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Effect of fertigation on granulation in Kinnow mandarin

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Abstract

The present investigations entitled “Effect of Fertigation on Granulation in Kinnow mandarin” was carried out in the Horticultural Garden, Bihar Agricultural University, Sabour, Bhagalpur during the year 2016-2018. The experiment was laid down in Randomized Block Design with 5 treatments and 4 replications. The study comprises of one experiment in which Kinnow trees under investigation were subjected to different level of fertigation, viz. T1- 120% of RDF as fertigation; T2- 100% of RDF as fertigation; T3- 80% of RDF as fertigation; T4- 60% of RDF as fertigation; T5- 100% of RDF as soil application and fruit samples were harvested monthly starting from the month September till December for analysis. The results revealed that the degree of granulation found maximum (1.75 %) in 60% RDF as fertigation (T₄) which is at par with T₃ and minimum degree in 120 % of RDF as fertigation. Enzymatic activity linked to granulation as like diastase activity was recorded highest (24.80 mol/min.) in 100% RDF as fertigation and lowest (16.81mol/min) in 60% RDF as fertigation and with advancement in fruit ripening diastase activity decreases. However, for the pectin esterase activity, there was non significant effect of the different fertigation treatments and its value decreases as fruit undergoes maturation.

Keywords: kinnow, granulation, nutrient, diastase, pectin esterase activity

Introduction

Citrus being one of the important and highest value fruit crop of the world, covers a pre-eminent position among horticultural crops. Citrus belongs to the family Rutaceae and subfamily Aurantoidea. According to the area under cultivation, citrus is the third largest fruit crop in India after banana and mango. In India, among major citrus fruit, the highest area, production and productivity is of mandarin followed by sweet orange and acid lime. However, Among mandarin, Kinnow; a hybrid of *Citrus nobilis* and *Citrus deliciosa* keeps a prominent place in citrus industry becoz of its attractive appearance, full of juciness and many health benefits. Kinnow mandarin fruit suffers from a quality disturbance physiological disorder “granulation”. Owing to previous studies, it has been reported that granulation is severe in Sweet orange cultivar (*i.e.* Blood red, Pineapple, Hamlin, Valencia late) and mandarin cultivars (*i.e.* Nagpur, Dancy and Kaula) but less significant in Pummelo, Grape fruit, Kinnow (Singh., 2001) [12]. But now, today this disorder also goes to a extent in Kinnow mandarin. Under this disorder, the juice sacs of fruit get shrivelled, enlarged and hard and has lesser extent of juices (Pal and Selvaraj., 1987) [3]. The juice sacs of affected fruit acquire an opaque white colour and get hardened, stiffened and lignified. The dense white tissue in granulated segment becomes visible due to thicker and gelatinous epidermis (Xiong., 2014) [14]. The first report of granulation noticed by Bartholomew *et al.* (1934) [1] in California. After that many researcher reported that the incidence of granulation. By virtue of granulation, it leads to inferior quality of fruit and lowers down the commercial value. So, growers fetches considerable losses (Zheng., 2006) [16]. Diverse factors viz. lack/excess of nutrients, recurrent irrigation, tree age, rootstock, delayed harvesting etc. are investigated to be related to this problem (Singh., 2001, Sharma and Saxena., 2001) [12]. Reports unfolds the fact that granulation is related to the nutritional status of plants (Wang *et al.*, 2014) [13]. The relatedness of enzymes like diastase and pectinmethyl esterase to citrus granulation has also been reported (Sharma *et al.*, 2004). The information on the role of nutrients on granulation and granulation related enzymes is however limited. So, the present experiment is to conducted to see the effect of fertigation on granulation in Kinnow mandarin.

Materials and Methodology

The field experiment were conducted on six year old kinnow mandarin plant at high density orchard of the permanent experimental area of Bihar Agricultural University, Sabour,

Bhagalpur. The climate of the experimental orchard is situated in the subtropical zone at latitude of 25.15° 48' north and east longitude 87.2° 42' and at an altitude of 45.72m above the mean sea level with desiccating hot summer, cold but frostless winter with mean annual rainfall of about 1380mm, out of which most of the rains are received during mid June to mid October. 40 plants of Kinnow plants of healthy and uniform size planted under the concept of high density were undertaken as experimental materials. The experiment was laid out in randomized block design with five fertigation level based on recommended dose of fertilizer (RDF) i.e. 500:240:240gram/ plant/ year, the treatments were T₁- 120% of RDF (600:288:288g); T₂- 100% of RDF (500:240:240g); T₃- 80% of RDF (400:192:192g); T₄- 60% of RDF (300:144:144g); T₅- 100% of RDF (500:240:240g) as basal without drip irrigation and each treatment were replicated four times with two plant in each replication. The treatment T₁, T₂, T₃, T₄ were applied in split doses whereas, treatment T₅ supplied directly in plant basin. Fertigation scheduling was administrated at monthly interval (Table 1). The fertilizer source used for fertigation were urea for nitrogen and mono potassium phosphate for phosphorus and sulfate of potash for potash. Fruit samples were harvested monthly starting from the month September till December for analysis. The extent of granulation was expressed as the percentage of the fruit affected by the disorder. It was based on the estimate of the portion of the fruit affected, which was classified as zero, below 10, 10–25, 25–50, 50–75 and 75–100 % (Singh 1977) [9]. All the fruits of each lot (25) in each replication were used to study the extent of granulation. For this, the fruits were first peeled and their finger removed. Then, individual finger was hand-peeled for observing the percentage of portion affected by granulation (Sharma and Saxena 2004; Sharma *et al.* 2006) [7,6]. There are two enzymes namely diastase and pectin esterase which are closely linked to granulation. Diastase activity was measured in juice of Kinnow fruit according to Sharma *et al.* (2004). To 5ml juice, 23 ml acetate buffer will be added and incubated for 1 h at 33 °C. After incubation, 2ml each of 3.58N H₂SO₄ and 12% sodium tung state will be added followed by thorough shaking. The solution will be filtered immediately, and the first 8–10 drops will be discarded. From the remaining filtrate, a 2.5 ml aliquot will be transferred to a test tube, to which 10 ml of potassium ferricyanide will be added and the mixture will be boiled slowly for 20 min. The contents will be cooled immediately under running tap water and transferred to a 100 ml conical flask, to which 25 ml acetic acid and 1ml starch-iodine solution will be added, and after through shaking, it will be titrated against 0.1N sodium thiosulphate. A blank determination will also be carried out similarly. The activity will be expressed in terms of mol/min. Pectinesterase activity will be measured in juice of Kinnow fruit according to Sharma *et al.* (2004). Initially, 20ml of 1.0% pectin solution will be made up in 0.25M NaCl solution and added to 5ml of fruit juice plus drops of Hinton's indicator. The volume will be made up to 40 ml with 0.1N NaOH and 0.125N NaCl solution for optimum activity. After 30 min, the quantity of liberated carboxyl group due to enzyme activity will be measured by titrating the solution against 0.02N NaOH. The activity will be expressed by the symbol (PE.u) g, which represents the milliequivalents of esters hydrolyzed per minute per milliliter of fruit juice.

Table 1: Monthly fertigation scheduling in kinnow orchard

Month	Date	N	P	K
January	15	-	-	-
February	15	✓	✓	-
March	15	✓	✓	✓
April	15	✓	✓	✓
May	15	✓	-	✓
June	15	✓	-	✓
July	15	-	-	✓
August	15	-	-	✓
September	15	-	-	✓
October	15	-	-	✓
November	15	-	✓	✓
December	15	-	-	-

Result and Discussion

Degree of granulation

The data on degree of granulation had significant differences among the treatments (Table 2). Pooled mean analysis of degree of granulation indicated that the application of 40 % RDF as fertigation (T₄) registered the highest degree of granulation (1.75%) which was at par with T₃ whereas the lowest degree of granulation was recorded in treatment T₁ (0.25%).

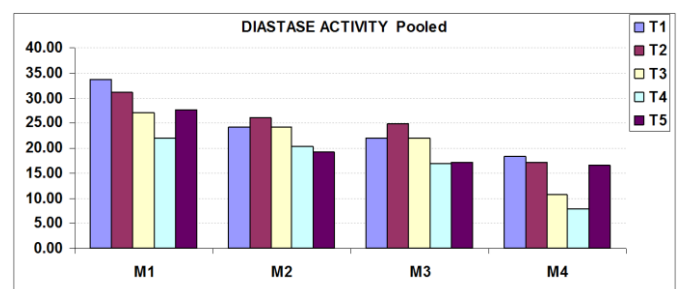
Table 2: Effect of fertigation on degree of granulation in kinnow mandarin

Treatments	Degree of granulation (%)
T1	0.25
T2	0.63
T3	1.38
T4	1.75
T5	0.38
Sem (±)	0.3558
CD	1.0306

Diastase activity

The data presented in fig.1 showed that the effectiveness of different dose of fertigation as NPK on diastase enzyme activity. The activity of diastase was found significant over all treatments. The highest activity was observed in T₂ (24.80mol/min) which was statistically at par by 24.61 mol/min in T₁ while 16.81 mol/min in T₄ during the pooled analysis of the experimental years 2016-2018.

The monthly variation in data of diastase activity presented in fig.1 show that the activity of diastase followed a decreasing trend during fruit maturation from the month September to December. The activity of diastase enzyme decreased from 28.32 to 14.17 mol/min.

**Fig 1:** Effect of fertigation on changes in diastase activity (mol/min) during fruit maturation

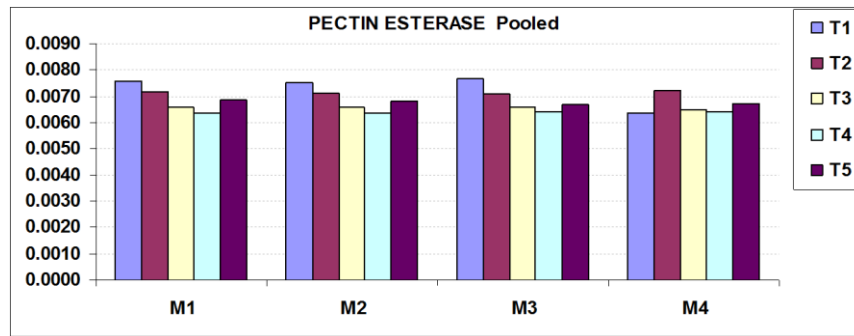


Fig 2: Effect of fertigation on changes in pectin esterase activity (PE.u)g. during fruit maturation

Pectin esterase activity

The perusal of data in fig.2 indicate that the treatment has no significant effect on PE activity. The monthly variation in data of pectin esterase activity presented in fig.2 show that the activity of pectin esterase followed a decreasing trend during fruit maturation from the month September to December. The activity of diastase enzyme decreased from 0.00923 to 0.00175 (PE.u)g.

From the Table 2, it revealed that the degree of granulation was found maximum in the treatment which is fertigated with 60% of RDF of NPK fertilizer and lesser in 120% of RDF as fertigation. It might be due to balanced application of fertilizer or nutrients either through soil or fertigation. Further, diastase activity was found maximum in 100 % of RDF as fertigation and minimum in 60% of RDF as fertigation. This result signifies the role of nutrients in enzyme metabolism specially nitrogen. The results on diastase activity in juice tissues revealed that there were significant decrease in activity during fruit maturation (Singh, 1981) [10]. It is fact that citrus fruits do not accumulate starch. Amylase which participate in starch degradation showed decreasing activity pattern during advancement of maturation. The decrease in activity of enzyme has also been reported in kagzi lime (Selvaraj and Raja, 2000) [5] have positive correlation in peel and Juice tissues with fruit firmness. The treatment has no significant on PE activity but the activity of PE activity decreased during fruit maturation. Our result matches with the finding of Robertson (1983) [4]. The decreased in fruits analysed between colour break stage and mature stage. The decrease in PE activity after colour break stage indicates that the role of PE was over after making the pectin substances for polygalacturonase enzyme to act upon because PE effects description of wall galacturonans and repulsion of galacturonan Chain facilitate the mobility of enzyme sending in pectin layer. Further, our finding has been also satisfied by Barmore *et al.*, 1976 [2] and Zauberman *et al.*, 1972 [15] and Singh., 1985 who concluded that PE activity during maturation might be a very good index of maturity because they recorded that activity of this enzyme pectin methyl esterase (PE) decreases significantly with maturity of the avocado fruit.

Conclusion

From the experiment it can be concluded that degree of granulation found maximum (1.75 %) in 60% RDF as fertigation (T₄) and in 120 % of RDF as fertigation. Enzymatic activity linked to granulation as like diastase activity was recorded highest (24.80 mol/min.) in 100% RDF as fertigation and lowest (16.81mol/min) in 60% RDF as fertigation and with advancement in fruit ripening diastase activity decreases. However, for the pectin esterase activity, there was non significant effect of the different fertigation

treatments and its value decreases as fruit undergoes maturation.

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