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Growth, Yield and Quality Attributes of Mango Cultivars under the Sultanate of Oman Conditions

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ADAPTATION of mango varieties to local environmental conditions is one of the most important alternatives for sustainability of mango cultivation in Oman, taking advantage of the high genetic diversity. Seventeen mono-embryonic Indian mango varieties grafted on local Omani rootstock were studied with respect to growth, yield and quality attributes. The results revealed that there was a variation between varieties with respect to their vegetative growth parameters which had large variation viz. 3.10- 7.5 cm for tree height, 3-7 m vegetative growth spreading, 45-98 cm for trunk girth and 15.09-195.06 m^3 tree vegetative canopy volume. These data identified the growth habit of each variety in the sense that Ross variety (3.10 m) was dwarf compared to tall varieties of Immampasand, Zafran, and Pairi (7.50, 6.50 and 6 m, respectively) and had vigorous growth (195.06, 104.76 and 101.89 m^3, respectively). The results showed that average fruit weight ranged between 200-1200 g/fruit, where Tanneru variety gave the highest fruit weight (1200 g/fruit), while Chambtan, Ross, Pairi, Baramasi and Alphonso were the lowest (200 g/fruit). Average fruit number varied from 77- 497 fruit/tree) and Neelum variety was the highest (497 fruit/tree) and Baramasi was the least (977 fruit /tree). Ross trees were more efficient in production (16 kg/m^3), followed by Deshari (15.09 kg/m^3). Safeda Mulgoa distinct to other varieties in total soluble solids (21%). Tested varieties were classified into four maturity periods groups viz early, mid-early, medium and late. There was no significant difference between groups with respect to growth parameters. Numerically group of mid- early varieties were shorter and less vigorous in growth and more productive than other groups. Tree yield efficiency was negatively correlated with tree canopy volume ($r=-0.561$, $p \leq 0.05$). It was concluded that adaptation of mango genetic diversity would be very efficient strategy to develop sustainable mango cultivations under the Omani conditions.

Keywords: Chemical characters, Varieties, Growth paramaters, Yield components.

Mango (*Mangifera indica L.*) which belongs to the dicotyledonous family Anacardiaceae, is one of the most important tropical and subtropical fruit crops in

the world. Globally, it is fifth-ranked in production among major fruit crops, where 100 countries are recorded as mango producing countries in current FAO statistics. Mango was introduced to the Sultanate of Oman since hundred years, mainly from the Indian subcontinent and East Africa. Countrywide, it is fourth most important fruit crop after date palm (*Phoenix dactylifera* L.), banana (*Musa* spp) and lime (*Citrus aurantifolia*) in terms of area and production (148,514 hectare and 8637 ton, respectively, MAF 2013). Shortage and low quality of water are the main challenges regarding expansion in the cultivation of mango in the Sultanate, where the annual precipitation average is 100 mm. Mango genetic diversity is a key issue for sustainability cultivation of this cropas they have genetic characters enable to withstand local environmental conditions. Many researchers (Kaur *et al*., 2014, Naqvi *et al*., 2014, Okoth *et al*., 2013, Usman *et al*., 2011, Jilani *et al*., 2010, Rajan *et al*., 2001, Akhtar *et al*., 2009, Singh & Kanpure, 2006 and Chanana *et al*., 2005) have followed the same path in terms of the use of genetic diversity for the development of mango cultivation in their areas. This investigation aims to evaluate the performance of mango varieties grafted on local Omani rootstock in terms of growth, yield and quality attributes under Omani conditions.

Materials and Methods

Seventeen mono-embryonic Indian mango varieties namely, Allumpur Baneshan, Alfonso, Banglora, Baneshan, Baramasi, Cherukurasam, Dasheri, Imam Pasand, Langra, Mulgoa, Neelum, Pairi, Ross, Safed Mulgoa, Tenneru, Zafran and Chambatan grafted on local Omani mango monoemberyonic rootstock were planted and evaluated at Agricultural Research Farm, Rumais which had sandy loam soil. Bubbler irrigation system was used to irrigate the trees. The spacing between the trees was 7 m x 7 m. Fertilization and protection and other cultural practices were used according to the research centre recommendation. Data of growth parameters (tree height (m), tree spreading (m) (E-W, N-S), trunk girth (cm) and tree canopy volume (m^3) from ten years old trees were measured. Tree height was measured by clinometers instrument. Matric tape was used to determine tree spreading and trunk girth. For spreading, two observations on each of east west and north south sides of selected trees were measured. Tree canopy volume was calculated according to Zekri (1996). Yield components (fruit weight (g), fruit No./ tree , yield (kg) and tree yield efficiency (kg/m^3), flowering and maturity periods were recorded by taking representative random five fruits from each five trees per variety at harvesting date. Tree yield efficiency was calculated by dividing tree yield (kg) on the tree canopy volume (m^3). Total soluble solids (TSS %) was measured using digital refractometer (model optic ivymen system, ctra. N-z km 585.1 Abrera (Barceluna), Spain). All data were recorded and statistically analyzed by using GenStat version 11 and SPSS statistics 17.0.

Results and Dicussion

Vegetative growth behaviour

Mango tree growth habit, viz. tree height, tree spreading, trunk girth and tree canopy volume is one of the most important issues that suppose to be taken in consideration in such studies as reported in the previous studies (Kaur *et al*., 2014,

Singh & Kanpur, 2006, Chaman *et al*., 2005, Rajan *et al*., 2001 and Abutiate, 1987). These characters are important in the case of the expansion of the cultivation of any variety ,in the sense plant density per unit area. The results of this investigation showed a wide range of variability between mango genotypes with respect to tree growth characters (Table 1). This variation in tree growth habit was also reprted by Kaur *et al*. (2014), Chaman *et al*. (2005) and Rajan *et al*. (2001) who evaluated mango variaties under different Indian regions. Average tree hight ranged between 3.10 - 7.5 cm, where Ross variety recorded the lowest height (3.10 m) followed by Dashehari (3.80 m), while Imampasand was the highest (7.50 m). Same varieties recorded the same trend with respect to the tree spread (West – East and North-South) which ranged between 3-7.10 and 3.0-7.0 m, respectively as well as trunk girth and tree canopy volume (45-98 cm and 15.09-195.06 m^3 , respectively). Our results differs from the results of Chanana *et al*. (2005) who found that Dashehari and lLangra varieties have big tree canopy volume (186.33 and 311.38 m^3, respectively) under Punjab region in India, while Alphonso variety recorded canopy volume (58.98 m^3) close to that under Omani conditions.

TABLE 1. Growth characters of different mango varieties grown under the Sultanate of Oman conditions.

Varieties	Tree height (m)	E-W spread (m)	N-S spread (m)	Trunk girth (m)	Canopy volume (m^3)
Allumpur Baneshan	4.50	4.80	4.70	63.00	53.13
AlPhonso	5.70	4.80	4.80	64.50	68.72
Banglora	4.60	4.70	4.70	62.00	53.17
Baneshan	4.10	3.90	4.00	49.40	33.47
Baramasi	4.50	3.50	3.60	61.00	29.67
Cherukurasam	5.40	4.90	4.80	76.00	66.46
Dashehari	3.80	4.00	4.00	49.50	31.82
Imampasand	7.50	7.10	7.00	98.00	195.06
Langra	5.00	5.60	4.60	63.00	67.40
Mulgoa	4.50	4.50	4.30	60.00	45.57
Neelum	5.60	5.80	4.60	70.00	78.19
Pairi	6.10	5.60	5.70	77.00	101.89
Ross	3.10	3.00	3.10	45.00	15.09
Safeda Mulgoa	4.90	4.90	4.40	65.20	55.28
Tenneru	5.00	4.60	4.30	54.00	51.75
Zafran	6.50	5.60	5.50	75.00	104.76
Chambatan	5.50	5.40	5.30	80.00	82.37
Mean	5.08	4.86	4.67	65.45	66.69
SE±	1.24	1.19	1.14	15.96	16.27
Range	3.10-7.50	3-7	3.10-7	45-98	15.09-19.5

Kaur *et al*. (2014) found tree height of Alphonso 12.43 m. Assuming that there was no mistakes regarding variety names, theses differences may be

attributed to the variation in cultural practices between locatins and also to the rootstock. The compilation of varieties according to the maturity periods made it clear that all varieties were under four groups, early, mid-early, medium and late (Table 2). Tenneru, Zafran and Pairi are early mature (April-May), Ross and Banglora are mid-early mature (Mid of May to June), Neelm variety is late August-September) while the rest varieties are medium mature.

As compared with other groups, all varieties in mid-Early group are considered as dwarf varieties having short tree height, 3.9 m and 34.1 m^3 in canopy volume while early varieties were more vigorous, viz.5.9 m tree height and 86.1 m^3 for canopy volume follwed by late variety which gave 5.6 m tree height and 80 m^3 canopy volume. This confirms the importance of mango genetic diveristy in extending fruiting season for mango and consequently contributing in sustainability cultivation of this crop.

TABLE 2. Growth characters of mango varieties according to maturity periods.

Maturity period	Tree height (m)	Trunk girth (cm)	Tree Spreading		Canopy volume (m^3)
			N-S (m)	E-W (m)	
Early	5.9±0.449	68.7±7.356	5.2±0.437	5.3±0.333	86.1±17.212
Mid-Early	3.9±0.750	53.5±8.500	3.9±0.800	3.9±0.850	34.1±19.04
Medium	5.2±0.432	66.2±5.683	4.8±0.376	5.1±0.386	74.1±20.681
Late	5.6±0.050	75.0±5.000	5.0±0.350	5.6±.0200	80.3±2.093

Flowering, maturity, yield and quality behaviour

It was observed that flowering initiatiated from December to February in most varieties (Fig.1). Early varieties like Tanneru, Zafran and Pairi flowerd in early December while the medium varieties (Safeda Mulgoa, Beneshan, Alphonso, Langra, Mulgoa) by the end of December to middle of January. Late varieties (Neelum and Chambatan) flowered during middle of January to end of February. Most varieties remained in maturity during the middle of May till end of July and were categorized as medium (Fig. 2). The varieties fruiting during August and September are catogrized as late varieties (Neelum and Chambatan) and those fruiting during middle of April to middle of May were grouped as early varieties (Tenneur, Zafran, Pairi). Varieties harvested during end of April to end of June were considered as Middle early (Ross and Banglora). Difference between mango varities in flowering and maturity was also observed by Jilani *et al.* (2010) under Pakistan conditions. Yield and yield component are a key target for mango groweres. The results presented in Table 3 indicated that there was a significant variation between mango genotypes in their response to local environmetal conditions with respect to yield components. Average fruit weight significantly varied from 200 g in Chambtan, Ross, Pairi, Baramasi and Alphonso varieties to 1200 g in Tenneru. Similar result was recorded by Chanana *et al.* (2005) on Alphonso and Langra under Indian conditions, while compared to our results the research result obtained by Kaur *et al.* (2014) with

respect to fruit weight show inferior values. On the other hand, Jilani *et al*. (2010) obtained higher fruit weights for Alphonso (355.33 g) under Pakistan conditions. Neelum variety recorded the highest number of fruits (497 fruit/tree) and Baramasi was the lowest (77 fruit /tree). Average total yield per tree ranged from 15.4 kg in Baramasi to 217.3 kg in Banglora. The higher yield in Banglora may be attributed to its varietal nature of regular bearing habit, unlike Baramasi where the fruiting pattern for this variety is not uniform through the year and unpredictable. Only Neelum Banglora and Pairi exhibited true regular bearing habit. Ross trees were more efficient in production (16 kg/m^3), followed by Dashehari (15.09 kg/m^3). Tree yield efficiency was negatively correlated with tree canopy volume ($r=-0.561$, $p \leq 0.059$) which a illustrates the importance of calculating tree canopy size and linkimg that to the productivity of the tree. The results showed that Safeda Mulgoa and Mulgoa outperformed other varieties regarding TSS contebt (21 and 20 % TSS), an important factor for indicating of fruit quality while Tenneru fruits had the lowest values (13% TSS). Similar results for Dashehar and Langra were reported by Kaur *et al*. 2014, but TSS% was higher (26.84%) in the case of Alphanso as compared to our result for this particular cultivar. While, Jilani *et al*. (2010) recorded similar results in Pakistan for most of tested cultivars in our experiment and may be this due to the simiarlity of climatic conditions favourable for mango cultivation in both regions. Given the nature of maturity as presented in Table 4, Middle early varieties group were significantly more productive (133.8 kg/tree) than other groups, however, Early group characterized with large fruit size (650 g/fruit) while medium group have high quality fruits (18.9 %).

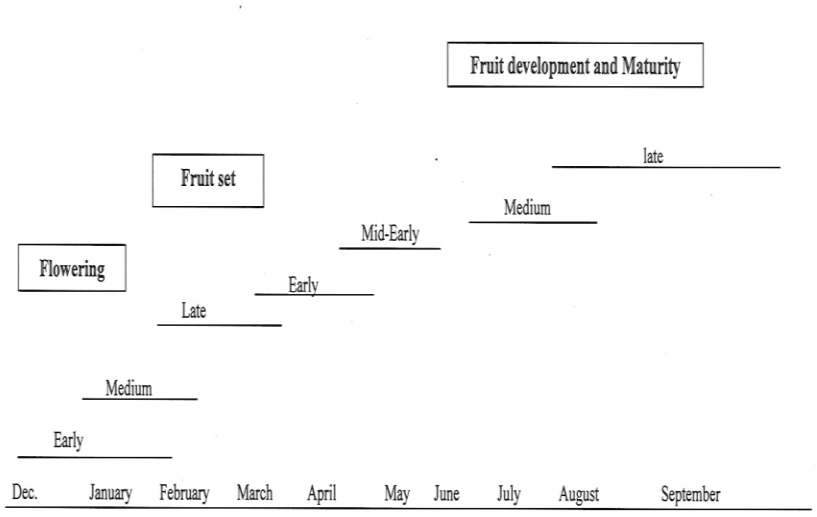

Fig. 1. Flowering, fruiting stages for mango varieties.

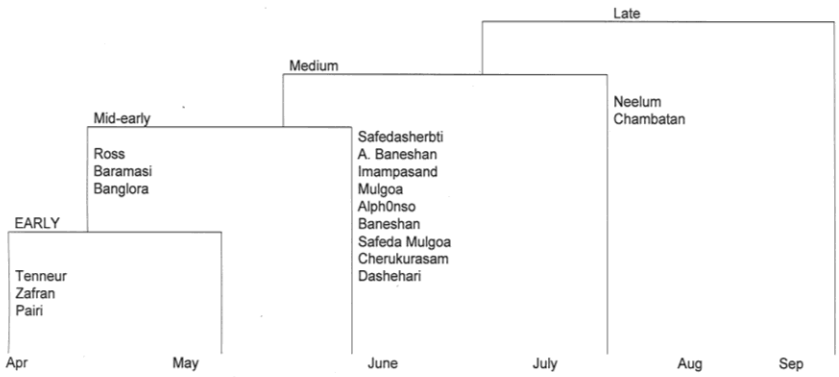

Fig. 2. Classification of mango varieties according to maturity period.

TABLE 3. Yield components of different mango varieties grown under the Sultanate of Oman conditions.

Varieties	Fruit weight (g)	Fruit No./ tree	Tree yield (kg)	Tree yield efficiency (kg/m^3)	TSS %
Allumpur Baneshan	300.00	131.00	39.30	2.47	18.00
AlPhonso	200.00	223.00	44.60	3.24	17.00
Banglora	550.00	395.00	217.30	7.43	16.00
Baneshan	450.00	152.00	68.40	4.54	19.00
Baramasi	200.00	77.00	15.40	2.60	18.00
Cherukurasam	316.00	254.00	80.00	3.82	18.00
Dashehari	200.00	480.00	96.00	15.09	19.00
Imampasand	492.00	90.00	44.00	0.46	18.00
Langra	234.00	312.00	73.00	4.63	19.00
Mulgoa	347.00	165.00	57.00	3.62	20.00
Neelum	240.00	497.00	119.30	6.36	18.00
Pairi	200.00	352.00	70.40	3.45	18.00
Ross	200.00	251.00	50.20	16.64	14.00
Safeda Mulgoa	450.00	187.00	84.20	3.38	21.00
Tenneru	1200.00	93.00	111.60	1.80	13.00
Zafran	550.00	153.00	84.20	1.46	17.00
Chambatan	200.00	251.00	50.20	3.05	15.00
Mean	372.29	239.00	76.77	4.94	17.53
SE±	90.80	58.29	18.72	1.21	4.28
Range	200-1200	93.00-497.00	15.40-217.13	2.60-16.64	13-21.00

TABLE 4. Yield and chemical characters of mango varieties according to Maturity periods.

Ripening period	Fruit weight (g)	TSS %	Fruit No/ tree	Total tree yield Kg/tree	Tree yield efficiency (kg/m^3)
Early	650.0 ±292.973	16.0±1.528	199.3±78.274	88.7±12.107	2.2±0.616
Mid-Early	375.0±175.000	15.0±1.000	323.0±72.000	133.8±83.550	12.0±4.604
Medium	353.3±043.247	18.9±0.508	180.0±27.094	58.6±6.442	3.2±0.537
Late	220.0±020.000	16.5±1.500	374.0±123.000	84.8±34.550	4.7±1.655

Conclusion

The studied mango varieties varied gratly in vegetative, reproductive and fruit quality characters. Based on a wide range of maturity periods, varieties were calassified as Early, Mid-early, Medium and Late. These results will encourage the efforts of sustainability of mango cultivation in different agro-climatic conditions regions of the Sultanate. However, multilocational and on-farm variety trials are needed.

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نمو وإنتاجية وجودة صفات اصناف المانجو تحت ظروف سلطنة عمان

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تعتبر دراسة تكيف وتأقلم أصناف المانجو للظروف البيئية المحلية من الخيارات المهمة لاستدامة زراعتها في السلطنة ، مستفدين من التنوع الجيني لتلك الأصناف. تضمن البحث زراعة سبعة عشر صنفا من أصناف المانجو هندية الأصل أحادية الجنين تم تطعيمها على اصل المانجو العماني وقد تم دراستها في الحقل من حيث النمو والإنتاجية وجودة صفات الثمار. اشارت النتائج إلى وجود تباين معنوي بين الأصناف للظروف البيئية المحلية وذلك من حيث صفات النمو الخضري : حيث تراوح ارتفاع الأشجار بين ٣,١٠-٧,٥ م وانتشار المجموع الخضري (٣-٧ م)، في حين تراوح متوسط سمك جذع الأشجار بين ٤٥-٩٨ سم ووصل حجم المجموع الخضري للأصناف بين ١٥,٠٩-١٩٥,٠٦ م٣. حددت هذه البيانات طبيعة نمو كل صنف بمعنى ان صنف الروس كان متقزم (٣,١٠ م) مقارنة بأصناف امام بسند وزعفران والبايري (٧,٥ ، ٦,٥٠ ، ٦م، على التوالي) الطويلة والتي تمتاز بالنمو الغزير (١٩٥,٠٥ ، ١٠٤,٧٦، ١٠١,٨٩ م٣ ، على التوالي). أوضحت النتائج بأن متوسط وزن الثمرة تراوح بين ٢٠٠-١٢٠٠ جم / ثمرة ، حيث سجل الصنف تنيرو أعلى وزناً للثمرة (١٢٠٠ جم /ثمرة) ، في حين كانت اصناف شمبتان والروس والباراماسي والفونسو أقل وزناً للثمرة (٢٠٠ جم /ثمرة). تراوح متوسط عدد الثمار بين الأصناف من ٧٧-٤٩٧ ثمرة / شجرة. وقد انتج الصنف نيلم أعلى عدد للثمار (٤٩٧ ثمرة / شجرة) في حين أعطى الصنف باراماسي أقل عدد للثمار (٧٧ ثمرة / شجرة) مقارنة ببقية الأصناف. كانت اشجار صنف الروس أكثر كفاءة في الإنتاج (١٦ كجم / م٣)، يليها أشجار الصنف ديشهري (١٥,٠٩ / م٣). تميز الصنف سفيدا ملجوا عن بقية الأصناف في نسبة المواد الصلبة الذائبة (٢١ ٪). صنفت الأصناف المزروعة من حيث مواعيد النضج إلى أربع مجموعات: مبكره، مبكره- متوسطة ومتوسطة ومتأخرة. لم يكن هناك فرق معنوي بين مجموعات الأصناف فيما يتعلق بصفات النمو الخضري. أما عددياً ، فأن مجموعة الأصناف مبكرة- متوسطة النضج كانت أقصر في طول الأشجار وأقل غزارة للمجموع الخضري ولكنها أكثر انتاجاً من المجموعات الأخرى.

توجد علاقة سلبية بين كفاءة انتاج الشجرة وحجم مجموعها الخضري (r = - 0.561، P≤ 0.05).

خلاصة البحث تبين بأن أقلمة أصناف المانجو ذات التنوع الجيني تعتبر طريقة فعالة لتطوير زراعة واستدامة محصول المانجو تحت ظروف السلطنة.