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Propagation of phalsa by cutting: A review

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Abstract
Phalsa is commercially propagated by seeds in India but seed has less viability up to 90-120 days hardly and it is difficult to maintain purity of characters for generation after generation by natural pollination. So, these reasons divert the attention toward vegetative method of propagation in phalsa. In vegetative method of propagation, generally it can be propagated by hardwood cuttings and layering. Propagation by cutting is economically better for farmers and widely employed method because it produce root easily and provide higher survival of cutings. Some factors strongly influenced on growth parameters in phalsa cutting such as growing condition, plant growth regulators, time of planting of cuttings, place of adaptability etc. According to number of previous experiments, phalsa cuttings treated with IBA concentration solution and planting in mist chamber condition showed highest value in number of leaves, survival percentage, shoot length, root length, number of primary root per cuttings, fresh weight of root and dry weight of root per cutting as compare to other plant growth regulators treatments. Mist chamber condition is most suitable for better shoot and root parameters while July planting showed maximum result in all observed characters due higher humidity. Phalsa is hardy crop and can grow easily by hardwood cuttings. So, it does not require any special antiseptic and highly environmentally control condition for propagation.

Keywords: Propagation, phalsa, *Grewia subinaequalis*

Introduction
Phalsa (*Grewia subinaequalis*) is bushy plant and grows mostly in some arid and semi arid areas of India. It is considered as a minor fruit crop which belongs to family Tiliaceae. It is originated from the Indian sub-continent and South-East Asia. It is one of the important fruits of arid and semi arid zones of north India, north western and southern part of India. It is mostly cultivated in Uttar Pradesh, Bihar, Madhya Pradesh, Gujarat and Maharashtra. Due to less knowledge about importance of phalsa and problem like non synchronizing ripening behavior, this crop is avoided by farmers to cultivate for larger scale. Phalsa is known by different name in different states of India. In Hindi, phalsa is known as dhamin, parusha and shukri, while in Punjabi, it is called dhaman. It is also known as man-bijal in Assamese, phalsa and shukri in Begali, phalsa in Gujrati, and phalsi in Maharashtra.
Phalsa is commercially propagated by seeds in India but seed has less viability up to 90-120 days hardly when stored in ambient condition and it is difficult to maintain purity of characters for generation after generation by natural pollination hence, vegetative propagation is mostly accepted now a days. The propagation of phalsa can be done by hardwood cuttings as well as layering (Samson, 1986) [10]. Propagation of phalsa by cutting is accepted due to easy root initiation and less precision requirement during cultivation. In cuttings, plant growth regulators like IBA, NAA etc. applied exogenously induce better and early rooting.
Rooting of cutting in phalsa depends on various factors such as type of cutting, pre-treatment of cutting, environmental factors, time of planting, method of planting etc. which effects on survival ability of cuttings. In phalsa, generally growth regulators are used to improve its rooting ability. There is exists of lot of contradiction with regards to optimum concentration of growth regulator treatments. Hence, it is possible that optimum use of growth regulators would help for rapid multiplication in propagating of phalsa cuttings.
Various classes of growth regulators such as auxins, cytokinins, gibberellin and ethylene influence root initiation in cuttings in which, auxins play important role in root formation in cuttings. Among these growth regulators, different growth inhibitors and promoters play minor role in adventitious root formation (Krul, 1968) [7]. IBA is mostly preferred to induce the root formation in cuttings of vegetative propagated plants. Roots induced by IBA showed a highly increased number of vascular strands in relation to its concentration while NAA stimulates the development of fertile branches in plants.

Auxin enhances the adventitious root formation in cuttings (Blazich, 1988) [1], while the combination with other compounds promotes more root formation the root formation (Kling and Meyer, 1983; Singh and Singh, 2005) [6, 12]. Hence, it is possible that by using optimum concentration of plant growth regulators rapid multiplication in phalsa cuttings can be received.

Reviews of Some Literature

1) Effect of growing condition

Growing condition plays important role in propagation of phalsa by cuttings. Higher humidity and warmer atmospheric condition enhance rooting of cutting. The phalsa cuttings raised in mist chamber condition gave maximum percentage of sprouting, number of sprouts per cutting, length of longest sprout per cutting (cm), number of leaves per cutting, percentage of cuttings rooted, number of roots per cutting and minimum number of days taken for first sprout to appear as compare to open condition (Jadhav, 2007) [5]. Ratnamala *et al.* (2014) [9] observed maximum shoot growth, root growth and survival percentage of phalsa cutting when it was planted in shade net house condition as compare to open condition. Mist chamber condition contains higher humidity and cool condition for better survival of propagules by inhibiting burning effect due to higher temperature and dry condition. The highest value of survival percentage, length of longest sprouts (cm), diameter of thickest sprouts (mm), number of leaves, rooting percentage, number of primary roots, length of longest root (cm), diameter of thickest roots (mm), fresh weight of roots per cutting (g) and dry weight of roots per cutting (g) in phalsa in mist chamber condition as compare to shade house condition observed by Singh *et al.* in 2015 [16]. Singh and Chouhan (2016) [14] also revealed that the phalsa cutting in mist chamber condition gave best value of number of sprouted cuttings, length of longest sprout, diameter of sprout (cm), number of leaves, rooting percentage, longest root length (cm), root diameter (cm), secondary rooting (%), fresh weight of root (g) and dry weight of root (g).

2) Effect of plant growth regulators

Plant growth regulators show beneficial effect on early sprouting and root initiation of cuttings. Prasad and Ram (1989) investigated effect of IBA, NAA, Ethrel and phenolic compound on rooting of phalsa through stool layering and revealed that 10,000 ppm of IBA solution showed pronounced effect on rooting whereas combine effect of IBA 5000 ppm and catechol 5000 ppm produce more number of root and increase root length significantly. The phalsa cutting treated with 200 ppm IBA solution gave maximum percentage of sprouting, number of sprouts per cutting, length of longest sprout per cutting (cm), number of leaves per cutting, percentage of cuttings rooted, number of roots per cutting and minimum number of days taken for first sprout to appear (Jadhav, 2007) [5]. Hardwood cuttings of phalsa treated with IBA at 200 ppm concentration followed by NAA at 100 ppm concentration were most effective for obtaining maximum shoot growth, root growth and survival percentage for its large scale multiplication (Ratnamala *et al.* 2014) [9]. Devi (2015) [2] studied that phalsa cuttings treated with IBA 300 ppm showed highest survival percentage, net returns and cost: benefit ratio. Minimum days taken to sprout, maximum shoot length, shoot girth, number of shoot per cutting, percentage of rooted cutting, number of roots per cutting and length of root in solution combination of IBA 400 ppm and NAA 200 ppm concentration in phalsa was observed (Singh and Bahadur, 2015) [16]. Singh and Tomar (2015) [16] observed the highest value of rooting percentage, number of primary roots, length of longest root, diameter of thickest root, fresh weight of root per cutting, dry weight of root per cutting, length of longest sprout, diameter of thickest sprout, number of leaves, and number of sprout per cutting in phalsa cuttings treated with IBA 2000 ppm concentration. The concentration solution of IBA 2000 ppm shows the best result on survival percentage, length of longest sprouts (cm), diameter of thickest sprouts (mm), number of leaves, rooting percentage, number of primary roots, length of longest root (cm), diameter of thickest roots (mm), fresh weight of roots per cutting (g) and dry weight of roots per cutting (g) in phalsa (Singh *et al.* 2015) [16]. Devi *et al.* (2016) [3] observed the maximum shoot and rooting performance of phalsa under 300 ppm concentration of IBA solution. Singh and Chouhan (2016) [14] reported that the phalsa cutting treated with IBA 2000 ppm concentration solution gave best value of number of sprouted cuttings, length of longest sprout, diameter of sprout (cm), number of leaves, rooting percentage, longest root length (cm), root diameter (cm), secondary rooting (%), fresh weight of root (g) and dry weight of root (g). The phalsa cuttings treated with 200 ppm concentration of IBA solution gave minimum days taken for sprouting, maximum rooting success (%), number of leaves, leaf area (cm^2), number of roots, root length (cm), fresh root weight (g), dry root weight (g), fresh shoot weight (g), dry shoot weight (g), root shoot ratio, survival percentage (%) (Ghosh *et al.* 2017). The highest value of number of sprouted cutting, survival percentage of cutting, length of longest sprout (cm), diameter of thickest sprout, number of leaves, number of sprout per cutting, percentage of rooted cutting, number of primary roots, diameter of thickest root (mm), length of longest root (cm), fresh weight of root (g), dry weight of root (g) in phalsa cuttings treated with 1000 ppm IBA solution (Singh, 2017).

3) Effect of time of planting

In phalsa cuttings, the time of planting play significant role in survival percentage. Planting time shows variation according to different places and their environmental condition. The planting of cutting in monsoon showed better survival due to higher humidity. The planting of phalsa cutting in mid June month gave highest value of rooting percentage, number of planting, length of longest root, diameter of thickest root, fresh weight of root per cutting and dry weight of root per cutting as compare to month of summer and winter season (Singh and Tomar, 2015) [16]. Jadhav (2007) [5] revealed that phalsa cutting planted in July month in mist chamber condition show maximum value of sprouting percentage, length of longest sprout per cutting, number of leaves and rooting percentage as compare to month of summer and winter season.

Conclusion

It is concluded that the phalsa cuttings treated with IBA 2000 ppm concentration solution and planting in mist chamber condition showed beneficial effect in all shoot and root parameters. Higher humidity induces early rooting in cutting while placed in mist chamber condition. The time of planting of cutting also influenced on growth parameters of cuttings. The phalsa cuttings were planted in the month of July showed highest results as compare to other winter and summer season months.

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