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Research Article

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Effect of Interstock on Growth of Vigorous Mango Cultivars under Eastern Plateau and Hill Region of India

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Abstract

Investigations were undertaken at Ranchi of Jharkhand state of India to test the efficacy of mango genotypes Amrapali and Latra be used as interstocks for reducing the plant size of vigorous but popular mango varieties viz. Langra, Himsagar and Bombay Green under eastern plateau and hill conditions of India. Data on plant growth parameters during 2012-13, 2013-14 and 2014-15 indicated decrease in rate of growth of plant height, canopy spread, girth of rootstock, girth of interstock, girth of scion, average length of shoot extension growth in cultivars Himsagar and Bombay Green with interstock of Amrapali. Hence, it was concluded that mango cultivar Amrapali can be effectively used as interstock for reducing plant vigour of mango cultivars Himsagar and Bombay Green.

Keywords

Interstock; Amrapali; Latra; Girth of interstock

Introduction

The eastern plateau and hill agroclimatic zone of India offers suitable climatic conditions for successful cultivation of a number of fruit crops. During the last decade, the region has received attention of the policy makers for largescale area expansion under fruit crops due to the availability of huge tracts of fallow uplands. Among the different fruit crops, mango occupies the most important position with respect to the preference of the growers of the region which is evident from the fact that the crop occupies more than 67% of the total area under fruit crops even if the productivity in the region is significantly lower than other fruit crops. The low productivity of mango in the region is attributed to edaphic constraints like low organic carbon in the soil, soil acidity, deficiency of phosphorus, boron etc. High density orcharding can be the most important practice for improving the productivity of mango in the region. Nath have already reported the feasibility of high density orcharding of mango cv Amrapali under this agroclimatic zone of India.

Among the mango cultivars, the major share under the area expansion programme in the region during the last decade has come from cv Amrapali. This is mainly due to its prolific bearing and high yielding ability. Due to the the dwarf canopy size, the plants of mango cv Amrapali can be planted in high density system which also contribute towards higher productivity of this cultivar. However, late fruit maturity coinciding with heavy rainfall results in poor fruit quality of mango cv Amrapali which fetches lower market price in the region (Banerjee et al. 2015). Fruits of traditional mango cultivars like Langra, Himsagar and Bombay Green fetch higher market price due to the superior fruit quality and time of availability of the fruits under the eastern plateau and hill conditions. However, lower yield of these cultivars, results in unprofitability of traditional mango orcharding under the eastern plateau and hill conditions. Development of high density orcharding can ensure profitability of mango cultivation of these traditional vigorous mango cultivars. However, strategies for high density orcharding have not yet been developed for vigorous cultivars like Langra, Bombay Green and Himsagar.

Control of tree vigour is the first strategy for high density orcharding in any fruit crops. Use of dwarfing rootstock and growth retardants are some of the commonly recommended practices for control of tree vigour in mango Among the growth retardants, use of Paclobutrazol have been found most effective in mango. However, apprehensions on residue in the fruit and harmful effects of paclobutrazol on soil microflora is a limiting factor. Although rootstocks have several applications such as improving fruit quality, imparting adaptability to climatic and edaphic conditions and inducing dwarfing, the priorities of rootstocks selection in the tropics and subtropics have been focused mainly on vigour management and securing regular high fruit yields [1]. Although a number of polyembryonic dwarfing rootstocks have been identified in mango [2] their unavailability on a largescale is a major constraint for their use in high density orcharding. Use of interstocks have also been found to be effective in reducing vigour of mango plants [3-8] although no effect of interstock on plant vigour has also been reported by many workers [9-11]. The interstock is a segment of a tree trunk that it is grafted between the rootstock and the tree. It has been used with different fruit trees to modulate the tree size, fruit production and quality, and the aging of the tree.

The mango hybrid Amrapali and and genotype Latra are known for their dwarf tree size. Although fruits of Amrapali and Latra are abundantly available, due their monoembryonic nature limits their use as dwarfing rootstocks. No information is available on behavior of mango cv Amrapali and Latra as interstock. Keeping this fact in view we undertook an investigation to test the efficacy of these genotypes to be used as interstocks for reducing the plant size of vigorous but popular mango varieties viz. Langra, Himsagar and Bombay Green under eastern plateau and hill conditions.

Materials and Methods

The investigations were undertaken during 2011-2015 at ICAR Research Complex for Eastern Region, Research Centre, Ranchi, Jharkhand, India. The area is situated at 23^{0}25' N and 85^{0}20' E and 620 m above msl. The treatment comprised of combinations of three interstocks viz., no interstock, interstock of Latra and interstock of Amrapali and three vigorous mango cultivars viz. Langra, Himsagar and Bombay Green used as scions. The plants were planted in the field in July, 2010 at a spacing of 5 m x 5 m in a factorial randomized block design with four replications and 10 plants per replication. In case of double grafted plants with interstocks, the uniform length of

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interstock was maintained (10 cm). However, due to the drying of scions of double grafted plants with Latra as interstock during the first year, in-situ grafting of scion on plants with Latra interstock was done during August, 2011. Yearly data were recorded during 2012-13, 2013-14 and 2014-15 on plant growth parameters like height, canopy spread, girth of rootstock, girth of interstock, girth of scion and number of vegetative flushes per year and average shoot length of vegetative flushes. Girth of the rootstock was measured at 5 cm below the first graft union while girth of interstock and scion were measured at 5 cm above the first and second graft union, respectively. The data on plant growth parameters were recorded during the month of September in each year. Values on percent increase over previous season in different growth parameters were also estimated for better interpretation of results. The year wise data were subjected to analysis of variance.

Results

Effect on plant height

During all the three years, significant differences were recorded with respect to effect of interstock and interaction between Interstock x Genotypes (Table 1). In case of two year old plants (2012-13), the minimum plant height was recorded in case of plants with Latra as interstock whereas plants with Amrapali interstock and no interstock did not differ significantly. The lower values of Latra were attributed to the mortality at the time of plant establishment. With respect to interaction effect, the difference in plant height between No interstock and Interstock of Amrapali in all the three genotypes were non-significant. In case of three year old plants (2013-14), the plant height with Interstock of Latra was significantly lower than other treatments although the % increase in plant height over previous season (29.44%) was markedly higher. This can be attributed to their delayed field establishment and persisting juvenility. Although the plant height with No interstock and Interstock of Amrapali did not differ significantly, the rate of increase with Interstock of Amrapali (5.76%) was significantly lower than that with No interstock (18.48%). With respect to the interaction effect, plants of cv Langra with Amrapali interstock had significantly lower plant height than that with no interstock and no such difference could be recorded in case of cvs Himsagar and Bombay Green. However, significantly lower values of % increase in plant height were recorded with both the interstocks in case of the cultivars Himsagar and Bombay Green. This hinted at reduced plant height of mango cultivars Himsagar and Bombay Green with interstock of Latra and Amrapali after three years of planting. During the fourth year of planting (2014-15), both the interstocks resulted in significantly lower values of plant height than that with no interstock. With respect to the interaction effect, the plant height of cultivar Langra and Bombay Green was significantly low with use of interstocks. However, significantly lower values of % increase in plant height was recorded in case of Himsagar on interstock of Latra (2.29% than 18.53% in case of no interstock) and Bombay Green on interstock of Amrapali (10.36% than 34.86% in case of no interstock). Hence, after four years of planting, reduction in plant height of mango cultivars Himsagar and Bombay Green was recorded with use of interstocks of Latra and Amrapali, respectively.

Effect on canopy spread

With respect to average canopy spread, significant effects of interstock, genotypes and interaction between interstock x genotype was recorded during 2012-13 and 2013-14 while during 2014-15, the effect of interstock was significant only (Table 2). However, significantly lower canopy spread of double grafted plants was recorded only in cultivar Langra during 2012-13. With respect to % increase over previous year, significantly lower values than the single grafted plants were recorded in case of cultivar Bombay Green on Amrapali interstock during both the years. Hence, as recorded in case of plant height, use of interstock of Amrapali resulted in reduction in the canopy spread of mango cultivar Bombay Green after four years of planting.

Effect on girth of rootstock

With respect to girth of rootstock, significant effect of interstock and interaction between Interstock x Genotype was recorded throughout the experimental period (Table 3). During 2012-13, the girth of rootstock with interstock of Latra was significantly lower which was attributed to delayed plant establishment. In case of cv Langra with interstock of Amrapali, the value was significantly lower than that in No interstock while no such difference was recorded in other genotypes. During 2013-14, similar trend was recorded. However, marked reduction in the values of % increase over the previous season was recorded during this year with use of interstock particularly in the cultivars Himsagar and Bobmay Green. During 2013-14, the girth of rootstock with interstock of Latra was significantly lower than that with No interstock in all the three cultivars. In case of interstock of Amrapali, the girth was significantly lower than thant of No interstock in mango cultivars Langra and Himsagar. However, the value of % increase over the previous season was markedly lower than that of No interstock only in case of Himsagar on Amrapali interstock. Hence, after four years of planting reduction in the growth rate of rootstock was recorded in of Mango cv Himsagar on interstock of Amrapali. Reduction in circumference of rootstock has also been reported by Yonemoto [8] by use of dwarf variety Khom as interstock indicating.

Effect on girth of interstock

During all the three years of experimentation, the girth of interstock differed significantly and it was significantly higher in case of Amrapali (Table 4). With respect to % increase in the girth

Table 1: Effect of interstock on plant height (m) of mango plants.

	2012-13				2013-14				2014-15			
	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype
Langra	2.35	0.54	1.79	1.56	2.54	0.86	1.92	1.77	2.75	1.74	2.23	2.24
Himsagar	1.59	1.13	1.74	1.48	1.78	1.31	1.81	1.63	2.11	1.34	2.24	1.90
Bombay Green	1.61	1.51	1.82	1.65	2.18	1.72	1.93	1.94	2.94	1.68	2.13	2.25
Average	1.85	1.06	1.78		2.17	1.30	1.89		2.60	1.59	2.20	
SEm±	Interstock (I): 0.17; Genotypes (G): 0.11; I x G: 0.29				Interstock: 0.08, Genotypes: 0.12, I x G:0.15				Interstock: 0.13, Genotypes: 0.11, I x G:0.18			
C.D. at 5%	Interstock (I): 0.48; Genotypes (G): ns; I X G: 0.83				Interstock: 0.24, Genotypes: ns, I x G: 0.46				Interstock: 0.36, Genotypes: ns, I x G: 0.51			

over previous year, during 2013-14, the values in cultivar Langra was markedly lower in case of interstock of Amrapali whereas during 2014-15, values in cultivars Langra and Bombay Green were markedly lower in case of interstock of Amrapali. Hence, the results clearly indicated influence of scion on the growth of interstock also and interstock of Amrapali with cultivar Langra had slower growth rate than that of Latra.

Effect on girth of scion

Significant effects of interstocks and its interaction with Genotypes were recorded on girth of scion during all the three years (Table 5). However, significantly lower girth was recorded in case of interstock combinations of cultivar Langra only. With respect to % increase over previous season, during both 2013-14 and 2014-15, the values in case of cultivars Himsagar and Bombay Green with interstock of Amrapali were markedly lower than that with No interstock. Hence, after four years of planting, interstock of Amrapali resulted in slower growth rate of scion of mango cultivar Himsagar and Bombay Green.

Effect on vegetative flushing and shoot growth

During all the three years, number of vegetative flushes was significantly influenced by interstock and during 2014-15, the effect of interstock x genotype was significant (Table 6). During 2012-13 and 2013-14, the number flushes with interstock Latra was significantly higher which was attributed the juvenility due to delayed establishment. During 2014-15, the number of flushes in cultivar Bombay Green was significantly lower with interstock of Amrapali than that with no interstock. The average length of extension growth was significantly influenced by interstock and interaction between interstock x genotype during all the three years (Figure 1). During 2012-13, in all the cultivars, the length was significantly lower with interstock of Amrapali than with no interstock. However, during 2013-14 and 2014-15, the length with interstock of Amrapali was significantly lower than that with no interstock only in case of Himsagar and Bombay Green.

Discussion

Use of dwarfing rootstock for control of tree vigour is already a common practice in many temparate fruit crops. Plant vigour is an interaction between different plant growth parameters and dwarfing effect of interstock is the resultant of its effect on diffferent plant growth parameters. The present study clearly indicated effects of different interstock of plant growth parameters where interaction between interstock and genotype played important role. Use of interstock of Amrapali successfully resulted in decrease in the plant height, canopy spread of mango cultivars Bombay Green whereas no such consistent

Table 2: Effect of interstock on average spread of mango plants (m).

	2012-13				2013-14				2014-15			
	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype
Langra	2.11	0.78	0.95	1.28	2.15	0.86	1.15	1.38	2.34	1.17	1.54	1.68
Himsagar	1.40	1.02	1.37	1.27	1.42	1.15	1.43	1.33	1.58	1.35	1.57	1.50
Bombay Green	0.88	0.74	0.97	0.87	1.08	0.86	1.13	1.02	1.63	1.56	1.50	1.56
Interstock	1.46	0.85	1.10		1.55	0.95	1.24		1.85	1.36	1.53	
SEm±	Interstock (I): 0.11; Genotypes (G): 0.12; I x G: 0.34				Interstock: 0.10, Genotypes: 0.12, I x G: 0.33				Interstock: 0.11, Genotypes: 0.12, I x G: 0.35			
C.D. at 5%	Interstock: 0.31; Genotypes : 0.34; I x G: 0.98				Interstock: 0.31, Genotypes: 0.33 , I x G: 1.04				Interstock: 0.31, Genotypes: ns, I x G: ns			

Table 3: Effect of interstock on girth of rootstock of mango plants (cm).

	2012-13				2013-14				2014-15			
	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype
Langra	88.11	15.11	55.24	52.82	114.97	28.32	75.32	79.54	121.08	74.64	87.25	94.32
Himsagar	59.18	46.52	58.95	54.88	87.71	51.41	72.34	70.49	105.10	62.00	82.83	83.31
Bombay Green	62.41	48.95	61.29	57.55	98.32	50.32	74.31	74.32	108.36	81.18	82.99	90.84
Average	69.90	36.86	58.49		100.33	43.35	73.99		111.51	72.61	84.35	
SEm±	Interstock (I): 4.54; Genotypes (G): 3.15; I x G: 6.79				Interstock: 6.78, Genotypes: 1.48, I x G: 9.04				Interstock: 8.46, Genotypes: 4.48, I x G: 7.18			
C.D. at 5%	Interstock (I): 13.86; Genotypes (G): ns; I x G: 19.14				Interstock: 18.3, Genotypes: 5.34, I x G: 28.63				Interstock: 24.64, Genotypes: ns, I x G: 22.46			

Table 4: Effect of interstock combinations on girth of interstock of mango plants (cm).

	2012-13			2013-14			2014-15		
	Interstock of Latra	Interstock of Amrapali	Average	Interstock of Latra	Interstock of Amrapali	Genotype	Interstock of Latra	Interstock of Amrapali	Genotype
Langra	8.45	28.74	18.59	28.16	56.80	42.48	53.39	62.78	58.08
Himsagar	30.69	33.44	32.06	50.45	65.40	57.92	51.84	72.74	62.29
Bombay Green	29.26	36.45	32.85	37.66	53.08	45.37	57.56	65.39	61.47
Average	22.80	32.88		38.76	58.43		54.26	66.97	
SEm±	Interstock (I): 3.66; Genotypes (G): 3.98; I x G: 4.94			Interstock: 5.64, Genotypes: 6.73, I x G: 9.42			Interstock: 3.98, Genotypes: 2.66, I x G: 7.59		
C.D. at 5%	Interstock (I): 9.46; Genotypes (G): 10.42; I x G: ns			Interstock: 16.61, Genotypes: ns, I x G: ns			Interstock: 11.18, Genotypes: ns, I x G: ns		

Table 5: Effect of interstock on girth of scion of mango plants (cm).

	2012-13				2013-14				2014-15			
	No interstock	Interstock of Latra	Interstock of Amrapali	Average	No interstock	Interstock of Latra	Interstock of Amrapali	Average	No interstock	Interstock of Latra	Interstock of Amrapali	Average
Langra	76.20	5.96	30.74	37.64	81.42	10.48	32.31	41.40	102.23	46.40	49.03	65.89
Himsagar	47.81	27.49	32.09	35.80	55.36	36.61	35.28	42.42	85.53	39.75	49.15	58.15
Bombay Green	49.53	28.73	35.36	37.87	59.61	33.51	37.44	43.52	88.68	57.31	48.09	64.69
Average	57.85	20.73	32.73		65.46	26.87	35.01		92.15	47.82	48.76	
SEm±	Interstock (I): 4.19; Genotypes (G): 2.44; I x G: 8.38				Interstock: 7.83, Genotypes: 3.65, I x G: 13.46				Interstock: 7.46, Genotypes: 2.44, I x G: 15.11			
C.D. at 5%	Interstock: 12.68; Genotypes : ns; I x G: 28.63				Interstock): 22.11, Genotypes: ns, I x G: 41.16				Interstock: 21.49, Genotypes: ns, I x G: 44.61			

Table 6: Effect of interstock on total number of vegetative flushes per year.

	2012-13				2013-14				2014-15			
	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype	No interstock	Interstock of Latra	Interstock of Amrapali	Genotype
Langra	3.16	4.68	3.19	3.67	3.64	4.31	3.71	3.89	3.19	3.84	2.84	3.29
Himsagar	3.61	4.52	3.24	3.79	3.28	4.16	3.86	3.77	2.98	3.79	2.11	2.96
Bombay Green	3.61	4.66	3.14	3.80	3.11	4.24	4.01	3.79	3.11	3.98	2.18	3.09
Interstock	3.46	4.62	3.19		3.34	4.24	3.86		3.09	3.87	2.37	
SEm±	Interstock (I): 0.24, Genotypes (G): 0.18, I x G: 0.71				Interstock: 0.19, Genotypes: 0.24, I x G: 0.51				Interstock: 0.23, Genotypes: 0.11, I x G: 0.39			
C.D. at 5%	Interstock (I): 0.74, Genotypes (G): ns, I x G: ns				Interstock: 0.62, Genotypes: ns, I x G: ns				Interstock: 0.68, Genotypes: ns, I x G: 0.91			

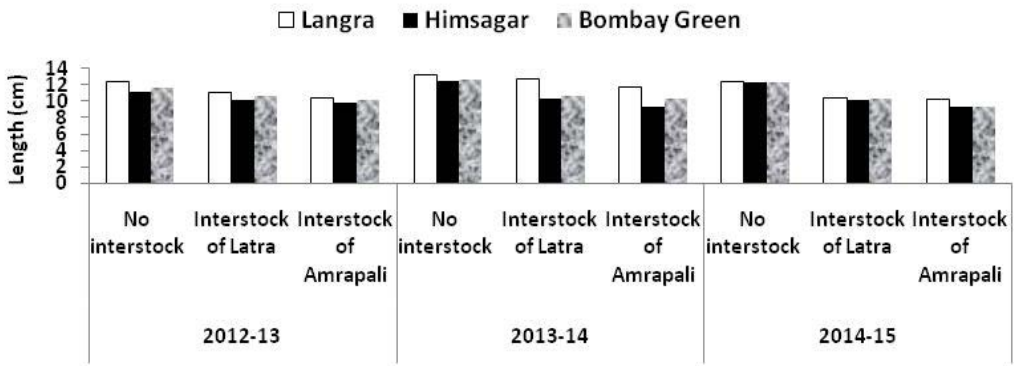

Figure 1: Effect of interstock on average length of shoot extension growth in mango.

trend was recorded in other interstock-scion combinations. Efficacy of interstocks in mango have been found to vary according to the rootstock-interstock-scion combinations [12,13] . Willis and Marler [14] have shown that rate of vegetative growth of mango appears to be more dependent on scion genotype than on the rootstock. Hence non-dwarfing effect of interstock as reported by different workers [9-11] can be attributed to incompatible combination of scion-interstock in their respective studies. Avila [7] have also reported reduction in tree height and canopy spread of 9 year old mango cv Manila on interstock of Thomas on rootstock of Esmeralda.

Tree crown weight is closely correlated with trunk girth or its crosssectional area and trunk measurements are the most commonly used method of estimating tree size. After four years of planting reduction in the growth rate of rootstock was recorded in of Mango cv Himsagar on interstock of Amrapali. Although the mechanism of stionic effects on rootstock has not been studied in mango, reduction in circumference of rootstock has also been reported by Yonemoto [8] by use of dwarf variety Khom as interstock. Use of interstock of Amrapali also resulted in decrease in the girth of scion of mango cvs Himsagar and Bombay Green. Reduction in the scion girth of mango with interstock has also been reported by Yonemoto [8]. Although the mechanism of action of interstock on scion has not been studied, Zhu [13] recorded variation in leaf nutrient composition in apple with different interstock. Jones [14] had reported depleted nutrient concentration in the xylem sap of apple plants with interstock which contributed towards the dwarfing effect of interstock. The same study also indicated production of growth inhibitors on the extending shoots from the interstock which contributed towards dwarfing in cherry.

Decrease in canopy size may result from reduction in shoot growth, changes in branching pattern and crop load. In mango, shoot growth is cyclic with distinct periods of extension followed by no extension [15] and the periods of extension is preceded by emergences of vegetative flushes. Yonemoto [8] have reported decrease in the shoot length of mango cultivars Irwin and Keitt by use of dwarf genotype Khom as interstock. Hence, reduction in number of flushing and average length of extension growth contributed towards reduction in the overall plant growth of mango cultivars Himsagar and Bombay

Green with interstock of Amrapali. Although, rootstocks which result in reduced annual shoot growth may not necessarily be dwarfing, if trees simply grow slowly but at maturity are of large size, the slow growth rate of shoots ensures merit by the ease in maintaining canopy size through pruning [16].

Conclusion

The study indicated decrease in the plant vigour of mango cultivars Himsagar and Bombay Green with the use of mango hybrid Amrapali as interstock whereas no such trend was observed in case of mango cultivar Langra. The reduction in the vigour due to interstock was apparent through decrease in the rate of increase in plant height, spread, girth of rootstock, interstock, scion and decrease in length of extension growth of shoot. Hence, use of interstock of Amrapali can be an effective strategy for reducing the plant vigour of mango cultivars Himsagar and Bombay Green under the eastern plateau and hill conditions of India.

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