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EFFECT OF TIME OF NITROGEN APPLICATION ON FRUIT SET AND YIELD OF GRAPEFRUIT

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Abstract

Study was carried out to investigate the best application time and dose of fertilizer for maximum yield and good quality of grapefruit, at Horticultural Research Institute Faisalabad, Pakistan during the year 2004-06. Mature bearing trees of grapefruit were selected and NPK fertilizers were applied at different time before flowering and after fruit setting. Full dose of phosphorus (625 g) and sulphate (625 g) per plant was applied at two different times i.e. February and April along with the half dose of nitrogen (625g) and remaining dose of N was applied in April and August in separate treatments. Among all treatments the highest fruit set (4.24%), fruit yield (332 fruits plant^{-1}) and lowest fruit drop (81.21%) were recorded, where half dose of nitrogen (625 g) and full dose of P and K (625 g each) was applied in February and remaining half dose of nitrogen was applied after fruit setting during the month of April. Attractive fruit colour and better quality regarding pulp weight, juice weight percentage and total soluble solids, also observed.

Key words: Grapefruit, *Citrus paradisi*, fertilizer, time of application, fruit set, yield

INTRODUCTION

The whole scenario of Pakistan fruit culture is dominated by citrus with an area 183.8 thousand hectare and production 1943.7 thousand tons (Anonymous, 2005). Grapefruit is one of the prominent groups of citrus having nutritional and therapeutic qualities. It is much liked by all sorts of people due to dietary values, large amount of juice and excellent taste. It is invariably suggested for diabetic and blood pressure patients. The cultivation of grapefruit in Faisalabad (Pakistan) has positive impact on the improvement of social life as well as health of farming.

Unfortunately, the production from the grapefruit orchards is very low. There are so many reasons for this low yield but fruit drop, alternate bearing insufficient plant protections and non-judicious use of fertilizer are the major limitations. Nitrogen is a component of chlorophyll (the green pigment in leaves) and is associated with important tree functions such as growth, leaf production, flower initiation, fruit set, fruit development and quality. A deficiency of nitrogen in the spring makes the leaves pale and small (Agfact, 2002). Nitrogen fertilization plays an important role in fruit yield and quality of citrus, especially in sandy soils that contain small

amounts of available nutrients (Futch and Alva, 1994). Fruit quality attributes such as juice volume, total soluble solids and SSC may be improved by increasing N rates (He et al., 2001).

Supplies of nitrogen in sufficient quantities are inevitable for better crop yield and improved quality of citrus fruit. Since the losses of N after application are quite high, therefore, its judicious application is essential. Improved nitrogen fertilizer application is needed to reduce production costs and obtaining a good growth (Maust and Williamson, 1994). Nitrogen fertilization and irrigation are crucial for sustainable citrus production (Davies, 1997). There is a positive correlation between chlorophyll and N content in plants, therefore; limited N availability for crop, generally results in a reduction of protein production and, consequently, in a decrease of chlorophyll proteins (Bredemeier and Schmidhalter, 2001; Barraclough and Kyte, 2001).

There is a need to establish adequate rates of N to optimize growth and development of citrus trees, to avoid excessive N application which is non-productive, costly and may result in loss of N through leaching or run off (Thompson et al., 2003). Several factors influence the adequate N rate for young trees, such as the fertilizer programs used in the nursery, soil characteristics, sources of fertilizer, time and method of application. Nitrogen has significant effects on orange yield and number of fruits per tree (Tucker et al., 1995; Dasberg et al., 1983). Single spring application of 750 g nitrogen per tree maintains N levels in old leaves, spring shoots, ovaries, fruit and bark statistically equal to those obtained using double doses of ammonium nitro-sulphate (ANS) in two applications (Maquieira, 1984). Nitrogen influences biomass accumulation in plants. Nitrogen availability, particularly during the period of maximum growth of axes, influenced the shoot growth components and thus tree architecture (Mediene et al., 2002).

Fertilizers are being used by the growers at any time of the year without knowing the proper time at which fertilizer may improve the crop more effectively and its impact on yield. Successful fertilizer programme in orchards depends upon right kind of fertilizers applied at right time in the right place and in right amount. In literature some references available where research have done to investigate the effect of fertilizer in citrus but it is mostly on Kinnow. Unfortunately grapefruit is generally ignored by the research workers and scientists. . Therefore; this project was started to investigate the recommendations of fertilizer doses and time of application of nitrogen and their effect on the yield and quality of grapefruit.

MATERIALS AND METHODS

Present studies were conducted at Horticultural Research Institute Faisalabad for the improvement of yield and quality of grapefruit during the year of 2004-06. Twelve plants with same age and size of 12 years old grapefruit cv. Shamber were selected for these studies. The experiment was laid out according to Randomized Complete Block Design (RCBD) with four treatments and each treatment repeated thrice. The following treatments were tested:

T_1: Full dose of N (1250 g) + P (625 g) + K (625 g) during February.

T_2: Half dose of N (625 g) + P (625 g) + K (625 g) in February and half dose of N (625 g) in August

T_3: Half dose of N (625 g) + P (625 g) + K (625 g) in April and half dose of N (625 g) in August

T_4: Half dose of N (625 g) + P (625 g) + K (625 g) February and half dose of N during April (Control / Standard dose)

Treatments including NPK combinations were applied by broadcast method up to the area of plant canopy leaving 45 cm from the main stem. Plants were irrigated immediately after the application of all treatments. Following parameters were recorded:

- Fruit set (%)
- Fruit drop (%)
- Yield (number of fruits plant^{-1})

Fruit yields per plant on weight basis were recorded from 2004-2006. Ten fruits per plant were picked randomly during January of each year to determine fruit weight (g), juice contents (%age), peel (%age), total soluble solids (%age), acidity (%age) and TSS/acidity ratio

The data obtained were subjected to statistical analysis using analysis of variance technique and treatment means were tested using least significant difference test at 5% probability (Steel et al., 1997).

RESULTS AND DISCUSSION

The data in Table1 shows that the highest fruit set (4.19%) was recorded in T_4 followed by T_2 (4.03%), T_1 (3.84%) and T_3 (3.36%). So the maximum fruit set percentage was in T_4 where half dose of nitrogen was applied in February and remaining half in April. Same results were obtained in second year of the project and T_4 gave best results with maximum fruit set (4.24) as shown in Table 1 and T_2 take 2nd position by setting (4.08 %) fruit. It means the application of N in April play an important role to fruit. The data in Table1 shows that the highest fruit drop (89.78%) was recorded in T_1 followed by T_3 (87.34%), T_2 (84.03%) and T_4 (81.73%). T_4 again remains best with minimum fruit drop during the two year study on fruit drop %age T_4 remains best with minimum fruit drop like (81.73 % and 81.21 %) according to Table 1 & 2, respectively. There were maximum fruit drop in T_1 as (89.78 % and 88.70 %) during 1st and 2nd year of the study respectively, where full dose of NPK were applied in February. Fruit yield also evaluated during the two year study and data presented in Table1 showed that the maximum yield (317 fruits plant^{-1}) was recorded in T_4, followed by T_2 (299), T_3 (296) and T_1 (281) fruits plant^{-1}. During the second year of the study again T_4 gain 1st position by producing (332 fruits plant^{-1}) and T_2 take 2nd position by yielding (314 fruits plant^{-1}) followed by T_3 and T_1 with (311 & 296 fruits plant^{-1}).

Table 1: Physiological parameters recorded during 2004-06

Treatments	Fruit Set (%)		Fruit Drop (%)		Yield (No. of fruits)	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
T_1	3.48 c	3.53 c	89.78 a	88.70 a	281 c	296 c
T_2	4.03 b	4.08 b	84.03 c	83.48 c	299 b	314 b
T_3	3.36 c	3.41c	87.34 b	86.79 b	296 b	311 b
T_4	4.19 a	4.24 a	81.73 d	81.21c	317 a	332 a

Table 2: Physiological parameters recorded during 2004-06

Treatments	Fruit Weight (g)		Juice (%)		Peel (%)		Rag (%)	
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
T_1	476.0a	445.0b	47.88b	50..00b	30.90c	29.63b	21.22a	20.37b
T_2	456.0b	462.0a	48.54b	48.56c	33.00a	31.02b	18.46c	20.42b
T_3	477.0a	480.0a	45.74c	46.23d	32.01b	32.36a	22.25a	21.41a
T_4	460.0a	470.0a	49.40a	51.20a	28.91d	27.01c	21.69b	21.79a

It is quite obvious from the above results that T_4 remains best in comparison with other treatments. In this treatment we applied half dose of N and full dose of P&K during February and half N during April. There were maximum fruit set and yield with minimum fruit drop in T_4. It is may be due to the nitrogen availability at the proper time and in proper amount (Tucker et al., 1995) because nitrogen fertilization plays an important role in fruit yield and quality of citrus (Futch and Alva, 1994; Agfact, 2002). February and April are growing periods of grapefruit during which flower emergence and fruit setting take place, so at this time plant requires more and rapid nutrition (Maquieira, 1984; Mediene et al., 2002).

All quality parameters are given in Table 2 & 3. Fruit weight was maximum (480 g and 470 g) where N was applied in April and August. T_4 (where N was applied in February & April) showed the superiority in juice contents containing more than 51%. Where P and K were applied in the month of April showed minimum juice percentage. TSS, acidity and TSS/acidity showed haphazard results but T_4 showed significantly higher TSS and lower acidity than other treatments. It can safely be assumed that PK applied before flowering play important role to develop the constituents which are responsible for total soluble solids and fruits took enough time to convert the constitute into sugars.

Table 3: Chemical characteristic of grapefruit during 2004-06

Treatments	TSS (%)		Acidity (%)		TSS/acidity ratio	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
T_1	7.22b	8.00b	1.35b	1.29b	5.34	6.20b
T_2	7.00b	7.99b	1.59a	1.42a	4.40	5.62b
T_3	8.02a	8.13ab	1.48a	1.56a	5.41	5.14c
T_4	8.20a	8.22a	1.36b	1.20b	6.02	6.85a

CONCLUSIONS

It is concluded that T_4 is the best treatment in which nitrogen was applied in two doses i.e. half dose of nitrogen (625 g) with full dose of P and K (625 g each) in February and other half dose of nitrogen (625 g) in April just after the fruit setting.

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