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Studies on the influence of seedling physiological parameters with vigour in some polyembryonic and monoembryonic mango genotypes

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ABSTRACT

Selection of dwarf mango rootstocks through long range field trials is a laborious and time consuming process. Hence investigations were carried out to screen the mango genotypes for their vigour at seedling stage. Twelve polyembryonic and ten monoembryonic genotypes were screened for their vigour at nursery stage with different physiological parameters like stomatal density, phenolic contents, chlorophyll fractions, bark percentage and relative water content. Among the different parameters phenolic contents, bark percentage and chlorophyll fractions were found to be very useful in predicting vigour of mango rootstocks at nursery stage.

Key words: Mango, rootstocks, vigour, phenol, chlorophyll fractions, polyembryony.

INTRODUCTION

Mango (*Mangifera indica* L.) is a major commercial fruit crop of India. However the productivity of mango orchards is comparatively low in India mainly because of wider spacing and less number of plants per unit area. For high density planting vigour management is important and rootstocks are a means to achieve this (Reddy *et al*., 11). Mango has added advantage of polyembryonic genotypes which would minimize problem of seedling rootstock of unknown pedigree. Since the nucellar seedling of the polyembryonic genotypes gives the beneficial effect of clonal rootstocks with the advantage of taproot system, they can be better utilized in mango (Reddy *et al*., 11). Selection of mango rootstocks for dwarfing through long range field trials is a laborious and time consuming process. Hence for early screening of mango rootstocks at the nursery stage various parameters were suggested to predict the rootstock vigour like stomatal count (Srivastava *et al*., 14), chlorophyll fractions, leaf area, dry matter, moisture content (Pal *et al*., 9) and phenolic content (Babu *et al*., 3). Taking into account of the availability of polyembryonic genotypes in mango an attempt has been made to screen these genotypes at nursery stage for their vigour in comparison with a few monoembryonic genotypes.

MATERIALS AND METHODS

The experimental material included twelve polyembryonic and ten monoembryonic genotypes. The stones of ten monoembryonic genotypes namely Amrapali, Bombay Green, Chausa, Dashehari, Langra, Mallika, Pusa Arunima, Pusa Surya, Sensation and Tommy Atkins and twelve polyembryonic genotypes namely Bappakkai, Chandrakaran, Kensington, Keraka 1, Kerala 2, Kerala 5, Kurukkan, Nekkare, Olour Peach, Starch and Vellaikolumban were included in the study. Seedling growth parameters were recorded six months after sowing the stones. The vigour index of the seedlings was calculated in two ways as suggested by considering both length of the seedlings (vigour Index I) and dry weight of the seedlings (vigour index II) along with the percent germination (Abdul Baki and Anderson, 1). The stomatal density was determined from ten randomly selected leaves by the method as suggested by Srivastava *et al*. (14). The phenolic contents in leaves and buds were determined by the method as suggested by Malik and Singh (8). The chlorophyll content (chlorophyll a, b and total) of the leaves were analysed as suggested by Barnes *et al.* (4). The relative water content of freshly matured leaves was determined using the method suggested by Singh and Gupta (13). Bark percentage was calculated by taking the ratio of fresh bark and shoot weight. The results were statistically analyzed using completely randomized design (Panse and Sukhatme, 10) and correlation between seedling growth and vigour was detemined by using variance and co-variance components as suggested by Al-Jibouri *et al*. (2).

RESULTS AND DISCUSSION

Table 1 shows the different seedling growth parameters of polyembryonic and monoembryonic genotypes. Significant differences were obtained for seedling growth characters like stem girth, leaf area, shoot length, root length, fresh and dry weight of shoot and root system among the polyembryonic and monoembryonic genotypes. Based on the growth

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Table 1. Seedling growth parameters of different poly- and mono-embryonic genotypes.

Genotype	Seedling girth (cm)	Leaf area (cm²)	Shoot length (cm)	Root length (cm)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
Bappakai	0.66	32.3	38.0	15.4	17.2	7.6	11.2	4.6
Chandrakaran	0.57	22.2	24.9	14.9	16.2	6.9	9.0	3.9
Kensington	0.48	14.3	15.9	13.6	14.3	5.4	7.1	2.4
Kerala 1	0.46	23.7	16.0	14.2	14.2	5.2	8.5	2.2
Kerala 2	0.56	20.5	21.6	14.6	15.9	6.7	8.5	3.7
Kerala 5	0.62	28.4	34.3	16.4	17.0	7.5	10.4	4.5
Kurukkan	0.49	13.2	16.9	9.4	13.8	4.8	4.8	1.8
Nekkare	0.69	34.5	39.7	17.2	18.1	8.9	12.4	5.9
Olour	0.50	19.2	19.6	15.3	14.8	6.9	8.4	3.9
Peach	0.40	12.1	15.3	10.5	13.7	6.1	8.1	3.1
Starch	0.36	10.7	13.5	6.9	10.5	2.6	4.6	1.8
Vellaikolumban	0.52	19.4	19.9	12.6	15.2	7.2	9.0	4.0
Amrapali	0.81	19.6	21.3	13.1	15.6	7.3	9.2	3.1
Bombay Green	1.21	39.6	45.3	18.6	18.5	9.6	12.2	5.5
Chausa	0.82	19.7	22.3	13.6	15.8	7.4	9.4	3.2
Dashehari	1.15	38.4	43.1	18.2	18.2	9.3	12.0	5.0
Langra	0.84	19.9	23.2	13.9	16.1	7.5	9.5	3.3
Mallika	1.12	37.1	42.8	18.0	18.1	9.2	11.9	4.9
Pusa Arunima	1.18	38.2	43.5	18.3	18.3	9.4	12.1	5.1
Pusa Surya	0.93	28.8	36.8	17.5	17.6	7.7	11.2	4.6
Sensation	0.96	28.9	37.1	17.8	17.9	7.8	11.5	4.8
Tommy Atkins	0.87	28.7	36.2	17.1	17.3	7.6	11.0	4.4
CD at 5%	0.19	1.64	1.82	1.38	1.48	0.28	1.77	0.28

potential it was observed that among polyembryonic genotypes Nekkare, Bappakai and Kerala 5 were more vigorous than other polyembryonic genotypes. In monoembryonic genotypes, Bombay Green, Pusa Arunima and Dashehari were more vigorous than other genotypes. High and low growth potential of different genotypes might be due to their genetic characters. Similar observations were made by Khobragade *et al.* (5). Significant differences were found in the vigour index of different genotypes based on growth basis as well as weight basis (Fig. 1). Nekkare gave most vigorous seedlings based on its growth and weight (9477 and 2295, respectively), which was significantly higher than all other polyembryonic genotypes. Whereas, Starch was the least vigorous genotype (1489 and 358 respectively). In monoembryonic genotypes, Bombay Green, Pusa Arunima, Dashehari and Mallika produced vigorous seedlings on growth basis. Furthermore, on weight basis, Bombay Green produced most vigorous seedlings and least vigorous seedlings was recorded in Amrapali (2697 and 806, respectively). Due to its less vigorosity, Amrapali has been recommended for high density planting (Majumder and Sharma, 7). In polyembryonic genotypes, the vigour index might be due to their vigorous growth. Starch has also given the least vigour indices, which might be due to its dwarf nature. Similar observations were made by Khobragade *et al.* (5) in mango rootstock.

To find the relationship between the seedling growth characters and physiological parameters, observations were recorded on stomatal density, chlorophyll fractions, phenol content, RWC and bark percentage and the results are presented in Table 2 and Fig. 2. It was observed that the Kurukkan has more number of stomata per unit leaf area (21.1) followed by Nekkare (20.3) and Bappakai (20.1). Whereas, the lowest number of stomata per unit leaf area was recorded in Starch (10.7). In monoembryonic genotypes, Bombay Green, Pusa Arunima, Dashehari and Mallika had statistically higher number of stomata per unit leaf area in comparison to other varieties. Amrapali has the minimum number of stomata per unit leaf area (18.0). The remaining genotypes did not differ significantly with it. In polyembryonic as well as

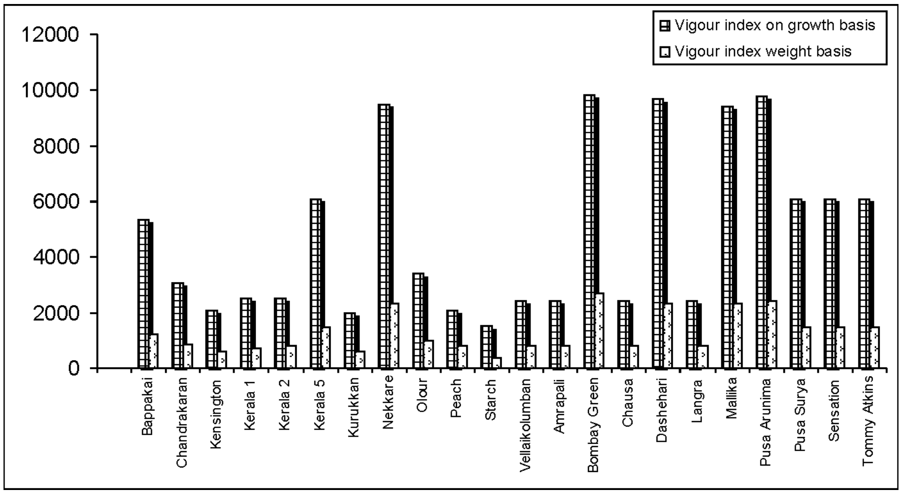

Fig. 1. Vigour index on growth and weight basis of some poly- and mono-embryonic genotypes.

Table 2. Stomatal density, phenolic content and chlorophyll fractions in different mango genotypes.

Genotype	Stomata/ unit area	Phenolic content of leaf (mg/g)	Phenolic content of bud (mg/g)	Chlorophyll 'a' (mg/g)	Chlorophyll 'b' (mg/g)	Total chlorophyll (mg/g)
Bappakai	20.1	22.7	24.2	1.42	0.93	2.36
Chandrakaran	14.8	22.5	30.6	1.27	0.77	2.04
Kensington	16.6	30.8	62.2	1.25	0.76	2.02
Kerala 1	17.9	31.2	66.5	1.22	0.67	1.90
Kerala 2	13.6	26.4	34.7	1.25	0.75	1.99
Kerala 5	18.3	23.5	25.3	1.36	0.88	2.25
Kurukkan	21.1	28.9	60.6	1.24	0.74	1.98
Nekkare	20.3	21.6	21.3	1.44	0.94	2.39
Olour	14.4	27.4	68.8	1.32	0.80	2.12
Peach	13.3	32.5	71.3	1.14	0.59	1.74
Starch	10.7	36.2	74.5	1.13	0.53	1.67
Vellaikolumban	17.8	27.4	62.8	1.36	0.87	2.23
Amrapali	18.0	27.2	61.2	1.38	0.88	2.26
Bombay Green	21.2	19.7	18.6	1.54	0.99	2.53
Chausa	18.2	27.1	61.0	1.38	0.89	2.27
Dashehari	20.5	19.8	19.1	1.51	0.98	2.49
Langra	18.3	26.9	60.8	1.39	0.90	2.29
Mallika	20.1	20.1	19.2	1.47	0.96	2.43
Pusa Arunima	21.6	19.8	18.9	1.52	0.98	2.50
Pusa Surya	18.5	22.7	24.1	1.40	0.92	2.32
Sensation	18.6	22.5	23.8	1.42	0.93	2.35
Tommy Atkins	18.5	22.9	24.2	1.39	0.91	2.30
CD at 5%	1.56	1.59	2.32	0.24	0.05	0.14

monoembryonic genotypes, the stomatal distribution did not appear to be useful criteria to predict the vigour of mango. Because, the most dwarf variety of Amrapali did not differ in stomatal density with Langra, Chausa etc., which are very vigorous varieties. Similar results were reported in mango by Reddy (12). Phenol contents in buds and leaves of different mango genotypes are given in Table 2. Starch gave the highest phenolic contents in leaves and buds (36.2 and 74.5, respectively), which was highly significant over all

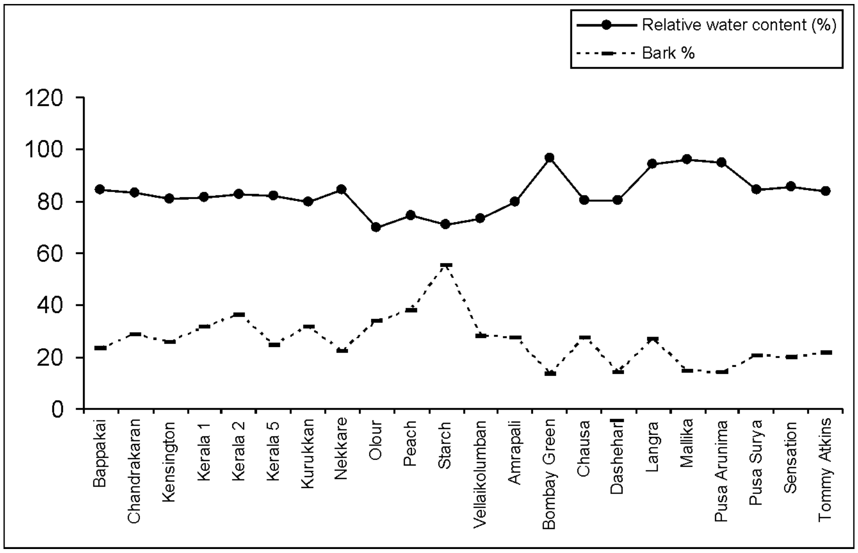

Fig. 2. Relative water content and bark percentage of some polyembryonic and monoembryonic mango genotypes.

other polyembryonic genotypes. Nekkare, Bappakai, Chandrakaran and Kerala 5 have statistically lower phenolic contents in leaves. However, Nekkare and Bappakai recorded statistically minimum phenolic contents in buds. Among monoembryonic genotypes, Amrapali, Chausa and Langra had more phenolic contents both in leaves as well as in buds. However, Bombay Green, Pusa Arunima, Dashehari and Mallika have statistically lower phenolic contents in comparison to other varieties. Similar results were reported by Babu *et al.* (3). Less vigorous genotypes were found to have more phenolic compounds in present study too. Vigorous polyembryonic (Nekkare) as well as monoembryonic (Bombay Green) genotype had the maximum chlorophyll 'a', chlorophyll 'b' and total chlorophyll contents (Table 2). However, chlorophyll fractions and total chlorophyll contents were lower in less vigorous genotypes. Pal *et al.* (9) found positive correlations between vigour of mango rootstocks and chlorophyll contents. Starch gave the maximum bark percentage, which was four times more than Bombay Green. Among polyembryonic genotypes, minimum bark percentage was found in Nekkare (22.4), which was about 2.5 times lesser than Starch (55.5). Amrapali recorded the maximum bark percentage (27.3) among the monoembryonic genotypes. All the monoembryonic genotypes gave much lesser bark percentage in comparison to polyembryonic genotypes (Fig. 2). Further, bark percentage was minimum in vigorous plants and maximum in less vigorous plants of both the genotypes. Therefore, it might be inferred that the genotypes with higher bark percentage would produce dwarf plants. Similar results were observed by Kurian (6) based on anatomical observation of xylem and phloem.

Bappakai has maximum relative water content, which was at par with most of the polyembryonic genotypes except Peach, Vellaikolumban, Starch and Olour (Fig. 2). Among monoembryonic genotypes, Bombay Green gave the maximum relative water content, which was at par with Mallika, Pusa Arunima and Langra. The minimum relative water content was recorded in Amrapali, which was at par with five remaining varieties. Water deficiency was found to be a major limiting factor in mango production. High relative water content was considered a drought tolerant related character in them. Therefore, they gave special significance for mango rootstock related to water content (Pal *et al.*, 16).

Correlations among the different seedling growth and vigour characteristics were worked out and a correlation matrix was formed (Table 3). All the seedling growth characters had positive correlation with vigour index I and II (Table 3). With respect to physiological parameters, the phenolic content of leaves, buds and bark percentage are positively correlated with each other but negatively correlated with vigour. It indicated that the plants with higher bark percentage or phenolic contents would have less vigour. The total chlorophyll had significant positive correlation with vigour index II (0.804) and I (0.795) at 5% level of significance. However, it gave very high negative correlation with bark percentage (-0.910). Whereas, the relative water content was not significant with total chlorophyll like chlorophyll 'a' and 'b' (Table 3). It was interesting to note that the bark percentage had only negative

Table 3. Correlation among seedling growth and vigour characters.

Character	Seedling girth	Leaf area	Shoot dry weight	Root dry weight	No. of stomata/ per unit area	Phenolic content (leaf)	Phenolic content (bud)	Chlorophyll 'a'	Chlorophyll 'b'	Total chlorophyll	Bark (%)	Relative water content (%)	Vigour index-I (Growth basis)	Vigour index-II (Weight basis)
Seedling girth	1.000	0.843*	0.714*	0.699	0.705*	-0.922**	-0.923**	0.894**	0.846**	0.878**	-0.839**	0.689	0.955**	0.934**
Leaf area		1.000	0.863**	0.878**	0.713*	-0.908**	-0.887**	0.882**	0.819**	0.858**	-0.841*	0.688	0.949**	0.936**
Shoot dry weight			1.000	0.902**	0.689	-0.915**	-0.759*	0.919**	0.909**	0.919**	-0.890**	0.651	0.819*	0.856**
Root dry weight				1.000	0.525	-0.899**	-0.855**	0.827*	0.807*	0.824*	-0.749*	0.520	0.872**	0.873**
No. of stomata/ unit area					1.000	-0.704*	-0.576	0.799*	0.805*	0.811*	-0.854**	0.644	0.666	0.666
Phenolic content (leaf)						1.000	0.920**	-0.891**	-0.896**	-0.898**	0.885*	-0.674	-0.854**	-0.847*
Phenolic content (bud)							1.000	-0.738*	-0.735*	-0.742*	0.755*	-0.650	-0.856**	-0.814*
Chlorophyll 'a'								1.000	0.973**	0.993**	-0.894**	0.670	0.830*	0.843*
Chlorophyll 'b'									1.000	0.973**	-0.910**	0.642	0.746*	0.752*
Total chlorophyll										1.000	-0.910**	0.659	0.795*	0.804*
Bark (%)											1.000	-0.712*	-0.787*	-0.798*
Relative water content (%)												1.000	0.628	0.650
Vigour index-I (Growth basis)													1.000	0.988**
Vigour index-II (Weight basis)														1.000

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed) correlations with vigour index II (-0.798), vigour index I (-0.787) and relative water content (-0.712) that too at 5% level only. The relative water content was found non significant with both vigour index I and II. However, both the vigour indices had quite high positive correlation with each other (Table 3). Thus from the Table 3, it can be concluded that phenolic contents and bark percentage have high significant negative correlation with vigour. The chlorophyll fractions have significant positive correlation with vigour. Kurian (6) also found negative correlation of vigour with phenolic contents and higher ratio of phloem and xylem. Therefore, it might be possible to screen the mango plants at the seedling stage by their phenolic content, bark percentage and chlorophyll content. Since the polyembryonic genotypes are of nucellar origin, they have particular preference to be used as rootstocks in mango and dwarf polyembryonic genotypes can be screened if they have more of phenolic contents and bark percentage and less of chlorophyll fractions at their seedling stage.

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