

Research Article



Evaluation and Screening of Sweet Orange Cultivars for Vegetative Growth and Citrus Canker

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Abstract | This study was conducted at National Agricultural Research Center, Islamabad. The experiment was performed on randomized complete block design (RCBD) consisting of eleven treatments (cultivars) replicated three times during 2015. The results showed that Tarocco attained maximum height (156.13 cm), followed by Mexican Lemon (146.80 cm). Similarly, maximum plant spread and leaf area were recorded in Mexican Lemon 124.07 cm and 11.35 cm², respectively. However, Hamlin showed the highest stem girth (9.90 cm) and number of branches (66.53). The internode length was the greatest in Kinnow cultivar (2.66 cm). In case of disease incidence maximum lesion on leaves were found in Kinnow (14.2) while in Cara Cara, Salustiana and Arnold Blood, lesser lesions were found. On the basis of results and overall performance Tarocco and Hamlin performed best in all aspects while Arnold Blood and Cara Cara revealed poor growth.

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Keywords | Citrus cultivars, Plant height, Plant spread, Stem girth, Internode length, Number of branches, Leaf area, Disease incidence

Introduction

Citrus is a large group of shrubs or trees belong to the family *Rutaceae*. The Origin of citrus is believed to be the southern Himalaya, North East of India and China (Gmitter et al., 1990). It is extensively grown under tropical and sub-tropical climatic conditions, where the soil and climatic regimes are favourable for its growth (Shah, 2004). Due to its ornamental value, health benefits and importance in terms of fruit juice industries, citrus production increased in Pakistan and around the globe. In Pakistan it is the largest group of fruits grown over an area of 195.6 thousand hectares with an annual production of 1986.7 thousand tonnes, while Khyber Pakhtunkhwa contribute an area of 4.3 thousand hectares with total production of 33.5 thousand tonnes (Stat, 2011-12). Pakistan is ranking among the top ten producers of the world for

citrus production (Nawaz et al., 2011) and sixth largest producer of Kinnow (Syed, 2009). Citrus is grown on about 170,000 hectares of land in Pakistan, constituting about 30 percent of the area under all fruit orchards (Saleem et al., 2008; Ashraf et al., 2010). Average yield of citrus in Pakistan (11 t/ha) is low as compared to the average yields of other citrus producing countries e.g. Brazil, USA and Turkey (22000, 26000 and 27000 kg/ha respectively) (Nawaz et al., 2011). Citrus is vulnerable to a number of diseases caused by different pathogen, harsh environmental condition and practices. Citrus canker was discovered in Florida in 1910 (Dopson, 1964; Loucks, 1934). It is thought to have originated in south eastern Asia or India (Civerolo, 1984). Citrus canker caused by *Xanthomonas axonopodis* pv. *citri* is one of the most important citrus diseases (Gottwald et al., 2001, 2002). It is the most devastating disease and occurs throughout

the citrus growing countries of the world (Koizumi, 1985) including Pakistan. Keeping in view, the importance of citrus the present study was designed at the Fruit Program, Horticultural Research Institute in National Agricultural Research Centre Islamabad (NARC) to check the performance of different sweet orange cultivars primarily for their vegetative growth and for screening of different species resistant to citrus canker. The effective way of controlling the disease is by using resistant varieties.

Table 1: Screening of citrus cultivar against citrus canker in 2015

| Cultivar | Severity rating Scale | Response | Lesion / leaf |
|------------------|-----------------------|----------|---------------|
| Arnold Blood | 0 | I | 1.03 de |
| Cara Cara | 0 | I | 0.96 e |
| McMahon Valencia | 0 | I | 1.67 cde |
| Daisy Mandarin | 1 | R | 1.7 cde |
| Harvard Blood | 0 | I | 2.03 c |
| Ryan Navel | 1 | R | 6.6 a |
| Tarocco | 1 | R | 1.93 cd |
| Kinnow | 1 | R | 3.3 b |
| Salustiana | 0 | I | 1.03 de |
| Hamlin | 1 | R | 2.47 bc |
| Mexican Lemon | 1 | R | 7.07 a |

Mean in the column followed by the like letters are not significantly different from each other while followed by the different letters are highly significant at $P < 0.05$; I= Immune; R= Resistance

Materials and Methods

The study was conducted on one and half year old cultivars of sweet orange plants grown in the field area of Fruit Program, Horticultural Research Institute (HRI) in NARC Islamabad during 2015. The sweet orange cultivars included Arnold Blood, Cara Cara, McMahon Valencia, Daisy Mandarin, Hamlin, Harvard Blood, Tarocco, Kinnow LS, Ryan Navel, Salustiana and Mexican Lemon. The experiment was performed from June to September and data regarding plant growth and disease incidence i.e citrus canker was recorded. The vegetative behaviour of the experimental plants was observed by recording plants height through measuring tape from soil level to the peak branch of the plant. Stem girth was measured by a measuring tape just above the rootstock and scion joint. Leaf area was calculated by taking ten different matured leaves at four different sides of each plant. The internode length was measured through digital Vernier calliper. All the branches were counted in

each varieties and the disease incidence particularly the intensity of citrus canker was checked on the basis of number of lesions on the leaves. Ten different leaves at four different sides North, South, East and West of each plant were collected from lower, middle and upper portion of the plant randomly. To measure the spread of the plant, two observations were taken from North to South and East to West at right angle with the help of measuring tape in a cross section up to the maximum outgrowth of the plant.

Statistical analysis

The data were analysed by using Randomized Complete Block Design (RCBD) with 11 treatment combination, replicated three times and the mean were further separated using Least Significant Difference (LSD) test. Statistical computer software "Statistix 8.1" was applied for computing both ANOVA and LSD (Jan et al., 2009).

Results and Discussion

Plant height

Plant height is important part of vegetative growth of citrus, if the plant has more height so there will be more number of branches and total number of leaves. The data for plant height revealed a highly significant difference ranging from 156.13 to 64.90 cm as shown in Figure 1. Maximum plant height (156.13 cm) was observed in Tarocco.

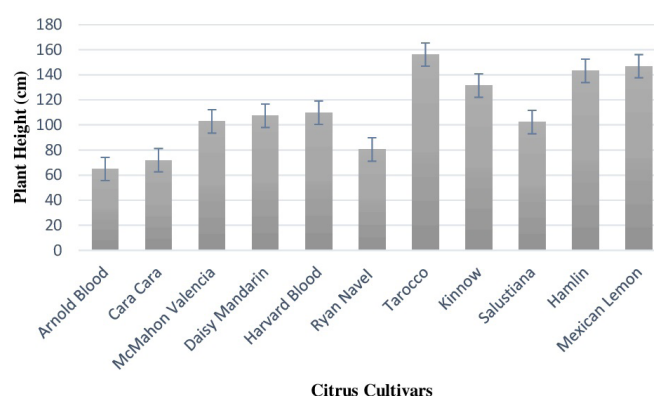


Figure 1: Effect of citrus cultivars on plant height
Level of significance= 0.05; LSD= 20.64

The results of our finding are in agreement with the early work of Khan et al. (2010) who previously reported that Tarocco-N cultivar produced tallest plants, followed by Mexican Lemon (146.80 cm), Hamlin, Kinnow LS, Harvard Blood, Daisy Mandarin, McMahon Valencia, Salustiana, Ryan Navel, Cara Cara and Arnold blood. It is very much clear from the

results that Tarocco and Mexican Lemon performed very well regarding plant height, while Cara Cara and Arnold Blood produced shortest plants as discussed early.

Stem girth

Vegetative growth is based on different parts in which stem girth is an important indicator for good performances of plant. The data regarding stem girth revealed a highly significant difference ranges from 9.90 to 3.98 cm as shown in Figure 2. Maximum stem girth was found in Hamlin (9.90 cm) progressively, followed by Mexican Lemon (8.63 cm), Daisy Mandarin, Harvard blood, Kinnow LS, Tarocco, McMahon Valencia, Ryan Navel, Salustiana, Arnold Blood, whereas minimum stem girth was observed in Cara Cara (3.98 cm). The stem girth is highly dependent on mineral nutrition which affected the photosynthetic rate, decreased carbohydrates production and proteins, which led to control plant growth and development (Taiz and Zeiger, 2002).

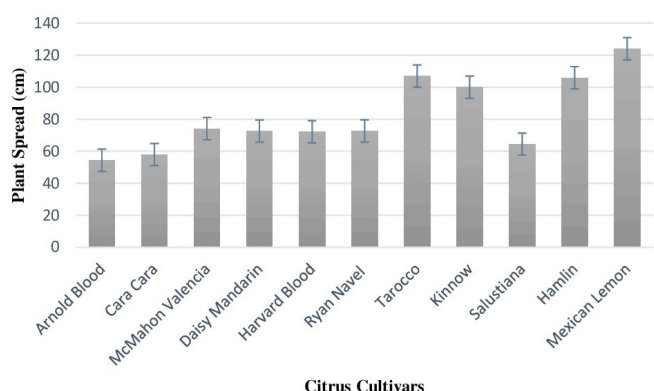


Figure 2: Effect of citrus cultivars on plant spread
Level of significance= 0.05; LSD= 15.13

Plant spread

Plant spread indicated a highly significant difference ranges from 124.07 to 54.38 cm (Figure 3). Highest plant spread was observed in Mexican Lemon (124.07 cm), progressively followed by Tarocco (106.92 cm), Hamlin, Kinnow LS, McMahon Valencia, Ryan Navel, Daisy Mandarin, Harvard Blood, Salustiana, Cara Cara, whereas minimum plant spread was observed in Arnold blood (54.38 cm). The result of our finding are in agreement with the Qureshi et al. (1993) who reported plant spread showed significant difference among citrus cultivars. Due to favourable environmental conditions and soil allowed the maximum increased in plant spread as it has been reported by Qureshi et al. (1993) ultimately showed high significant variation among different cultivar.

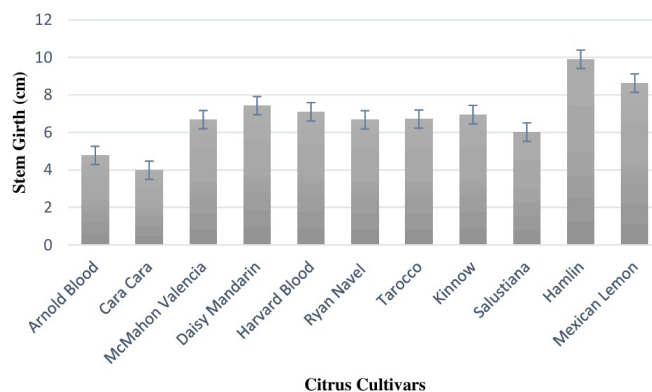


Figure 3: Effect of citrus cultivars on stem girth
Level of significance= 0.05; LSD= 1.5

Leaf area (cm²)

The data regarding leaf area showed a high significant difference ranges from 55.15 to 23.98 (Figure 4). The results indicated that bigger leaf area was found of Mexican Lemon (55.15 cm²), followed by Hamlin (41.57 cm²). However, the lowest leaf area was found in Ryan Navel (23.98 cm²). It was concluded from the results that Mexican lemon and Hamlin produced bigger leaf area might be due to better performance of the cultivar and compatability with the root stock (Castle et al., 1998). Similarly the better adoptability of the cultivar to take up the water and nutrients in higher quantity (Richardson et al., 2003). Leaf area is also a successful indicator for the success of crops where photosynthetic process initiated as in our study Mexican Lemon resulted in maximum plant spread so it may be allowing the larger leaf area.

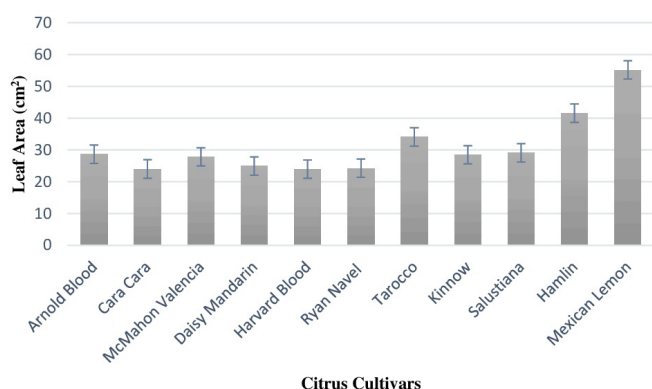


Figure 4: Effect of citrus cultivars on leaf area
Level of significance= 0.05; LSD= 1.13

Number of branches

The data regarding number of the branches revealed a highly significant difference ranges from 76 to 66.5 as shown in Figure 5. The results showed that maximum number of branches were found in Kinnow (76) followed by Hamlin (66.5) and were far signif-

icant from Tarocco and Daisy mandarin. While lower numbers of branches were found in Arnold blood (13.2). The observation of this parameter showed a significant variation among different citrus cultivars. The Kinnow cultivar bitterly performed to the environmental condition of the area. Similarly the cultivar difference in the production of number of branches might also be attributed to the adaptation to different ecological conditions (Khan et al., 2014) and ultimately had better impact on the reproductive growth of citrus (Ahmed et al., 2006).

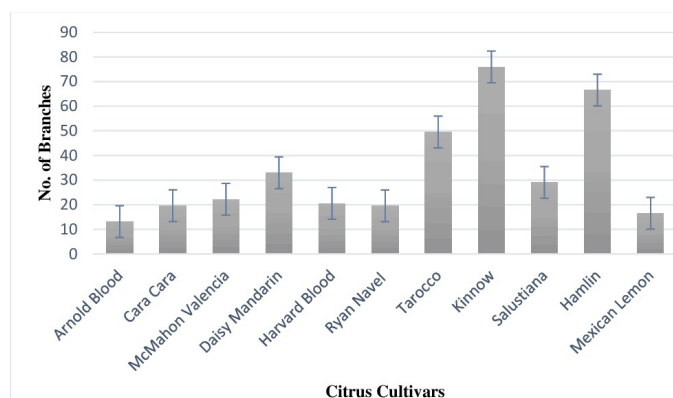


Figure 5: Effect of citrus cultivars on number of branches
Level of significance= 0.05; LSD= 11.14

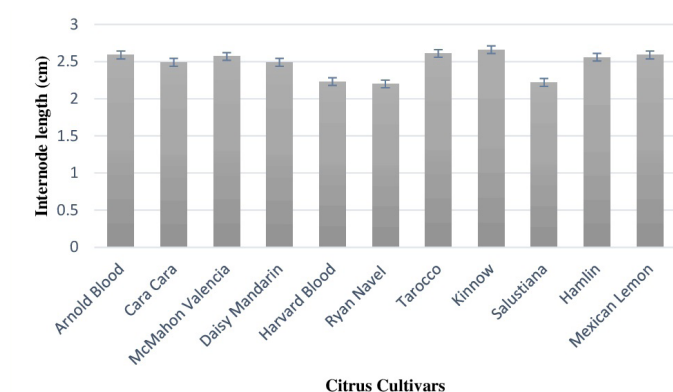


Figure 6: Effect of citrus cultivars on internode length
Level of significance= 0.05; LSD= 0.47

Internode length

The data regarding internode length revealed a significant difference ranges from 2.66 to 2.2 as shown in Figure 6. Kinnow were found having maximum length (2.66 cm), followed by Tarocco (2.61 cm). However, minimum internode length was found in Ryan Navel (2.2 cm), followed by Salustiana (2.22 cm) and Harvard Blood (2.23 cm). Similarly, Khan et al. (2014) indicated that internode length showed significant difference among citrus cultivars. Internode length is strongly dependent on cell elongation that is the best indicator of plant height and might be due to environmental stress response (Guthrie, 1993) and

genetic factor of the cultivar Ryan Navel and Salustiana showed shorter internodes. However, in the case of kinnow cultivar that thrive best to environmental stress, have higher internode length.

Lesion / Leaf

Disease rating scale ranges from 0-4 to know the level of resistance and susceptibility. The data regarding lesion per leaf revealed a highly significant difference ranges from 7.07 to 0.96 as shown in Figure 7. Our results indicated that higher number of lesions per leaf was found in Mexican Lemon (7.07), and Ryan Navel (6.6). However, the Cara Cara cultivar was found highly resistant and found only 0.96 lesions per leaf. Ijaz et al. (1999) also reported that Cara Cara cultivar was highly resistant to different fungal diseases. However, results were not supported by the work of Burhan et al. (2007) who reported that there was no significant variation among different citrus cultivars regarding citrus canker. Some cultivars resistant to the disease had already been reported by Leite et al. (1994) and Graham (2001).

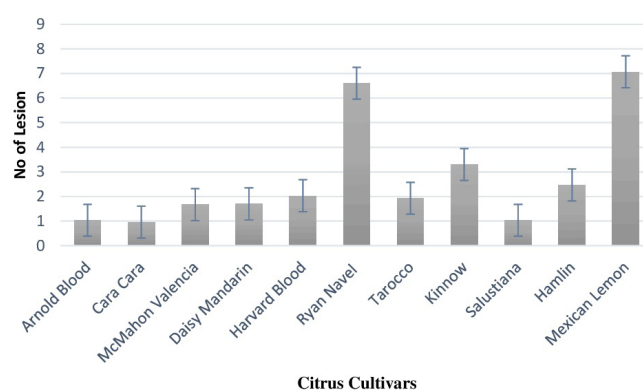


Figure 7: Effect of citrus cultivars on number of lesion
Level of significance= 0.05; LSD= 0.91

Conclusion

Based upon the finding of our study, it is recommended that, Tarocco and Hamlin performed best regarding plant growth (plant height, plant spread, stem girth, leaf area, internode length and number of branches) and disease incidence (citrus canker). Both the varieties were found resistant against citrus canker.

Acknowledgment

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Authors' Contribution

Nadeem Khan was the main investigator of this research work. Dr. Arshad Ali Khan worked as supervisor, Mukhtar Ahmad and Muhammad Nouman worked as co-supervisor and designed the research and helped during field study in NARC, Islamabad. While, Badshah Islam as co-supervisor internal helped in the draft and statistics analysis. All the authors have contributed intellectually in research and drafting.

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