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Graft compatibility among the Asian and *Algarobia Prosopis* species

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Abstract

Graft inter-relationships have been studied among four *Prosopis* species, viz. the Asian *P. cineraria* and *P. juliflora*, *P. alba* and *P. nigra* of section *Algarobia*. Reciprocal stock-scion combinations were attempted by bud grafting using each species as stock as well as scion. The autografts in all the four species were successful. In *P. cineraria*, *P. juliflora*, *P. alba* and *P. nigra* respectively 88.9, 88.9, 72.2 and 11.1 per cent successful grafts were obtained. The graft combinations between the species within section *Algarobia* were also successful. Patch budding *P. nigra* scion on *P. juliflora* rootstock gave 83.3 % successful grafts. Thus true-to-type plantations of these species could be raised by patch budding on their own roots. The combinations of *P. cineraria* with any of the other three species of section *Algarobia* were incompatible.

Key words : *Prosopis cineraria*, *P. juliflora*, *P. alba*, *P. nigra*, graft compatibility, *Algarobia* species, *stock-scion combinations*

Introduction

The genus *Prosopis* is widespread in dry tropical and sub-tropical regions of America, Africa and Asia and contains approximately 44 species of mostly thorny trees and shurbs that are well adapted to arid lands (Burkart, 1976). *Prosopis cineraria* (*khejri*) is indigenous to the Indian subcontinent and is most common in India. This important multipurpose species yields edible pods rich in protein, carbohydrates and minerals besides the nutritious leaf fodder and fuelwood. *Prosopis juliflora* belonging to the *Algarobia* section (series *Chilensis*), introduced in India from Latin America during 1857 (Harsh and Tewari, 1998), has had widespread adaptation in the extremely arid regions and now forms a dominant vegetation cover all over the warm tropics and subtropics. It is an important source of fuelwood to the people in the arid areas. *P. alba* and *P. nigra* also of the *Algarobia* section have also been introduced from Latin America.

From the extensive seedling population of *P. cineraria* showing wide genetic diversity, some genotypes that produce pods of high quality (sweet, less fibrous, tender, many seeded and green) have been identified (Pareek and Nath, 1997). True-to-type plantations of these elite trees can be raised by patch budding on the rootstock seedlings of *P. cineraria* (Pareek and Purohit, 2002). But *P. cineraria* is extremely slow growing. *Prosopis juliflora* has been observed to be fast growing and vigorous even under the extremely arid conditions and thus, if used as a rootstock, could invigorate *P. cineraria* scion. The Latin American *P. alba* and *P. nigra* could be more widely adapted if grown on the roots of the indigenous *P. cineraria* or on those of the well adapted *P. juliflora*. Therefore, the present studies were undertaken to study rootstock-scion inter-relationship in these *Prosopis* species.

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Material and methods

Four species, viz. *P. cineraria*, *P. juliflora*, *P. alba* and *P. nigra* were included in this study. The latter two species were included because these alongwith *P. juliflora* belong to section *Algarobia* (series *Chilensis*) and are reported to be graft compatible with each other (Wojtusik and Felker, 1993). To raise rootstock seedlings of these species, seeds were sown during August 2001 in polyethylene tubes (30 cm x10 cm) filled with a mixture of farm yard manure and sand in 1:1 ratio and kept in the nursery under shade net (Agro Shade Net HDPE; 75% shade, green colour polynet). The technique of patch budding, standardized earlier (Pareek and Purohit, 2002), was adopted for grafting. Following experiments were carried out :

i) Six budding operations were done for each stock-scion combination involving each species as stock as well as scion in June, 2002. These were replicated three times. Thus a total of 18 buddings for each combination were

done. Observations were made 40 days after budding (DAB) on scion bud sprouting in different stionic combinations, and 60 DAB on the length of main sprout from its base at the site of budding, diameter of sprout near the base and linear growth (cumulative length of all main and successively emerging sprouts),

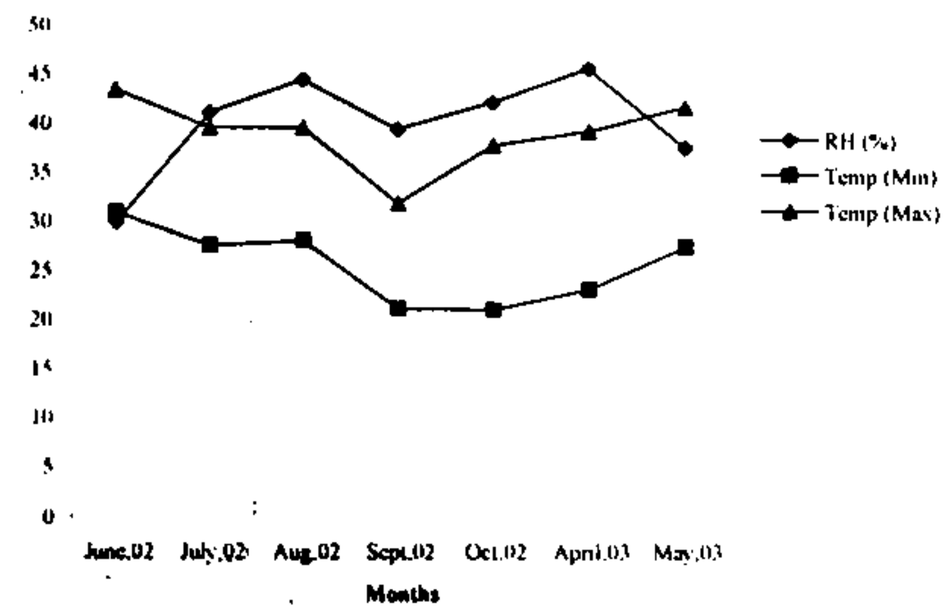
ii) Twenty budding operations were carried out using *P. cineraria* as rootstock and *P. juliflora* as scion during September 2002 and again during April 2003,

iii) Budding operations were done to prepare sufficient number of the following stock-interstock combinations during June 2002 for subsequent budding with *P. cineraria* scion :

a) *P. juliflora-P. juliflora*,
b) *P. juliflora-P. nigra*,
c) *P. juliflora-P. alba*,
d) *P. nigra-P. juliflora*, and
e) *P. alba-P. juliflora*.

On five of each of these stock–interstock combinations, *P. cineraria* scion buds were budded during September 2002. During April 2003, buddings were again done in each case with twenty five *P. cineraria* scion buds on *P. juliflora - P. alba* and *P. juliflora – P. nigra* combinations so that *P. alba* and *P. nigra* served as interstocks between *P. juliflora* rootstock and *P. cineraria* scion.

The temperature and relative humidity (RH) during the experimental period are given in below :



Results

The results presented in Table 1 show that whereas *P. cineraria - P. juliflora* combination gave cent percent sprouting after budding in June 2002, the reciprocal combination did not produce even a single sprout. *P. juliflora* scion made very rapid and lush green growth (246.31 cm linear growth) on *P. cineraria* rootstock but 60 DAB the shoots turned pale green, started drying from the tips 70 DAB and completely dried 95-100 DAB (Table 2). When repeat budding operations were tried in September 2002 and April 2003, even sprouting was not observed in this stock-scion combination. This indicates that both *P. juliflora - P. cineraria* and *P. cineraria – P. juliflora* combinations are not compatible even after sprouting under favourable agroclimate.

P. alba and *P. nigra* also gave respectively 88.88% and 66.66% sprouting on *P. cineraria* rootstock 40 DAB which were initially healthy but made much poorer growth (45.27 and 50.47 cm) than that observed by *P. juliflora* scion buds. These sprouts also started to wither respectively after 85 and 70 DAB and completely dried respectively after 120-180 and 90-120 DAB. The reciprocal grafts of *P. cineraria* on *P. alba* and *P. nigra* also produced 49.99% and 16.66 % sprouting respectively but in both cases the sprouts were dull green, made very poor growth (linear growth 3.5 and 3.2 cm) and withered 75 DAB. Thus the combinations of *P. cineraria* with these two Latin American species although produced sprouts but subsequently showed incompatibility. The time needed for the scion bud to sprout varied from 7 to 27 DAB (Table 2).

Both *P. juliflora–P. nigra* and its reciprocal combinations gave 83.33% successful grafts with linear growth respectively of 74.01 cm and 59.09 cm 60 DAB. Successful combinations of *P. juliflora–P. alba* and its reciprocal grafts were respectively, 44.44% and 66.67% with linear growth, respectively of 57.14 cm and 36.19 cm. In the combinations of *P. alba–P. nigra* and *P. nigra–P. alba* the successful grafts were respectively 22.21% and 44.44% with linear growth respectively of 32.96 cm and 40.08 cm. The successful grafts of these combinations were observed

Table 1. Per cent scion bud sprouting 40 days after budding in different stock- scion combinations of *Prosopis* speci

Rootstock \ Scion	*P. cineraria*	*P. juliflora*	*P. alba*	*P. nigra*	Mean
P. cineraria	88.88 (75.54)	100.00 (85.94)	88.88 (75.54)	66.66 (54.73)	86.01 (72.93)
P. juliflora	0.00 (04.05)	88.88 (72.58)	44.44 (41.75)	83.33 (65.90)	54.16 (46.07)
P. alba	49.99 (45.47)	66.66 (54.73)	72.21 (58.45)	22.21 (27.81)	52.77 (46.61)
P. nigra	16.66 (24.08)	83.33 (72.29)	44.44 (41.75)	11.10 (17.41)	38.88 (38.88)
Mean	38.88 (37.28)	84.72 (71.38)	62.49 (54.37)	45.82 (41.46)	
CD at 5%	R (Rootstock) 8.55	S (Scion) 8.55	R x S 17.10		

Data in parenthesis are angular transformed values.

Table 2. *Prosopis* scion growth on different rootstocks

Rootstock	Days to sprouting	Successful) combinations (%)	Scion growth vigour (60 days after budding) Length of main sprout (cm)	Diameter of main sprout (cm)	Linear growth (cm)	Growth pattern	Growth status
1. Scion : *Prosopis cineraria*							
P.cineraria	10-20	88.88	45.49	0.61	179.67	Normal growth	Healthy growth
P. juliflora	-	0	0.00	0.00	0.00	-	-
P. alba	10-22	0	3.03	0.10	3.50	Sprouts pale, dull green, leaves abscise when touched	Sprouts withered 75 days after budding
P.nigra	11-16	0	2.50	0.10	3.26	do	do
2. Scion : *Prosopis juliflora*							
P.cineraria	7-11	0	74.45	0.82	246.31	Initially shoot lush green, pale green 60 days after budding, vertical splitting at bud union, drying of shoot from apex started 70 days after budding	Shoots dried 95-100 days after budding
P.juliflora	8-26	88.88	30.28	0.40	67.25	Normal growth	Healthy growth
P. alba	9-27	66.67	9.32	0.15	36.19	Normal growth	Healthy growth
P.nigra	8-14	83.33	17.64	0.25	59.09	Normal growth	Healthy growth
3. Scion : *Prosopis alba*							
P.cineraria	8-22	0	13.06	0.30	45.27	Shoots healthy initially, 60 days after budding stunted and pale shoot tip drying 85 days after budding	Shoots dried 120-180 days after budding
P.juliflora	10-25	44.44	19.08	0.34	57.14	Normal growth	Healthy growth
P. alba	7-20	72.22	19.07	0.27	45.76	Normal growth	Healthy growth
P.nigra	9-27	44.44	11.65	0.12	40.08	Normal growth	Healthy growth
4. Scion : *Prosopis nigra*							
P.cineraria	10-23	0	17.40	0.34	50.47	Initially healthy, pale appearance after 50 days drying of shoot started 70 days after budding	Shoots dried 90-120 days after budding
P.juliflora	8-20	83.33	25.05	0.26	74.01	Normal growth	Healthy growth
P. alba	12-14	22.22	10.60	0.17	32.96	Normal growth	Healthy growth
P.nigra	8-13	11.11	7.81	0.15	12.88	Normal growth	Healthy growth
CD at 5%		17.1069	7.3113	0.07498	23.402	-	-

make normal and healthy growth. This shows that the three *Prosopis* species belonging to the *Algarobia* section are compatible with each other and *P. juliflora* proved to be the best both as rootstock and scion. However, the graft potential seems to vary, being the maximum in *juliflora – nigra* combination.

Table 3. Growth of *P. cineraria* scion on different rootstock - interstock combinations

(5 operations in each during September 2002)

Rootstock	Interstock	Number sprouted	Days to sprout	Linear growth (cm)	Growth stat
P. juliflora	*P. juliflora*	0	-	-	-
P. juliflora	*P.nigra*	1	15	1.5	withered 40 D
P. juliflora	*P.alba*	2	12-15	2.2	withered 120 D
P. nigra	*P. juliflora*	0	-	-	-
P. alba	*P. juliflora*	0	-	-	-

The autografts in *P. cineraria*, *P. juliflora* and *P. alba* were highly successful giving respectively 88.9, 88.9 and 72.2 per cent successful grafts but those of *P. nigra* gave only 11.10% successful grafts (Table 1). *P. cineraria* scion made normal, healthy and 179.67 cm linear growth on its own roots which was maximum among the autografts of these four *Prosopis* species (Table 2). The linear growth in autografts of *P. juliflora*, *P. alba* and *P. nigra* was respectively 67.25 cm, 45.76 cm and 12.88 cm. These results appear to be indicative of the graft potential of these four *Prosopis* species.

When *P. cineraria* scion buds were grafted on the successful graft combinations, *P. juliflora – P. nigra* and *P. juliflora – P. alba*, one sprout was obtained in the former and two in the latter during September 2002 and these respectively attained length of 1.5 and 2.2 cm but withered 40 and 120 DAB (Table 3). Repeat budding operations of *P. cineraria* scion buds on these combinations during April, 2003 did not even sprout. When *P. cineraria* buds were grafted on *P. juliflora – P. juliflora*, *P. alba – P. juliflora* and *P. nigra – P. juliflora* combinations, not even a single bud sprouted. These results confirm the presence of graft incompatibility between the Latin American and Asian *Prosopis* species and that the extent of incompatibility appear to be maximum between *P. juliflora* and *P. cineraria*.

Discussion

Bud grafts between the Asian species *P. cineraria* and each of the three species of section *Algarobia*, *P. juliflora*, *P. alba* and *P. nigra* did not survive. The graft combinations of species within the *Algarobia* section which came from the same geographical region were successful. Saidman *et al.* (1998) observed, on the basis of isoenzyme and DNA analysis, that the species of section *Algarobia* showed high degree of similarity among them. It seems that graft compatibility is related to the genetic similarities between the *Prosopis* species used as rootst and scion. Obviously, the less closely related Asian *cineraria* showed incompatibility with the three specie *Algarobia* section. Such inter - section incompatibility been observed by Wojtusik and Felker (1993) betw *Prosopis tamarugo* of the section *Strombocarpa* and species from section *Algarobia*.

The incompatibility reaction between the *Prosopis* sp of these two geographical regions was manifested by complete absence of scion bud sprouting and mortality as in case of *P. cineraria* scion on *P. juli* rootstock; or by unhealthy and poor growth of sp followed by their withering 75 days after budding (D as in case of *P. cineraria* scion on *P. alba* and *P.* rootstocks; or by initial healthy growth of sprouts later withered 90 to 180 DAB as in case of scions species of *Algarobia* section on *P. cineraria* roots The *P. juliflora* scion buds were initially lush gree made as much as 246.3cm linear growth before dryi 90 to 100 DAB. Hartman *et al.* (1990) described re vegetative growth, shoot die back, ill health and prem death of the scion as external symptoms of incompati The differential incompatibility behaviour manifested form of variations in growth patterns of scion co mediated by a mechanism of translocation of toxins one graft partner to the other as suggested by Mosse (Moore (1984) suggested that graft incompatibility only when compounds, that promote successful gr such as auxin, are overridden by toxins as these ma callus tissues unreceptive to growth prom compounds, prevent vascular differentiation and thu the scion of the required water and nutrients.

Healthy growth of the scion buds of the *Algarobia* species on *P. cineraria* rootstock but a or poor growth of scion buds on reverse grafting, *cineraria* on *Algarobia* rootstocks, indicate possibility of basipetal translocation of some toxin in *P. cineraria* scion to cause the incompatibility re Incompatibility of peach on almond rootstock ha ascribed by Gur and Blum (1973) to increased gly activity in almond tissues resulting in accumula cyanide at the graft interface. *P. cineraria* scion buds did not sprout on *P. juliflora* rootstocks, however, s

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me sprouting when either *P. alba* or *P. nigra* were used
interstocks. But the extent of sprouting and growth of
routs were much poorer compared to that by budding
n *P. alba* and *P. nigra* rootstocks. It is therefore, possible
at a factor in *P. juliflora* rootstock on translocation
ctivates the toxin present in the *P. cineraria* scion to cause
e incompatibility reaction. Such incompatibility response
as been reported by Gur *et al.* (1968) when some pear
ultivars were grafted on quince rootstocks. The mechanism
incompatibility operating in the graft combinations
volving Asian and *Algarobia Prosopis* species, however,
eeds to be clearly understood.

All the three species from *Prosopis* section
lgarobia were graft compatible with each other as also
ported earlier in five species of this section by Wojtusik
d Felker (1993). It will be necessary to continue to examine
aft compatibility as the tree reaches maturity because in
me species graft incompatibility may be expressed even
any years after grafting. Among the graft combinations
ithin the *Algarobia* species, *P. juliflora – P. nigra*
peared to be the best presumably because of the higher
aft potential in this combination. Conversely, the lower
afting success of *P. nigra* on *P. alba* or on its own roots
y be due to low graft potential between these
mbinations. Autografts in all the four species were
ccessful. This opens up the possibility of raising true-
ype plantations by multiplying the elite mother trees of
e species. Their existing wild plantations can also be
proved by topworking with the budwood from these elite
es. Considering the per cent success obtained in the
ografts of the four *Prosopis* species, it appears that *P.*
neraria and *P. juliflora* have the maximum graft potential
d the least in *P. nigra*.

The variable growth rates of a scion on different
otstock species may be owing to the metabolic differences
etween the rootstock species. On *P. cineraria* rootstock,
aximum sprouting and growth of sprouts was observed
respective of the scion species. It appears that this
otstock imparted the benefit of its higher metabolic rate
the growth of the scion.

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