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Propagation of Persian walnut (*Juglans regia* L.) under controlled climatic conditions

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Abstract
Wedge grafting was performed on two year old Persian walnut seedling stocks; in first week of March during the years of 2014 and 2015 under different low cost locally made polyethylene structures (T1, T2, T3, T4, T5 and in natural climatic conditions (T6). The pooled data observations revealed highest bud sprout (86.25 percent), grafting success (53.75 percent) and annual shoot growth (12.75 inches) under low tunnel-cum-trench (T4) against minimum figures of 47.50 percent, 2.50 percent and 6.20 inches respectively in natural climatic conditions (T6). Further, least number of days (54.67) were taken for shoot initiation under low tunnel- cum-trench against that of 78.25 days in natural climatic conditions.

Keywords: Grafting, polyhouse-cum-trench, propagation, walnut, Kashmir Valley

Introduction
Walnut is the main nut crop (above 90% area and production of dry fruits) being grown in the state of Jammu and Kashmir over an area of 91,872 hectares with a production of 2,75,449 MT (Anonymous, 2018) [1]. Of the total area and production under different fresh and dry fruit crops in Jammu and Kashmir State; walnut shares 26% and 11% respectively. The plantations mainly consist of seedling originated plants which have added to the vast gene pool of walnut in the state. Hundreds of such plants have been identified as promising by different scientists of this region; but they could not be multiplied due to very poor success though vegetative propagation in natural conditions (Wani, M.S., 2018) [19]. In other words, the state lacks regular orchards of known quality nuts and the produce mainly comes from the seedling origin trees with quite variable nut and kernel quality coupled with very low productivity (3.0 M T/ha). Even though different state agencies like directorates of horticulture, in Jammu and in Kashmir, SKUAST-Kashmir, CITH-Srinagar and a few nurserymen are involved in vegetative propagation of walnut; only few hundred plants are produced annually against an annual demand for lakhs of such plants by the farmers in general during last few years.

The techniques of vegetative propagation like wedge grafting and patch budding are well known in case of walnut (Gandev, 2009; Mir and Kumar, 2011) [10, 18]. However, there has been inconsistent reports of success of these techniques throughout the walnut growing areas of the world (Deering, 1991; Gandev and Arnaudov, 2011) [7, 12]. Under open field conditions graft success is between 0-20 percent only. Similarly, very little success is achieved through patch budding in case of walnut. Other methods of vegetative propagation such as cutting, layering or tissue culture have also proved futile (Guatam & Chauhan, 1990) [13]. The success of the one or another method of grafting depends largely on the climatic conditions where grafted plants are placed (Achim and Botu, 2001) [2]. It has been reported that walnut grafts do not produce any callus below 20 °C and ideal temperature for healing is 26 °C (Wilbur *et al.*, 1998) [20]. Production of phenolic compounds also results in graft failures. The weather conditions during grafting period (March) remain fluctuating in Kashmir Valley. Temperature and humidity standards required for successful graft- take are not met generally in open field conditions. The earlier recommended zero energy polyhouse technique and hot callusing cable for walnut propagation are felt impracticable by farmers and nurserymen. The state produces only few thousand grafted/budded walnut plants annually, however, demand is in lakhs. The main impediments to choose vegetative propagation of walnut are :- i) Lesser success to total failure of grafts in open field conditions. ii) Lack of electricity for hot callusing cable system. iii) Lack of healthy budwood and root stocks. iv) Difficulties in input arrangements and raising of zero energy polyhouse structures. V) Failure to maintain the requisite temperature and humidity standards in zero energy polyhouses. Considering the above mentioned limitations and requirements for successful grafting, the present study was aimed to find out the possibility of walnut propagation under low cost structures at high altitude conditions.

Materials and Methods

The experiment consisted of six treatments (T1, T2, T3, T4, T5 and T6) was laid out at Fruit Research Sub-station, Balpora (presently AARC), Shopian, Kashmir at an altitude of 1880 m amsl. Low cost locally designed structures like trenches covered with polyethylene (200 gauge) on northern and southern sloppy aspect of the field (T1 and T2 respectively), low tunnel (T3), low tunnel-cum-trench (T4), zero energy polyhouse (T5) were prepared from popular timber and polyethylene; for graft- take comparison with open field conditions (T6). Each of structure was built over a ground area of 30 square feet consisting of 40 plants in two rows (20 plants in each row) at the spacing of 6x18 inches and each replicate unit was taken as 10 no. of plants within a particular structure.

Grafting work was accomplished in first week of March during the year 2014 and 2015. Walnut seedling rootstocks were raised from thick shelled randomly selected nuts during the year of 2012 and 2013; over which wedge grafted was performed in *ex situ* (table grafting) with 15-20 cm long previous years scion wood carrying 2-3 buds. Scion wood was taken from the plants producing better quality nuts from farmer's field. Observations with respect to bud-sprout (percent), days to shoot initiation (1 inch length), graft take (percent) were recorded from time to time till final observations in each aspect. Leaf count was made at the end of August month when further leaf emergence ceased whereas scion girth (cm) and shoot growth (cm) were recorded after leaf fall in the month of October. Temperature and relative humidity were measured by thermo-hygrometer installed inside the polyhouse structure at 12.00 noon for the month of March-April and average was calculated. The pooled data was subjected to statistical analysis as indicated by Chandel (2006) [6].

Results and Discussion

The costs involved in preparing either trenches covered with polyethylene, low tunnel or low tunnel-cum-trench was found to be <70 percent to that of the cost incurred upon raising of zero energy polyhouse (Table 1). This may lure innovative and early adaptor, nurserymen and farmers to adopt vegetative propagation of walnut at grass root level. As delineated in data of Table 2, percent bud-sprout was significantly higher in all the polyhouse structures as compared to open field conditions with maximum value (86.25 percent) under low tunnel-cum-trench which may be due to relatively desirable temperature (33.9 ºC) and humidity (72%) records under this structure. Alike bud-sprout (percent), graft- take was also found significantly higher in all structures as compared to open field conditions and it was maximum (53.75 percent) under low tunnel-cum-trench environment. This may be due to the fact that temperature and humidity records in this structure were close to the optimum values of 25±5 °C (temperature) and 80±10 percent (humidity). Lagerstedt (1979) [15] and Millikan (1984) [16] have found optimum temperature as 27 °C (±3.5 °C) in walnut for callus formation. Karadeniz (2005) [14] reported that graft- take is affected by relative moisture and temperature. The studies of Gandev and Dzhuvinov (2006) [9] also supports the fact that walnut grafting is successful in controlled conditions than in open field conditions. Similar opinion has been expressed by and Mina *et al.* (2016) [17] Higher graft- take under low tunnel-cum-trench may also be attributed to lesser fluctuating temperature and humidity observed under such structure as compared to other structures and open field conditions. Also; in my opinion the hanging live grasses from inside upper surface of the trench towards the plants caused a shaddy effect resulting in lower phenol production at graft union, moreover such weeds might have improved humidity status within the structure. Balata *et al*. (1996) [5] have reported that the change of temperature and relative moisture especially during and after grafting directly affects the development of a good graft union.

Although non-significant differences were recorded in scion girth and number of leaves under all treatments; significant differences with respect to days taken for shoot growth initiation, total shoot growth, number of leaves and leaflets were recorded between different treatments. Days taken for shoot growth initiation were found minimum (54.67) under low tunnel-cum-trench treatment (T4) which is at par with zero energy polyhouse (T5), however, remarkably maximum number of days (78.25) were required for shoot growth initiation under open field condition (T6). This may be due to inadequate environmental conditions (18.06 °C and 38.50 percent relative humidity) resulting in slow callus formation and healing at graft union. Asante and Barnett (1997) [3] has reported very late initiation and low amount of callus production in mango at temperature below 20 °C. Total shoot growth also followed similar trend. However, higher shoot growth in trenches covered with polyethylene and in low tunnel-cum-trench could be because of phototropism effect and lower auxin degradation. Erdogan (2006) [8] has recorded shoot growth between 40-50 cm in successful walnut grafts. Number of leaflets among all the treatments except low tunnel-cum-trench were found at par. Least number of leaflets under low tunnel-cum-trench could be because of higher competitions for water and nutrients and light among the grafted plants because of higher graft- take success.

It may be concluded from this experiment that walnut grafting and subsequent shoot growth is greatly influenced by environmental conditions prevailing around the grafted plants and keeping grafts slightly shady proves helpful for graft success. Low-tunnel-cum-trench is better choice for walnut propagation compared to earlier recommend zero energy polyhouse structures. However, such structures should be raised in the areas where water seepage and land erosion is avoidable.

Table 1: Structural cost involved, temperature and relative humidity records under these structures.

Structures (treatments)	Structural cost involved /30 square feet area (Rs.)	Temp. (°C)	Relative Humidity (%)
Trench covered with polyethylene on northern sloppy aspect of field (T1)	980	31.53	68.93
Trench covered with polyethylene on southern sloppy aspect of field (T2)	980	37.42	62.00
Low tunnel (T3)	860	40.29	65.21
Low tunnel-cum-trench (T4)	935	33.96	72.14
Zero energy polyhouse (T5)	1512	34.09	65.50
Open field (T6)	0	18.06	38.50

Table 2: Graft-take success and related growth parameters under different climate controlling structures.

Structures (treatments)	Bud sprout (percent)	Graft take (percent)	Days taken for shoot growth initiation (<1 inch growth)	Total shoot growth (inches)	Scion girth (cm)	No. of leaves	No. of leaflets
Trench covered with polyethylene on northern sloppy aspect of field (T1)	78.75 (66.55)	25.26 (30.82)*	71.33	15.62	2.95	9.75	5.62
Trench covered with polyethylene on southern sloppy aspect of field (T2)	80.10 (63.43)	17.50 (24.73)	69.40	14.00	3.10	11.25	6.81
Low tunnel (T3)	71.25 (57.57)	12.50 (20.70)	71.00	8.52	2.70	11.75	5.37
Low tunnel-cum-trench (T4)	86.25 (68.23)	53.75 (47.15)	54.67	12.75	3.02	9.50	3.62
Zero energy polyhouse (T5)	76.25 (60.83)	23.75 (29.17)	59.33	11.42	2.90	10.50	5.81
Open field (T6)	47.50 (43.57)	2.50 (9.12)	78.25	6.20	2.30	9.67	5.50
CD @ 5 percent LSD	7.76	6.84	6.53	3.31	NS	NS	1.67

*Figures within parentheses are angular transformed values

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