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Fruit Set and Drop Patterns as Affected by Type and Dose of Fertilizer Application in Mandarin Cultivars (*Citrus reticulata* Blanco.)

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ABSTRACT

Fruit set and drop patterns in two commercial mandarin (*Citrus reticulata*) cultivars (Kinnow & Feutrell's Early) under Faisalabad conditions were studied in response to different types and doses of fertilizer. Engro compound fertilizer (17: 17: 17) was compared with simple fertilizer applications. Type of fertilizer had no effect on fruit setting as highest fruit set (169.75 fruitlets branch^{-1}) was recorded in Kinnow and Feutrell's Early (518.88 frutilets branch^{-1}) trees, when fertilized with simple and compound fertilizers, respectively. Treatment with compound fertilizer @ 3.0 kg (in two splits) resulted in minimum total fruit drop both in Kinnow (87.16%) and Feutrell's early (96.62%). Fruit set was more (399.63) in Feutrell's Early compared with Kinnow (122.78). Fruit drop up to June in Kinnow and Feutrell's Early was 83.59% and 96.36%, respectively. Feutrell's Early retained 2.44% fruit, in comparison to 10.81% in Kinnow mandarin until October, as the picking time of Feutrell's Early is earlier than that of Kinnow.

Key Words: Mandarins; *Citrus reticulate*; Fertilizer; Fruit set; Fruit drop

INTRODUCTION

Kinnow and Feutrell's Early are the recommended cultivars of mandarins in Punjab. The average per hectare yield of citrus fruits in the country is 10 tons, being one third of several citrus producing countries of the world (Anonymous, 2003). There is, therefore, a good potential to enhance citrus production in Pakistan in presence of good agro-climatic conditions, if management is improved. Like in other citrus species, fruit drop is a serious problem in mandarins, which start from blooming and continue till harvesting, particularly the pre-harvest drop. Assessment of such losses in mandarins revealed that out of forty to eighty thousand flowers, only two to seven hundred reach maturity (Zanini, 1950). High or low temperatures, rains, malnutrition, seeds in fruits, and pests and diseases are various casual agents associated with fruit drop in different species. Fruit drop and final fruit retention are mostly varietal characters, although water and nutritional stress increases fruit drop in susceptible trees (Rameshwar & Rao, 1980). Nitrogen deficiency at the time of blooming is one of the most common causes of too much abscission of flowers, resulting in less fruit set (Chandler, 1958). Gilani *et al*. (1991) reported a slight difference in fruit setting in Kinnow, when trees were supplied with ammonium sulphate (69.24%), calcium ammonium nitrate (68.10%) and urea (67.01%), as N source. Foliar spray of low biuret urea @ 3 lbs per 100 gallons of water, for fortifying N status of trees, before and after blooming resulted in least fruit drop percentage, although the results were statistically not different from control (Sattar, 1999).

Information on management of excessive fruit drop in citrus is scattered and many of the studies have been based on only the extent and pattern of fruit drop. Moreover, nutrient management of fruit drop is also lacking or has not been reported. The present studies were therefore, aimed at comparing fruit set, fruit drop patterns and yield in two mandarin cultivars (Kinnow & Feutrell's Early) in response to different fertilizer treatments.

MATERIALS AND METHODS

The experiment was conducted in the Experimental Fruit Garden, Sq. No. 9, Institute of Horticultural Sciences, University of Agriculture, Faisalabad during the year 2003. The experiment was laid out according to randomized complete block design (RCBD) in split plot arrangement, keeping the cultivars in main plot and fertilizers in subplot, with five treatments, each replicated four times. The experimental trees of both Kinnow and Feutrell's Early were already under trial to determine the effect of Engro's compound fertilizer (17: 17: 17) in comparison to simple fertilizer. Sets of fertilizer treatments were applied to the experimental trees are given in Table I.

Two trees of both Kinnow and Feutrell's Early from each treatment were selected for data collection. Four branches were tagged on each side of the tree. Leaves of 4-7 month age were collected to estimate the nutrient status of the trees before and after application of fertilizers.

Total nitrogen was estimated by the method described by Chapman and Parker (1961), which involved digesting the plant material with concentrated sulfuric acid and digestion mixture comprising K_2S O_4, $CuSO_4$ and $FeSO_4$ in ratio of 10: 0.5: 1.0.

The phosphorus and potash, after wet digestion by the method followed by Yoshida *et al*. (1976), were determined by the procedure defined by Chapman and Parker (1961). The digestion for phosphorus and potash was done by tri-acid mixture (HNO_3, $HClO_4$ & H_2SO_4) in ratio of 5: 2: 1.

Phosphorus was determined by spectrophotometer and potash by flame photometer.

Initial fruit set, fruit drop (%) and fruit yield (% of fruit set) were recorded on the selected branches. Fruit drop was noted on fortnightly basis during April, May, June and July, while at monthly interval from August to October. The data were statistically analyzed using the computer software MSTAT-C (Freed & Scott, 1986).

RESULTS

Fruit set. Fertilizer application significantly affected fruit set in both mandarin cultivars. However, the response of both mandarin cultivars to different fertilizer application was different (Fig. 1).

Kinnow plants fertilized with 2.0 kg of compound fertilizers (CF) had lowest fruit set, while trees treated with compound fertilizers @ 2.5, 3.0 and 3.0 kg (in two splits) had 148.63, 144.63 and 99.50 fruits per branch. Maximum fruit set was recorded in plants supplied with simple fertilizer i.e. 169.75 fruits per branch.

In Feutrell's Early, application of 2.0 kg CF per tree yielded maximum number of fruits per branch (518.88), while fruit setting in all other treatments was almost similar, including the control i.e. 380.63, 341.38, 378.50 and 378.75 fruit per branch in trees received 2.5, 3.0, 3.0 kg CF and simple fertilizer, respectively.

Fruit drop. Fertilizer application significantly affected fruit drop in both mandarin cultivars. In Kinnow maximum fruit drop was recorded with application of 2.5 kg CF per tree, which was similar to that of application of 3.0 kg CF per tree (Fig. 2). While minimum fruit drop was noted with the split application of 2.0 kg CF per tree and 1.0 kg urea in August (Fig. 2). Maximum fruit drop in Kinnow occurred during April, May and June with descending frequency, while fruit drop in later months was negligible (Fig. 3, 4).

In Feutrell's Early, similar fruit drop pattern was recorded in all the treatments (Fig. 2). As regards the monthly behavior, similar pattern as that of Kinnow was observed being maximum in April and low in later months, as in Kinnow (Fig. 3, 4).

Leaf NPK contents. Fertilizer application significantly affected leaf NPK contents in both mandarin cultivars. However, the response of both mandarin cultivars to different fertilizer application was different (Fig. 5, 6, 7).

Fertilizer application improved the nitrogen status of both Kinnow and Feutrell's Early trees except that of control Kinnow trees, which were treated with simple fertilizers (1.0kg ammonium sulphate, 2.0 kg SSP & 3.0 kg potassium sulphate). Increase in nitrogen level, supplied with compound fertilizer (CF) @ 2.0, 2.5 and 3.0 kg, and was significantly higher in comparison to those treated with simple fertilizers (SF) in Kinnow (Fig. 5). While in case of Feutrell's Early, maximum leaf N contents were measured in trees treated with simple fertilizers (1.0kg ammonium sulphate, 2.0 kg SSP & 3.0 kg potassium sulphate) (Fig. 5).

Fertilizer application improved the phosphorus status of both Kinnow and Feutrell's Early trees except that of Feutrell's Early trees, which were treated with the split application of 2.0 kg CF per tree and 1.0 kg urea in August. In Kinnow, maximum leaf phosphorus were recorded in trees, which were treated with the split application of 2.0 kg CF per tree and 1.0 kg urea in August, which was similar to that of application of 3.0 kg CF per tree (Fig. 6). In Feutrell's Early maximum leaf phosphorus was recorded with the application of 3.0 kg CF per tree, which was similar to that of application of 3.0 kg CF per tree and 0.5 kg urea per tree (Fig. 6).

Fertilizer application resulted in improved potash contents in both Kinnow and Feutrell's Early mandarin types, although the response to different fertilizer application did not differ (Fig. 7).

Table I. Sets of fertilizer treatments

Treatments	Fertilizer Application (Kg tree^{-1})		
	March	April	Aug-Sep.
T_1	1.0 $(NH_4)_2$ SO_4 2.0 S.S.P 3.0 K_2SO_4	1.0 $(NH_4)_2$ SO_4	-
T_2	2.0 (17:17:17)	0.5 Urea	-
T_3	2.5 (17:17:17)	-	-
T_4	3.0 (17:17:17)	-	-
T_5	2.0 (17:17:17)	-	1.0 (17:17:17)

Fig. 1. Effect of type of fertilizer application on fruit set (No. of fruits/branch) in Kinnow and Feutrell's Early

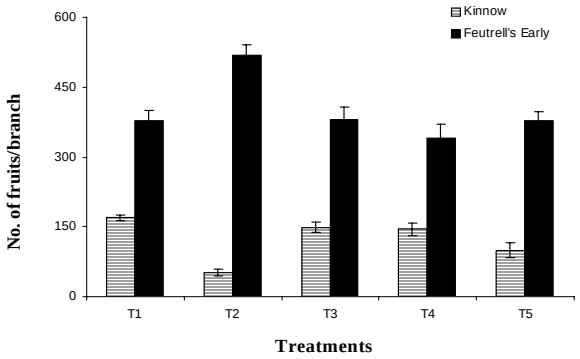
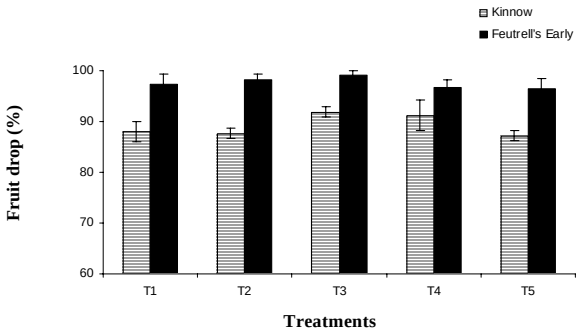


Fig. 2. Effect of type of fertilizer application on fruit drop in Kinnow and Feutrell's Early



DISCUSSION

Fruit set. Fruit set per branch was much higher in Feutrell's Early than Kinnow mandarin i.e. 399.63 as compared to

Fig. 3. Effect of type of fertilizer application on month-wise fruit drop (%) in (a) Kinnow and (b) Feutrell's Early

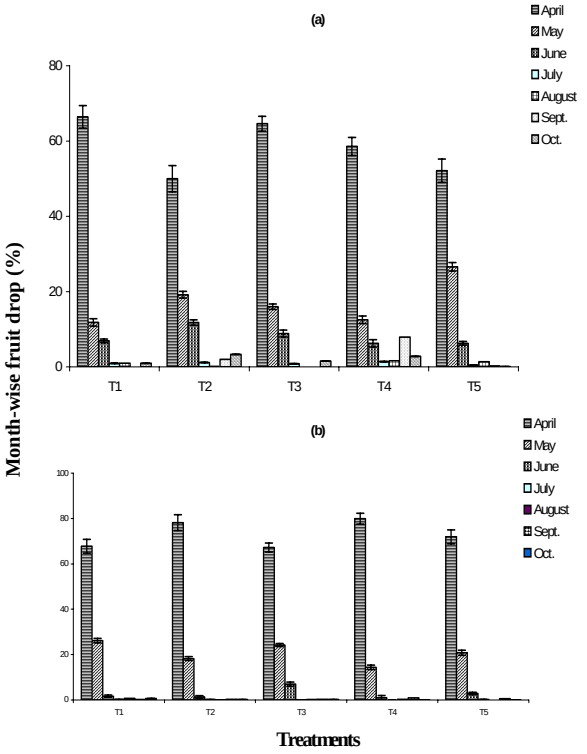
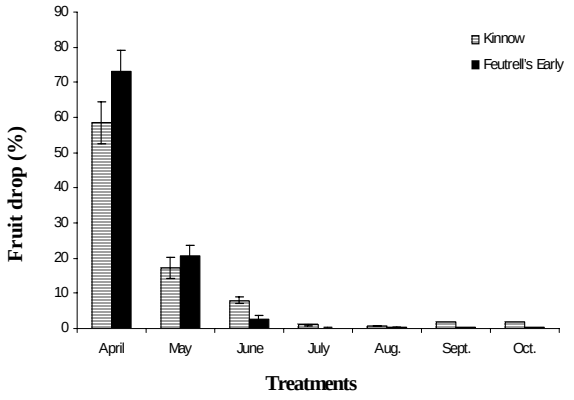


Fig. 4. Effect of type of fertilizer application on over all fruit drop (%) in Kinnow and Feutrell's early



122.78 fruit per branch, which could be due to varietal behaviour or alternate bearing habit in Kinnow.

Data on fruit set in both mandarins revealed that fruit set depends not only on the nutritional status of the trees at the time of flowering and fruit set but may also depend upon branch size, position of branch on the tree, number of flowers per branch and number of leaves on that particular branch. Our results were also supported by the earlier findings of Gilani *et al*. (1991), who reported a slight difference in fruit setting in Kinnow, when trees were supplied with ammonium sulphate (69.24%), calcium ammonium nitrate (68.10%) and urea (67.01%), as N source, which also supports our results.

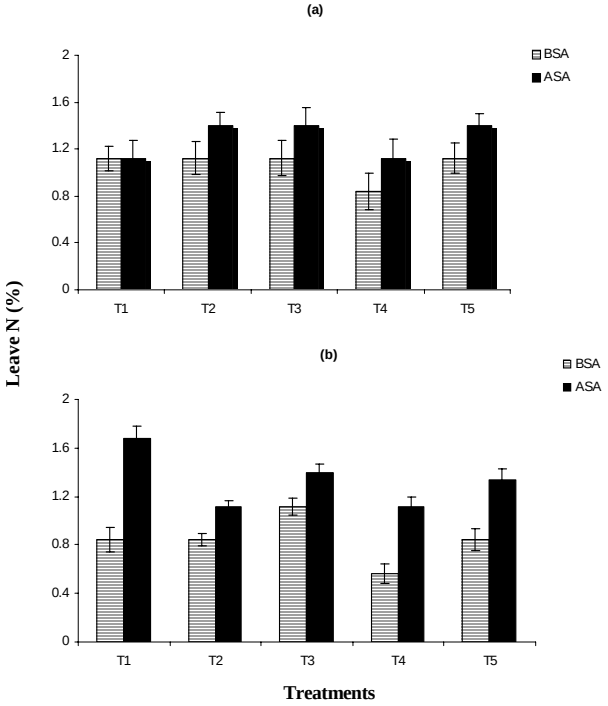
Fruit drop in different treatments showed less variation, with maximum (99.02%) in trees fertilized with 2.5 kg of fertilizers and minimum (96.49%) in trees received 3.0 kg of compound fertilizers (in two splits). Our results are supported by the findings of Rahim (1959) and Rashid (1961), who reported 88% fruit drop during April–May. Sattar (1999) observed maximum fruit drop in Kinnow up till June, which also confirmed our finding. Difference in fruit drop between the two mandarins became quite clear in June, which also indicated the varietal behaviour of two cultivars (Fig. 2).

It was evident that higher doses of fertilizers i.e. 2.5 and 3.0 kg per plant resulted in more fruit drop than lower doses (2.0 kg) or higher dose applied in two splits (3.0 kg). Overall fruit drop was 89.18 and 97.56% in Kinnow and Feutrell's Early, respectively (Table I), which also indicated that higher the fruit set higher was the drop.

Results indicated that more percentage of fruit retained in Kinnow mandarins than Feutrell's Early i.e. 10.81 and 2.44%, respectively. This could be due to different bearing habits as well as different fertilizer requirements. Results also indicate that application of fertilizer in two splits yielded better than single application.

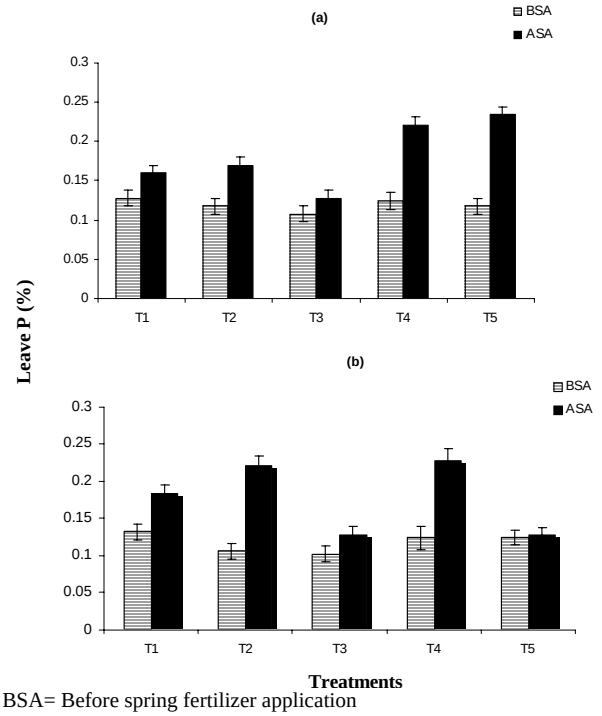
Fertilizer application at different rates significantly affected nitrogen and potash contents (Fig. 5, 7) but yielded no significant change in phosphorous contents of Feutrell's

Fig. 5. Effect of fertilizer application on leave N contents(%) in (a) Kinnow and (b) Feutrell's Early



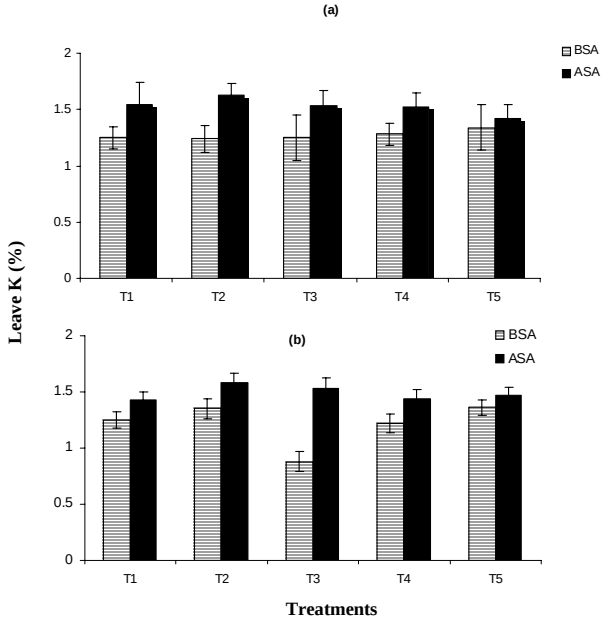
BSA= Before spring fertilizer application
ASA= After spring fertilizer application

Fig. 6. Effect of fertilizer application on leave P contents(%) in (a) Kinnow and (b) Feutrell's Early



BSA= Before spring fertilizer application
ASA= After spring fertilizer application

Fig. 7. Effect of fertilizer application on leave K contents (%) in (a) Kinnow and (b) Feutrell's Early



BSA= Before spring fertilizer application
ASA= After spring fertilizer application

Early leaves. Nitrogen contents of leaves increased after fertilizer application in all the treatments. Trees supplied with simple fertilizer and those with 3 kg CF (single application) showed hundred% increase in nitrogen contents of leaves i.e. from 0.84 to 1.68% and from 0.56 to 1.12%, respectively. Although phosphorous contents were statistically non-significant for all the treatments, both before and after fertilizer application, but fertilizer application increased the phosphorous contents in all the treatments except in trees receiving 3 kg CF in two splits (Fig. 6). Potash contents of trees increased after fertilizer application. The increase was more pronounced in trees, which had lowest level of potash before fertilizer application i.e. from 0.88 to 1.53% in plants given 2.5 kg compound fertilizers. Maximum potash contents (1.58%) were recorded in trees fertilized with 2.0 kg compound fertilizer application, however, statistically similar to trees, which received 2.5 kg of compound fertilizer (1.53%). Potash contents in trees, which received 3.0 kg of compound fertilizers, both in single application and in two splits, were statistically similar to those supplied with simple fertilizers i.e. 1.44, 1.47 and 1.43%, respectively.

Fruit drop is a natural phenomenon, which occurs in all fruits. Initial fruit set was found to be based on number of flowers per branch. Fruit drop in early stages was independent of fertilizer application, as it comprised the drop of flowers, which failed to fertilize. Fruit retention depends upon the health of the tree and the later drop might be due to nutritional or physiological problems. The difference in final fruit retention was due to the difference in their time of maturity. Split application of compound fertilizer was more effective than single application of the same or simple fertilizer.

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