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# Effect of N and K application on yield and quality of pomegranate cv. Ganesh under rainfed conditions

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## ABSTRACT

**The pomegranate plants were treated with five levels of nitrogen (250, 375, 500, 625 and 750 g/plant) and potassium (200, 300, 400, 500 and 600 g/plant) to evaluate their influence on fruit yield and quality. The plants were raised and maintained under crescent bund with open catchment pits. Basal dose of FYM (15 kg/plant) and phosphorus (250 g/plant) were applied in mid December. Full dose of phosphorus (single super phosphate), potassium (muriate of potash) and half of nitrogen (calcium ammonium nitrate) were applied in the first fortnight of January and second half in the second fortnight of May. The experiments were conducted in randomized block design with three replications. The maximum fruit set (28.85 and 27.37%), fruit yield (14.94 and 14.91 kg), TSS (16.07 and 16%), total sugars (11.46 and 11.44%), non-reducing sugars (2.80 and 2.68%) and reducing sugars (9.56 and 9.58%) were recorded with the treatment $N_3K_4$ (N- 500 and K 500 g/plant). Whereas, maximum fruit weight (458.3 and 458.1 g) and fruits with high acidity (0.52 and 0.54%) were obtained with $N_5K_4$ (N-750: K- 500) and $N_5K_5$ (N-750: K-600) for both the years. The vitamin C content of the fruits was reported to increase with the higher doses of N and K (16.36 and 16.40 mg/100 g, respectively). The fruits with minimum yield, lowest TSS, total sugars, non reducing sugars and reducing sugars were obtained with higher doses of N and K (N-750: K-600) application. Thus, the application of N and K at optimum level of 500 g/plant/year of each was found to be superior as compared to other treatments for enhancing fruit set, yield, and quality.**

**Key words:** Pomegranate, nutrient management, fruit yield, quality.

## INTRODUCTION

Pomegranate (*Punica granatum* L.) belonging to family Punicaceae is a delicious and desert table fruit of tropical and subtropical regions of the world. It is liked for its cool refreshing juice, nutritional and medicinal properties. It is native to Persia (Iran), Afghanistan and Baluchistan. In India, it is found growing from Kanyakumari to Kashmir but the commercial plantations of pomegranate exists only in Maharashtra, Gujarat, Rajasthan, Karnataka and to a limited extent in Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana and Tamilnadu owing to its preference for arid climate. It is hardy and it is very suitable crop for dry, rainfed, pastured and undulating land, where other fruit crops cannot grow successfully. Owing to its xerophytic characteristics it can tolerate water stress and thus can be grown successfully in arid and semi-arid regions. It provides high yield and more income per unit area with low input. In the last decade, pomegranate has been introduced in the foothills of Himachal Pradesh for commercial cultivation. Lack of information on optimum fertilizer schedule of N, P and K for economic production of pomegranate is required. Hence, the present study was undertaken to note the effect of different levels of N and K levels on yield and quality of pomegranate cv. Ganesh under rainfed conditions.

## MATERIALS AND METHODS

The present study was conducted on six-year-old pomegranate plants of cv. Ganesh planted at 6 m × 6 m apart at the orchard of Department of Pomology, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan. Seventy-five plants of uniform size, vigour and productivity were selected. All plants were given uniform cultural practices. The experiment was laid out in a randomized block design with 25 treatments and each treatment was replicated thrice. The treatment consisted of application of N, *viz*., 250, 375, 500, 625 and 750 g/plant and K, *viz*., 200, 300, 400, 500 and 600 g/plant. The different treatment combinations of N and K are presented in Table 1. All the plants were maintained under water harvesting technique 'Crescent bund' with open catchment pits as per the recommendations made by Sharma (18). Basal dose of FYM (15 kg/plant) and

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**Table 1.** Details of the different treatments used in the study.

| Treatment | Details of treatment | |
|---|---|---|
| | N (g/plant) | K (g/plant) |
| $N_1K_1$ | 250 | 200 |
| $N_1K_2$ | 250 | 300 |
| $N_1K_3$ | 250 | 400 |
| $N_1K_4$ | 250 | 500 |
| $N_1K_5$ | 250 | 600 |
| $N_2K_1$ | 375 | 200 |
| $N_2K_2$ | 375 | 300 |
| $N_2K_3$ | 375 | 400 |
| $N_2K_4$ | 375 | 500 |
| $N_2K_5$ | 375 | 600 |
| $N_3K_1$ | 500 | 200 |
| $N_3K_2$ | 500 | 300 |
| $N_3K_3$ | 500 | 400 |
| $N_3K_4$ | 500 | 500 |
| $N_3K_5$ | 500 | 600 |
| $N_4K_1$ | 625 | 200 |
| $N_4K_2$ | 625 | 300 |
| $N_4K_3$ | 625 | 400 |
| $N_4K_4$ | 625 | 500 |
| $N_4K_5$ | 625 | 600 |
| $N_5K_1$ | 750 | 200 |
| $N_5K_2$ | 750 | 300 |
| $N_5K_3$ | 750 | 400 |
| $N_5K_4$ | 750 | 500 |
| $N_5K_5$ | 750 | 600 |

single super phosphate (250 g/plant) were applied in mid December. The application of cypermethrin @ 0.2% as recommended for the control of *anar* butterfly (*Virachola isocrates*) was given to all the experimental trees starting from mid March to August during both years. The full dose of the given quantities of phosphorus, potassium and half of nitrogen were applied in the first fortnight of January, while the remaining half dose of nitrogen was applied in the second fortnight of May.

Four branches of one metre length were selected on each tree in all the directions. The numbers of flowers present on these branches were counted 20 days after full bloom. The numbers of fruits were also counted as fruit set. Other data were recorded following standard procedures. Among the physico-chemical parameters, the weight of three randomly selected fruits was measured and average was calculated. The TSS of randomly selected fruits was determined with the help of Erma hand refractometer (0-32°Brix). The percent acidity, total sugars, reducing sugars, non-reducing sugars and vitamin C were determined as per the standard methods given by AOAC (1).

## RESULTS AND DISCUSSION

The data presented in Table 2 shows that treatment combination $N_3K_4$, significantly enhanced the fruit set of 28.85% in first and 27.37% in second year, while the minimum fruit set (19.04 and 20.04%) was recorded under $N_5K_5$ treatment. The treatment combination $N_3K_4$, though at par with $N_3K_3$, significantly enhanced the fruit yield (40.33 fruits/plant). However, in the second year, treatment combination $N_3K_5$, though at par with $N_1K_4$, $N_3K_3$, $N_3K_4$ and $N_4K_1$ treatment combinations, produced significantly more fruits (39.67 fruits/plant) than the other treatments. The minimum numbers of fruits (21.67 /plant) were harvested under $N_5K_4$ treatment combination during first year. Whereas, the minimum number of fruits (23.67 /plant) were harvested under $N_5K_3$ treatment combination. The combined effect of nitrogen and potassium significantly increased the fruit yield and fruit set of pomegranate plants in the present study. This effect could be because of the role played by these nutrients in various metabolic processes and translocation of metabolites. These results are in conformity with the findings of Pathak and Pundir (8) in pomegranate cv. Jyothi, and Chatzitheodorou *et al.* (3) in peach cvs. Spring Time and Red Haven. Similarly, the data presented in Table 2 shows that treatment combination $N_3K_4$ significantly enhanced the fruit yield (14.94 kg/plant) as compared to rest of the treatment combinations, while the minimum fruit yield (8.42 kg/plant) was recorded under $N_1K_2$ treatment combination in the first year. However during the second year of study, treatment combination, $N_3K_5$, though at par with $N_3K_4$, $N_4K_2$ and $N_5K_2$, significantly increased the fruit yield (14.91 kg/plant) over rest of the treatment combinations, while the minimum yield (8.00 kg/plant) was recorded under $N_1K_1$ treatment combination. The yield of fruits was reported to increase with increased levels of N and K ($N_{500}$ and $K_{500}$) probably because of the certain role of N and K in various metabolic processes which improved fruit bud differentiation, flowering intensity, higher ratio of perfect to male flowers, fruit set and productivity, which in turn improved the yield. The results obtained in the present study are in accordance with the findings of Pathak and Pundir (8), Haggag and Shamy

**Table 2.** Effect of N and K on yield parameters of pomegranate cv. Ganesh.

| Treatment | Fruit set (%) | | Yield (No. of fruits/plant) | | Fruit yield (kg/plant) | |
|---|---|---|---|---|---|---|
| | 1st y | 2nd y | 1st y | 2nd y | 1st y | 2nd y |
| $N_1K_1$ | 20.62 | 21.24 | 27.00 | 29.00 | 8.59 | 8.00 |
| $N_1K_2$ | 21.53 | 21.29 | 26.67 | 30.67 | 8.42 | 8.66 |
| $N_1K_3$ | 22.75 | 22.15 | 27.33 | 30.67 | 8.50 | 8.51 |
| $N_1K_4$ | 23.35 | 22.96 | 28.67 | 34.00 | 8.79 | 9.29 |
| $N_1K_5$ | 24.95 | 23.28 | 30.00 | 30.33 | 9.15 | 8.23 |
| $N_2K_1$ | 24.69 | 24.29 | 30.00 | 32.67 | 9.79 | 10.67 |
| $N_2K_2$ | 24.71 | 24.83 | 30.00 | 33.00 | 9.80 | 10.77 |
| $N_2K_3$ | 25.70 | 25.44 | 32.00 | 30.67 | 10.48 | 10.04 |
| $N_2K_4$ | 25.90 | 25.72 | 32.33 | 33.00 | 10.59 | 10.82 |
| $N_2K_5$ | 25.92 | 25.86 | 33.00 | 33.67 | 10.86 | 11.06 |
| $N_3K_1$ | 25.95 | 25.96 | 34.33 | 30.67 | 11.97 | 10.58 |
| $N_3K_2$ | 25.98 | 26.07 | 35.00 | 32.67 | 12.25 | 11.45 |
| $N_3K_3$ | 26.86 | 26.30 | 38.00 | 35.67 | 13.58 | 12.76 |
| $N_3K_4$ | 28.85 | 27.37 | 40.33 | 38.67 | 14.94 | 14.32 |
| $N_3K_5$ | 26.73 | 25.86 | 34.00 | 39.67 | 12.77 | 14.91 |
| $N_4K_1$ | 25.78 | 25.30 | 33.33 | 36.00 | 13.24 | 14.32 |
| $N_4K_2$ | 24.67 | 24.89 | 33.00 | 30.00 | 12.79 | 11.62 |
| $N_4K_3$ | 23.66 | 24.05 | 30.67 | 29.00 | 11.43 | 10.80 |
| $N_4K_4$ | 22.65 | 23.10 | 28.33 | 26.00 | 10.26 | 9.44 |
| $N_4K_5$ | 20.65 | 22.25 | 26.00 | 29.33 | 8.73 | 9.85 |
| $N_5K_1$ | 21.41 | 20.28 | 24.67 | 25.00 | 9.53 | 9.65 |
| $N_5K_2$ | 20.40 | 20.25 | 24.33 | 33.67 | 10.42 | 14.41 |
| $N_5K_3$ | 19.41 | 20.09 | 22.33 | 23.67 | 9.99 | 10.60 |
| $N_5K_4$ | 19.34 | 20.06 | 21.67 | 28.33 | 9.93 | 12.98 |
| $N_5K_5$ | 19.04 | 20.04 | 22.33 | 27.00 | 10.04 | 12.13 |
| $CD_{0.05}$ | | | | | | |
| N | 0.45 | 0.25 | 1.70 | 3.59 | 0.48 | 0.46 |
| K | NS | NS | NS | NS | 0.48 | 0.46 |
| N × K | 0.49 | 0.38 | 3.79 | 5.68 | 0.97 | 0.94 |

1st y = First year, 2nd y = Second year

(6), Singh *et al.* (13), El-Kassas *et al.* (4), Bewoor *et al.* (2), Wavhal (15) and Padmavathamma and Hulamani (7) who reported the highest flowering intensity, higher ratio of perfect to male flowers and yield with the combined application of nitrogen and potassium in different pomegranate varieties.

It can be deduced from the data presented in Table 3 that treatment $N_5K_4$, though at par with $N_5K_2$, $N_5K_3$ and $N_5K_5$, yet significantly increased the fruit weight (458.3 g) over all the remaining treatment combinations, while fruits with minimum weight (305.0 g) were harvested under $N_1K_5$ treatment combination. Similar results were recorded during second year. The integrated use of nitrogen and potassium exerted significant influence on fruit weight in the present investigations. It is probably because of the role of N and K in various metabolic processes, which resulted in the ambient availability of these nutrients. The increase in fruit weight, fruit size and other physical characters have also been recorded by various workers, *viz*., Razek *et al.* (9), Shinde *et al.* (12), and Wahdan *et al.* (14) in different fruit crops.

It was observed that treatment $N_3K_4$, significantly enhanced the TSS contents of fruits (16.07%) in the first and 16.00 in the second year, compared to all the remaining treatment combinations, whereas, the minimum TSS contents in fruits were recorded under $N_5K_5$ treatment during both years. The data presented in Table 2 reveal the treatment combinations $N_5K_4$ and $N_5K_5$ produced fruits with significantly more acidity (0.52% each) compared to all the remaining treatment combinations but were observed statistically at par with $N_5K_2$ and $N_5K_3$ treatment combinations whereas minimum acidity was recorded under $N_1K_1$ combination (0.29%). Similar results were recorded during the succeeding year of study. The total sugars contents were reported to be maximum (11.46%) by application of treatment $N_3K_4$ in first year of

**Table 3.** Effect of N and K application on quality of pomegranate cv. Ganesh.

| Treatment | Fruit weight (g) | | TSS (°Brix) | | Acidity (%) | | Total sugars (%) | | Reducing sugars (%) | | Non reducing sugar (%) | | Vitamin C (mg/100 g fruit) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st y | 2nd y | 1st y | 2nd y | 1st y | 2nd y | 1st y | 2nd y | 1st y | 2nd y | 1st y | 2nd y | 1st y | 2nd y |
| $N_1K_1$ | 318.0 | 275.9 | 14.43 | 14.65 | 0.29 | 0.31 | 10.68 | 10.66 | 9.24 | 9.23 | 2.33 | 2.31 | 15.24 | 15.77 |
| $N_1K_2$ | 316.0 | 282.3 | 14.47 | 14.78 | 0.31 | 0.33 | 10.79 | 10.77 | 9.26 | 9.28 | 2.39 | 2.37 | 15.28 | 15.80 |
| $N_1K_3$ | 311.2 | 277.4 | 14.53 | 14.85 | 0.32 | 0.33 | 10.88 | 10.86 | 9.29 | 9.31 | 2.45 | 2.43 | 15.31 | 15.82 |
| $N_1K_4$ | 306.8 | 273.3 | 14.58 | 14.97 | 0.34 | 0.36 | 10.98 | 10.96 | 9.32 | 9.34 | 2.49 | 2.47 | 15.36 | 15.87 |
| $N_1K_5$ | 305.0 | 271.4 | 14.63 | 14.97 | 0.34 | 0.36 | 11.04 | 11.02 | 9.33 | 9.37 | 2.52 | 2.49 | 15.39 | 15.88 |
| $N_2K_1$ | 326.3 | 326.5 | 15.40 | 15.04 | 0.35 | 0.37 | 11.08 | 11.06 | 9.35 | 9.39 | 2.53 | 2.50 | 15.44 | 15.91 |
| $N_2K_2$ | 326.5 | 326.5 | 15.46 | 15.18 | 0.37 | 0.39 | 11.10 | 11.08 | 9.38 | 9.40 | 2.54 | 2.53 | 15.49 | 15.92 |
| $N_2K_3$ | 327.3 | 327.3 | 15.51 | 15.74 | 0.39 | 0.41 | 11.15 | 11.13 | 9.40 | 9.40 | 2.58 | 2.55 | 15.54 | 15.93 |
| $N_2K_4$ | 327.6 | 327.8 | 15.54 | 15.74 | 0.40 | 0.42 | 11.42 | 11.17 | 9.43 | 9.42 | 2.61 | 2.59 | 15.59 | 15.96 |
| $N_2K_5$ | 329.2 | 328.7 | 15.59 | 15.76 | 0.41 | 0.43 | 11.23 | 11.21 | 9.46 | 9.46 | 2.63 | 2.61 | 15.67 | 15.94 |
| $N_3K_1$ | 348.7 | 344.9 | 15.61 | 15.81 | 0.42 | 0.44 | 11.27 | 11.25 | 9.48 | 9.47 | 2.65 | 2.63 | 16.04 | 16.01 |
| $N_3K_2$ | 350.1 | 350.5 | 15.66 | 15.83 | 0.43 | 0.45 | 11.31 | 11.29 | 9.51 | 9.51 | 2.66 | 2.64 | 16.08 | 16.01 |
| $N_3K_3$ | 357.3 | 357.9 | 15.70 | 15.88 | 0.44 | 0.46 | 11.36 | 11.34 | 9.53 | 9.56 | 2.69 | 2.66 | 16.11 | 16.02 |
| $N_3K_4$ | 370.4 | 370.4 | 16.07 | 16.00 | 0.46 | 0.48 | 11.46 | 11.44 | 9.56 | 9.58 | 2.80 | 2.68 | 16.15 | 16.02 |
| $N_3K_5$ | 375.6 | 375.9 | 15.65 | 15.84 | 0.46 | 0.49 | 11.40 | 11.38 | 9.26 | 9.37 | 2.00 | 2.00 | 16.18 | 16.03 |
| $N_4K_1$ | 397.3 | 397.7 | 15.61 | 15.74 | 0.47 | 0.50 | 11.33 | 11.31 | 9.23 | 9.28 | 1.96 | 1.97 | 16.21 | 16.05 |
| $N_4K_2$ | 387.6 | 387.4 | 15.57 | 15.72 | 0.47 | 0.49 | 11.27 | 11.25 | 9.20 | 9.63 | 1.95 | 1.95 | 16.20 | 16.07 |
| $N_4K_3$ | 372.8 | 372.5 | 15.53 | 15.68 | 0.48 | 0.50 | 11.19 | 11.17 | 8.90 | 8.95 | 1.90 | 1.91 | 16.24 | 16.12 |
| $N_4K_4$ | 362.1 | 363.0 | 15.50 | 15.59 | 0.49 | 0.51 | 11.10 | 11.08 | 8.85 | 8.92 | 1.89 | 1.88 | 16.26 | 16.17 |
| $N_4K_5$ | 335.6 | 335.7 | 15.45 | 15.52 | 0.50 | 0.52 | 10.98 | 10.97 | 8.82 | 8.86 | 1.87 | 1.86 | 16.29 | 16.23 |
| $N_5K_1$ | 386.3 | 386.0 | 14.53 | 14.95 | 0.49 | 0.51 | 10.86 | 10.84 | 8.79 | 8.75 | 1.85 | 1.83 | 16.31 | 16.29 |
| $N_5K_2$ | 428.4 | 428.1 | 14.47 | 14.90 | 0.51 | 0.53 | 10.79 | 10.77 | 8.76 | 8.80 | 1.83 | 1.80 | 16.33 | 16.33 |
| $N_5K_3$ | 447.7 | 447.9 | 14.42 | 14.77 | 0.51 | 0.53 | 10.64 | 10.62 | 8.73 | 8.79 | 1.81 | 1.78 | 16.34 | 16.34 |
| $N_5K_4$ | 458.3 | 458.1 | 14.40 | 14.72 | 0.52 | 0.54 | 10.58 | 10.56 | 8.69 | 8.77 | 1.77 | 1.77 | 16.35 | 16.39 |
| $N_5K_5$ | 449.7 | 449.4 | 14.38 | 14.68 | 0.52 | 0.54 | 10.55 | 10.53 | 8.65 | 8.74 | 1.76 | 1.76 | 16.36 | 16.40 |
| $CD_{0.05}$ | | | | | | | | | | | | | | |
| N | 17.33 | 17.23 | 0.05 | 0.05 | 0.01 | 0.01 | 0.03 | 0.02 | 0.06 | 0.08 | 0.01 | 0.01 | 0.02 | 0.01 |
| K | NS | NS | NS | NS | 0.01 | 0.01 | NS | NS | NS | NS | 0.01 | 0.01 | 0.02 | 0.01 |
| N × K | 38.73 | 38.42 | 0.09 | 0.16 | 0.02 | 0.02 | 0.09 | 0.08 | 0.14 | 0.18 | 0.02 | 0.04 | 0.04 | 0.02 |

1st y = First, 2nd y = Second year

study. However, in the succeeding year of study, treatment combination $N_3K_4$, though at par with $N_3K_5$, yet produced fruits of significantly higher total sugars (11.44%) as compared to all the remaining treatments. The minimum total sugars (10.55%) were recorded under $N_5K_5$ treatment combination in the first year, while the similar treatment combination $N_5K_5$ registered the minimum total sugars content in fruits (10.53%). It is clear from the Table 3 that treatment $N_3K_4$ produced fruits with significantly more non-reducing sugars (2.80%) compared to all the remaining treatment combinations, whereas the minimum non-reducing sugars were recorded under $N_5K_5$ treatment combination (1.76%) during first year. However, during second year, treatment $N_3K_4$, significantly increased the non-reducing sugars (2.68%) over all the remaining treatment combinations while treatment $N_5K_5$ produced fruits with minimum non reducing sugar contents (1.76%). However in case of reducing sugars, treatment $N_3K_4$ produced fruits with significantly more reducing sugar values (9.56%) whereas, minimum reducing sugars were recorded under $N_5K_5$ treatment combination (8.65%) during first year. In the succeeding year, treatment $N_3K_4$ produced fruits with significantly higher reducing sugars contents (9.58%) and minimum (8.74%) under $N_5K_5$ treatment combination.

The vitamin C content of fruits was observed to be maximum with the application of treatment $N_5K_5$, (16.36 mg/100 g fruit) over all the remaining treatment combinations. Whereas, the minimum vitamin C contents in fruits (15.24 mg/100 g fruit) were recorded under $N_1K_1$ treatment combination during first year. In the succeeding year of study, treatment combination $N_5K_5$ significantly increased the vitamin C contents of fruits (16.40 mg/100 g fruit) as compared to other treatment combinations except $N_5K_4$ where it showed no significant differences. The minimum vitamin C contents in fruits (15.77 mg/100 g fruit) were observed under $N_1K_1$ treatment combination. The application of N and K exerted significant influence on the chemical characters of fruits namely, TSS, sugars, acidity and vitamin C content during both the years of study. The total soluble solids and sugars decreased with the higher doses of N (Table 3) during both the years of study. The decrease in all these parameters with the higher dose of N could be anticipated due to the dilution of soluble solids and sugars with the increase in fruit size. The combined application of N and K at medium level ($N_{500}K_{500}$) resulted in significantly more chemical parameters (TSS, sugars, acidity and vitamin-C) as compared to the lower and higher doses of N and K. These results are in conformity with the findings of Fouad *et al.* (5) and Wahdan *et al*. (14), and Salem (10) who have reported the increase in quality parameters of different fruit crops when nitrogen and potassium were applied together in optimum doses, whereas the higher doses resulted in lower TSS, acidity and sugar content of the fruits.

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