however, reproductive and vegetative response in the third year showed that pruning of 1st order branches in the first year was the regulating factor. Cup-plate type of water harvesting structure had a positive interaction with all other treatments. This shape was found to be more efficient in maintaining root zone moisture status at optimal level for better vegetative and reproductive response of the almond trees. Amount, time and method

of application of irrigation water at critical growth stages is very much important to maximize the water use efficiency at the root zone for better shoot growth, canopy development and production of quality nuts (Prichard 1996). A positive relationship of pruning intensities with vegetative growth and a negative relationship with fruit set and yield were also reported by Kaith *et al.* (2011) in apple. Sufficient supply of nutrient elements to the rejuvenated trees which have been subjected to various intensities of pruning is very much important for growth and development of new shoot, leaf enlargement, flower bud development, nut growth and fruit quality (Saiful *et al.* 2009).

The present experiment could be concluded that the old and senile almond orchard can be improvised with judicious pruning along with fertilizer dose, water conservation strategy and well compatible varieties. In this experiment. The treatment combination P3F1W1V1 recouped the canopy size faster. The yield/tree and nut weight harvested highest in P1F1W1V1 treatment combinations.

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