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Original Article

Effects of different combinations of N, P and K at different time interval on vegetative, reproductive, yield and quality traits of mango (*Mangifera Indica*. L) cv. Dusehri

Efeitos de diferentes combinações de N, P e K em diferentes intervalos nas características vegetativas, reprodutivas, produtivas e de qualidade da manga (*Mangifera indica*. L) cv. Dusehri

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Abstract

The experiment was carried out on mango cv. Dusehri to investigate the effect of N, P and K fertilizers on vegetative, reproductive growth, yield and fruit quality. Eight different fertilizer combinations such as T1 (control), T2 (N), T3 (P), T4 (K), T5 (NP), T6 (NK), T7 (PK) and T8 (NPK) were used. Individual or combine fertilizer application of N (1000 g), P (750 g) and K (750 g) were applied during growing season in February and August. All the treatments significantly influenced on vegetative growth, flowering, fruiting, yield and other physiochemical attributes of mango as compared to control. Least effect was observed with individual fertilizer application while combine fertilizer treatments enhanced most of the investigated parameters. Especially, qualitative traits showed non-significant differences between treated and untreated mango trees. However, among the different treatments T8 (NPK) showed significance for fruiting aspects such as maximum size of growth flushes (177.51 mm), total number of panicles/tree (845), total number of flowers/panicle (974), sex ratio (69.18%), fruit retention (13.85%), total number of fruits/tree (379), yield (82 kg/tree), fruit weight (197.5 g), pulp weight (135.5 g) and physiochemical parameters namely TSS (24.53), Vit. C (57.63 mg/100 mL) and total sugar (20.84%). In general, combine application of NPK (T8) were the most effective in enhancing fruiting aspects, yield, physiochemical characteristics as well as improved fruit quality of mango trees.

Keywords: NPK fertilizers, vegetative and reproductive growth, fruit quality, yield, Dusehri.

Resumo

O experimento foi realizado em manga cv. Dusehri para investigar o efeito dos fertilizantes N, P e K no crescimento vegetativo, reprodutivo, produtividade e de qualidade do fruto. Foram utilizadas oito combinações diferentes de fertilizantes: T1 (controle), T2 (N), T3 (P), T4 (K), T5 (NP), T6 (NK), T7 (PK) e T8 (NPK). Cada tratamento de N (1.000 g), P (750 g) e K (750 g) foi aplicado duas vezes durante a estação de crescimento em fevereiro e agosto. Todos os tratamentos influenciaram significativamente o crescimento vegetativo, floração, frutificação, produtividade e outros atributos físico-químicos da manga em relação ao controle. Menos efeito foi observado com a aplicação individual de fertilizante, enquanto os tratamentos combinados aumentaram a maioria dos parâmetros investigados. Especialmente as características qualitativas mostraram diferenças não significativas entre mangueiras tratadas e não tratadas. No entanto, entre os diferentes tratamentos, T8 (NPK) apresentou significância para aspectos de frutificação, como tamanho máximo de folgas de crescimento (177,51 mm), número total de panículas/árvore (845), número total de flores/panícula (974), razão sexual (69,18%), retenção de frutos (13,85%), número total de frutos/árvore (379), produção (82 kg/árvore), peso do fruto (197,5 g) e peso da polpa (135,5 g), além de parâmetros físico-químicos, como TSS (24,53), vitamina C (57,63 mg/100 mL) e açúcar total (20,84%). Em geral, a aplicação combinada de NPK (T8) foi a mais eficaz no aprimoramento dos aspectos de frutificação, produtividade, características físico-químicas, além da melhoria da qualidade dos frutos das mangueiras.

Palavras-chave: fertilizantes NPK, crescimento vegetativo e reprodutivo, qualidade do fruto, produtividade, Dusehri.

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1. Introduction

Among the members of Anacardiaceace family, Mango (*Mangifera indica* L.) is of high importance, widely adopted across tropical and subtropical zones with diverse climatic and soil conditions (Chapman, 1999).

Mango is well known fruit in the world and titled as the "King of fruits" due to its many qualities such as its wide adaptability, richness in nutritive value, wide-ranging varieties, delicious taste, superb flavor and admiration among the masses (Purseglove, 1969). Ago-climatic conditions of Pakistan favor's the high-quality mango production.

Pakistan has been growing various types of fruits for their local and foreign consumption. It is a highly remunerative crop for the growers. Currently, 171.3 thousand hectares is under mango cultivation, contributing about 22.08% of the total fruit area and produced about 1653.8 million tonnes (MT). Mango is the second largest commercial fruit after the citrus in Pakistan. Pakistan holds 5th position after India, China, Thailand and Indonesia in the world (Pakistan, 2019).

Due to insufficient knowledge among the growers of mango yield is 10.4 tones/hectare, whereas some of the other major mango producing countries of the world are having more per hectare average yield than Pakistan i.e. China (11.4 tones/hectare), Brazil (12.6 tones/hectare) (FAOSTAT, 2016). However, with the proper understanding of growth pattern of mango high yield and good quality of mango can be achieved. In fact, proper amount and type of fertilizers at proper time are indeed main reasons of success for the better outcomes.

Previously, limited work has been done regarding the fertilizer management on mango production in the world as well as in Pakistan. It has been reported that fertilization with horse, cow manure and synthetic fertilizer (NPK), increased the mango yield 395, 293 and 310 fruit per tree, respectively as compared to control (Singh, 1987). NPK applied to young tree with different combinations and rates in a long-term trial. Lowest N rate (100 g N/tree) was found to effective for good vegetative growth and yield. While the P had no appreciable effect but K showed good results regarding the yield of mango (Kanwar et al., 1987).

Hasan et al. (2006) argued that application of 800 g N, 300 g P_2O_5, 1000 g K_2O and 50 kg of FYM together with pruning at 4-meter height produced the highest shoot length, shoot girth, number of leaves per shoot and tree spread.

Maximum flowering (63.60%) and fruiting (71.33%) found when NPK combine with Azospirillum and VAM fungus inoculation (Das et al., 2006).

Yeshitela et al. (2005) found that application of KNO_3 particularly together with urea (5 L KNO_3 (4%) + 0.5 g urea/tree and 5 L KNO_3 (4%) + 1 g urea/tree) improved the reproductive and yield parameters. Khamis et al. (2017) investigated that fertilization with compost at 100% level significantly enhanced fruiting aspects, physiochemical characteristics mango fruit of cv. Fajri Kalan. Meanwhile, the least effect observed with the with organic (compost) fertilizer applied at 100% level. At early stage of the panicle emergence, maximum hermaphrodite flowers opening was relatively higher that declines thereafter (Shu, 2006). Feungchan et al. (1988) investigated that NPK (15-15-15) increased the rate of flower bud differentiation in Cv. Khiewsa. Syamal and Mishra (1989) stated that treatment of 17 years old Mango trees cv. Langra with NPK produced highest shoot growth, leaf and flower numbers, fruit set, fruit retention and fruit size.

NPK application resulted in the greatest shoot growth, leaf and flower number, fruit set, fruit retention and fruit size. In mango, by applying 0.5 kg N + 0.4 kg P + 1.5 kg K/tree produced highest yield (Bahadur et al., 1998; Suriyapananont, 1991). Fertigation with elevated level of potassium promoted the fruit color, acidity, size and yield in four cultivated varieties (Neilsen et al., 2008). In *Actinidia deliciosa* 'Hayward' higher concentration of nitrogen and sulphur were recorded in those fruits treated with N (90 kg/ha) in comparison to those treated with dose of N (30 or 60 kg/ha) (Pacheco et al., 2008).

Duarte et al. (2008) reported application of N in split doses at bud sprout, after setting of fruit and before harvesting along with weekly application of potassium from bud stage to one week before harvesting increased the yield up to 33 kg/tree.

Therefore, it is necessary to apply a proper combination of nitrogen, phosphorus, and potash in a judicious manner to achieve the optimum vegetative, reproductive growth, yield and quality of mango trees. This can only be possible if we thoroughly understand the modern nutritional requirements of mango. This study was performed to reveal the impact of different combination of N, P and K on vegetative, reproductive growth, yield and quality of mango under the climatic condition of Faisalabad.

2. Materials and Method

2.1. Collection of fruit samples

The research work was conducted in the Experimental Fruit Garden Sq. No. 9, Institute of Horticultural Sciences (31°26' North, 73°06' East, Elevation 184.4m), University of Agriculture, Faisalabad during the month of February and August. Randomized complete block design (RCBD) was used for the application of fertilizer to the mango block. Experimental material used in fieldwork consisted of 24, twelve years old, healthy trees of mango cv. which were grafted on the local rootstock, and provided with the same cultural practices during the experiment. For data collection, three trees and ten branches on each side of the tree were selected in each treatment. During the trial, similar cultural practices such as irrigation, hoeing, weeding and protection measures were implemented for all experimental units. In this study, selective doses of fertilizers were applied to studies the effect of N, P and K on vegetative, reproductive growth of mango (*Mangifera indica* L.) cv. Dusehri. The fertilizer i.e. Urea, Triple Super Phosphate (TSP) TSP and Sulphate of Potash (SOP) were applied in this experiment. Randomized complete block design (RCBD) layout design with 8 treatments. N, P and

K were applied 1000 g, 750 g and 750 g, respectively. Fertilizers were applied in February and August, and amount for each treatment was calculated according to the said quantity of each element.

Growth size (mm) of flushed were calculated after tagging the 10 branches at side of the tree. Total number of panicles were counted in each treatment during the flowering season. Total number of flowers were counted on five panicles per tree from all the treatments. Total number of fruit set was determined in percentage by dividing the number of fruits per panicle to perfect flowers. Fruit drop was determined at different stages of fruit growth, such as pea, marble and preharvest stage during the fruit development.

Five fruit from each experimental unit tree were collected from the Experimental Fruit Garden and immediately brought to Pomology Laboratory, Institute of Horticultural Sciences, Faisalabad, Pakistan for physical and biochemical analysis of fruit. Vernier calliper was used for the measuring of fruit length and width, and average was mentioned in centimeter (cm). Digital weight balance (Japan) was used for the measurement of fruit weight and expressed in gram (g). Peel and stone were extracted from fruit separately, and then pulp weight (g) was determined by subtracting the peel and stone weight from fruit weight. For chemical analysis, juice was extracted and passed through a clean muslin cloth. Total soluble solids (TSS) percentage was estimated by using digital refractometer (ATAGO, Japan). Total acidity was determined by using the method of Hortwitz (1960). Sugar acid ratio was estimated by dividing total soluble solids with acid. Vitamin C (mg/100 mL) and total sugars were determined according to the method of Helrich et al. (1994).

All the collected data of this study was subjected to statistical techniques by using Statistix 8 (version 8.1) software for analysis of variance as explained by Steel and Torrie (1980) and means of data were compared using Least Significant Difference (LSD) test at a level of 5% significance ($P \leq 0.05$).

3. Results and Discussion

3.1. Effect of different fertilizer combinations of N, P and K on growth physiology of mango cv. Dusehri

Results revealed that growth size of flushes affected with the application of different doses of fertilizers. Maximum size of flushes (177.51 mm) was found with the application of T8 (NPK), followed by the treatments T2 (N), T5(NP), T4(K) and T6 (NK), While minimum sizes of flushes were found in control as compared to other treatments (see Table 1). Our results showed that when fertilizers were applied in combine form maximum growth sizes of flushes were obtained while in the split application growth size of flushes was recorded minimum. Similar finding has been reported with the application of adequate nitrogen to induce early flush of vegetative growth and foliar application of 2 to 6% urea solutions increase the vegetative growth (El Kadi and Kamh, 2004; Rajput and Tiwari, 1975).

Highest numbers of panicles are the representation for the high yield from the plant. It was found that treatment T8 (NPK) showed maximum number of panicles per tree (845.00), which was significantly different from the T6(NK) and T3 (K) which had also high number of panicles than T5 (NP) and T7(PK) in Table 1. The lowest numbers of panicles were found in P (T3) and control. Singh and Tripathi (1978) recorded an increase in panicle emergence in cv. Baramasi and Langra as a result of spraying three times with KNO_3 (3%) and NaH_2PO_4 (0.6%) solution.

The data regarding the total number of flowers per panicle showed obvious differences as affected by different doses of fertilizer and result was statistically significant. It is clear from the results that T8 (NPK) showed remarkably highest number of flowers per panicle (974.52) over all others fertilizer application followed by T6 (NK), T3 (K) and T5 (NP) treatments, while lowest numbers of flowers (543.21) were observed in control (see Table 2). Balance fertilizer application increased the emergence of panicles and total numbers of flowers on mango tree.

Table 1. Different fertilizer treatments for mango cv. Dusehri.

Treatments	Macro Element	Time of application	Amount of fertilizer(s)
T1	Control		
T2	N	February	1000 g Urea
	N	August	1000 g Urea
T3	P	February	1500 g TSP
T4	K	February	1500 g SOP
T5	NP	February	1000 g Urea + 750 g TSP
	NP	August	1000 g Urea + 750 g TSP
T6	NK	February	1000 g Urea + 750 g SOP
	NK	August	1000 g Urea + 750 g SOP
T7	PK	August	1500 g TSP+ 1500 g SOP
T8	NPK	February	1000 g Urea + 750 g TSP + 750 g SOP
	NPK	August	1000 g Urea + 750 g TSP + 750 g SOP

Table 2. Effect of different fertilizer combinations of N, P and K on reproductive physiology of mango cv. Dusehri.

Treatments	Growth size (mm)	Total No. of Panicle/Tree	Total no. of flowers / Panicle	Sex Ratio (%)	Fruit Drop (%)	Fruit Retention (%)
T1 (Control)	149.34d ± 3.89	397.67h ± 3.51	543.21h ± 3.61	51.17c ± 2.10	94.85a ± 1.40	1.83e ± 0.15
T2 (N)	166.67b ± 4.47	508.57f ± 4.51	612.47f ± 4.58	54.42bc ± 1.05	94.86a ± 2.41	5.57d ± 0.57
T3 (P)	156.26cd ± 4.85	467.33g ± 4.04	593.34g ± 3.61	53.57bc ± 1.01	91.72ab± 2.51	8.82bc ± 0.72
T4 (K)	164.80bc ± 4.95	634.57c ± 4.51	730.19c ± 4.56	57.39bc ± 2.38	94.26ab ± 1.79	5.83d ± 0.48
T5 (NP)	166.48b ± 4.98	584.47d ± 3.51	639e.46 ± 4.04	56.61bc ± 1.59	93.34ab ± 2.15	6.92cd ± 0.33
T6 (NK)	160.75bc ± 5.05	684.66b ± 4.50	810.62b ± 4.59	60.17b ± 2.53	90.28cd ± 2.71	9.74ab ± 0.66
T7 (PK)	159.42bc ± 4.98	559.71e ± 3.49	701.17d ± 3.61	55.31bc ± 1.02	92.96ab ± 2.56	7.49bcd ± 0.52
T8 (NPK)	177.51a ± 4.92	845.64a ± 3.61	974.52a ± 4.58	69.18a ± 2.87	86.10e ± 2.85	13.85a ± 0.43

Values within each column followed by the same letter are not significantly different at P < 0 .5 level.

It is also important to note that combine application of T8 (NPK) increases the total number of flowers as compared to other treatments. Previously, it has been reported that highest flowering found with the combine spray of urea and double super-phosphate 2 to 4% in cv. Chaunsa (Singh, 1987). However, total number of flowers were significantly reduced with application of 2,4-D, GA3 and NAA (Xiao et al., 2005).

3.2. Effect of different fertilizer combinations of N, P and K on flowering characteristics of mango cv. Dusehri

The data regarding the fruit retention percentage per panicle was found statistically significant. The results showed that maximum fruit retention percentage were found in T8 (NPK), which significantly influenced the yield of tree over other treatments. It was found that T6 (NK) and T3 (P) alone seems to have more fruit retention percentage than T5 (PK) and T7 (NP) treatments than control (see Table 2). A high rate of fruit set and fruit retention is main concern to the growers as a prerequisite for high yield. Nevertheless, fruit set percentage was very low, 0.1% flowers mature (Hayes, 1945) in mango cv. Bombay which sufficient average crop yield 200 fruit per tree. There are many factors such as high ratio of male flowers, pollination failure among the perfect the flowers, germination failure, poor pollen tube growth and unfavorable weather condition prevailing at anthesis which are responsible for low fruit retention. Percentage of perfect flowers directly linked to initial fruit set (Considine and Turner, 1991; Iyer et al., 1989). Singh (1960) indicated that less than 0.1% of hermaphrodite flowers developed into mature fruit, while more than 99.5% of them dropped off, and sometime only 0.1% of set fruit reach maturity in mango orchards (Chacko, 1986; Chadha et al., 1980; Kanwar et al., 1987).

Data revealed that minimum fruit drop was found in T8 (NPK). With the split application of T2 (N), T3 (P) and T4 (K) fertilizer, non-significant results were observed among different fertilizer treatments. However, with interaction of fertilizers NP showed slightly high fruit drop while T7 (PK) and T6 (NK) which were at par statistically, respectively (see Table 2). It had shown from the analysis that after the fruit setting maximum fruit drop takes place in the mango. With the split and different combination of fertilizers fruit drop could not control. However, with the combine application fruit drop comparatively decreased. There are many environmental factors such as insufficient soil fertility, in adequate soil moisture, diseases, and low temperature at time of bloom may also favor the incidence of fruit drop (Singh, 1960; Young and Koo, 1975). Fruit drop can be reduced with the proper amount fertilizer at suitable time, it provides proper nutrition to the developing fruit.

Sex ratios of flowers are very important aspect for the high yield. The data representing sex ratio (perfect flowers) indicated that the treatment effect on sex ratio was non-significant. However, highest sex ratio 69.10% was recorded with the T8 (NPK) treatment. Although, sex ratio percentage were found same in remaining treatments T6 (NK), T4 (K), T5 (NP), T7 (PK), T2 (N) and T3 (P), respectively, and lowest ratio was observed in control (T1) (see Table 2). Alone and interaction of different fertilizers did not show any significant results. India (1982) found that with the increase in nitrogen level from 0 to 300 g per plant number of perfect flowers increased. Similar observations were witnessed by Rajput and Tiwari (1975) that 2%, 4% and 6% urea spray improved the perfect flowers percentage and fruit set ratio in mango. Ratio of perfect to staminate flowers greatly varies with the panicle, trees and among cultivars and found to be lower than 50% (Anila and Radha, 2006; Baghel et al., 1988; El Nabawy et al., 1983; Hussein et al., 1989; Joubert et al., 1993; Pimentel et al., 1984). High percentage of perfect flowers found range from 25 to 36.6%, which is closely associated to high productivity in cv. Langra (Mukerjee, 1953). There was no significant difference among the maturity time of different fruits and all the treatments reached to maturity stage during first week of June.

3.3. Effect of different fertilizer combinations of N, P and K on yield parameters of mango cv. Dusehri

Data regarding the total number of fruits per tree as affected by different fertilizer treatments and result was statistically significant. Highest numbers of fruits 379.0 were recorded with the application of T8 (NPK), while

in split application T4 (K) showed the highest number of fruit (278.3) followed by the T3 (P) and T2 (N) with the total number of fruits 241.4 and 213.3, respectively. On contrary, in combine fertilizer treatment T6 (NK) significantly showed high fruit numbers (320) followed by T3 (NP) and T7 (PK) with the fruit number 288.6 and 274.3, respectively (see Table 3). It was revealed form above data combined fertilizer dose yielded higher number of fruits per tree rather than split application.

Results revealed that highest yield was obtained from T8 (NPK) as compared to all other treatments and T1 (control). In spilt application, T4 (K) showed the higher yield (55 kg) as compared to the T2 (N) and T3 (P) where the yield had 52 and 50 kg, respectively. While, in combine application yield was significantly higher in T6 (NK) followed by T5 (NP) T7 (PK) with the yield 66 kg, 57 kg and 54 kg, respectively. Rajput and Singh (1983) reported that two foliar applications of urea (6%) and GA3 (30 ppm) on mango trees just before bloom, increased the length of terminal shoot, leaves per shoot, flowering and yield (Sarker and Rahim, 2012). Malhi et al. (1988) noted the significant increase in vegetative growth of mango (cv. Dusehri) with the application of with N, P and K fertilization. the greatest response was observed with N followed by P and K and treatment with 100 g N, 200 g P_2O_5 and 200 g K_2O per tree per year of age showed the highest yield. Chadha et al. (1980) observed significant increase in the fruit yield of mango cv. Dusehri upon application of N (1 Kg/tree/year) (Reddy and Majmudar, 1983). Reddy and Majmudar (1983) found high yield about 88% compared to control by spraying orthophosphoric acid (0.5%) alone in combination with 2% urea three times during September, November and March. Yield increased up to 30% increase with the application of 80 Kg N per hectare (Avilan, 1974), and foliar application of 1 to 2% urea was found to increase the yield by about 8 times compared to control (Shawky et al., 1978; Xiuchong et al., 2001). Zhuang, (1987) found that both high and medium levels of fertilizer applications induced an increase of Ponkan fruit yield of 30.7% and 14.5% respectively, and as well as quality of fruits was improved.

3.4. Effect of different fertilizers combinations of N, P and K on fruit physical characteristics of mango cv. Dusehri

Data shows that fruit length was non-significantly affected by different fertilizers T3 (K), T6 (NK), T7 (PK) and T2 (P). However, maximum fruit length was achieved from T8 (NPK), and lowest fruit lengths was found in control (see Table 3). It was found that with proper combination and amount of fertilizer will increase the fruit length. Our results are in line with Ahmed et al. (2001) who observed that fruit length increased with the proper fertilizer combination. Syamal and Mishra (1989) showed that fertilizer application noticeably affected the fruit length in mango. Fruit size increase in tree receiving a combined spray of Urea and Super phosphate at 2-4% (Singh and Rajput, 1977). Singh and Tripathi (1978) found an increase in fruit size in cv. Baramasi and Langra with the foliar application of KNO_3 (3%) and NaH_2PO_4 (0.6%) solution (Shaban and Ibrahim, 2009).

Our results reveal highest pulp weight in the T8 (NPK) fertilizer treatment followed by T6 (NK), T5 (NP), and T7 (PK) (see Table 3). Application of individual fertilizers, T4 (K) showed the maximum pulp weight which closely followed by T3 (P) and T2 (N). Our results are in line with the Jagirdar and Sheikh (1970) who reported that mango cv. Bombay Alphanso when fertilized with nitrogen fertilizer showed improve fruit quality by increasing the pulp percentage of fruits. Results clearly indicate that mean stone fruit was greatly affected by various fertilizer combination used in this study. The highest stone weight was found form the T8 (NPK), while low stone weight was recorded in control (T1). In single fertilizer application, T3 (K) had the higher stone weight among the T3 (P) and T4 (N), respectively. These results are supported from Syamal and Mishra (1989) that stone weight increase with the application of NPK fertilizer.

Mango peel play important role in improving the nutritional status of unconventional feed of animal. From all these combinations, a notably significantly higher peel weight was found form NPK application. Among the single fertilizer application T4 (K) was obtained the higher peel weight which closely followed by T3 (P), T4 (K) and control obtained the minimum peel weight from all the treatments. While form the combine fertilizer application

Table 3. Effect of different fertilizer combinations of N, P and K on physical characters of mango cv. Dusehri.

Treatments	Total no. of fruit/tree	Yield (Kg/Tree)	Fruit Length (cm)	Fruit Weight (g)	Pulp Weight (g)	Stone Weight (g)	Peel Weight (g)
T1 (Control)	186.72g ± 4.51	40.01e ± 4.51	15.4b ± 3.17	155.15e ± 6.34	76.30g ± 2.22	24.14f ± 2.02	28.61f ± 1.86
T2 (N)	213.34f ± 3.06	52.70cd ± 4.50	16.4b ± 3.11	175.50bc ± 5.50	82.41f ±1.90	30.04de ± 2.21	33.70e ± 1.38
T3 (P)	241.40e ± 4.04	50.14d ± 5.03	18.3ab ± 2.75	169.24cd ± 5.41	85.23f ± 1.96	28.50e ± 2.00	35.62de ±1.94
T4 (K)	278.33d ± 3.51	55.23cd ± 4.50	19.3ab ± 2.99	182.01b ± 5.47	99.92e ± 1.89	31.26e ± 1.76	40.84c ± 1.35
T5 (NP)	288.62c ± 4.51	57.31c ± 5.03	17.2b ± 3.29	160.46de ±4.86	107.34c ± 2.11	35.63bc ± 2.02	37.81d ± 1.88
T6 (NK)	320.32b ± 3.05	66.61b ± 4.49	18.5ab ± 2.73	180.32b ± 5.35	118.04b ± 1.94	37.21b ± 1.81	46.92b ± 1.65
T7 (PK)	274.37d ± 2.52	54.85cd ± 4.51	18.1b ± 3.01	178.24bc ± 6.53	103.51d ± 1.79	33.07cd ± 1.95	42.14c ± 1.43
T8 (NPK)	379.05a ± 3.00	82.35a ± 3.51	23.3a ± 3.10	197.05a ± 5.62	135.32a ± 2.09	43.53a ± 2.07	52.09a ± 1.77

Values within each column followed by the same letter are not significantly different at $P < 0.05$ level.

Table 4. Effect of different fertilizer combinations of N, P and K on biochemical characteristics of mango cv. Dusehri.

Treatments	TSS (%)	Total Acidity (%)	TSS/Acid Ratio	Vit. C (mg/100 mL)	Total Sugar (%)
T1 (Control)	20.29d ± 1.05	0.52a ± 0.005	22.43	31.26f ± 0.92	14.52c ± 0.25
T2 (N)	21.06cd ± 0.95	0.49b ± 0.004	25.16	42.22c ± 1.18	15.24bc ± 0.41
T3 (P)	22.07bc ± 1.10	0.45c ± 0.005	29.13	39.37d ± 0.98	15.82bc ± 0.29
T4 (K)	21.41cd ± 1.25	0.37d ± 0.002	43.27	36.62e ± 1.21	16.89b ± 0.55
T5 (NP)	23.43ab ± 0.93	0.35d ± 0.001	40.48	42.09b ± 0.47	16.65b ± 0.61
T6 (NK)	23.30ab ± 0.08	0.32e ± 0.002	51.28	51.48b ±1.07	16.07b ± 0.71
T7 (PK)	2.35bc ± 0.05	0.31e ± 0.002	52.41	51.55b ± 0.95	15.01b ± 0.37
T8 (NPK)	24.53a ± 0.06	0.26f ± 0.001	73.53	57.63a ± 0.07	20.48a ± 0.53

Values within each column followed by the same letters are not significantly different at P <0.05 level.

T6 (NK) showed the higher peel weight which closely followed by T5 (NP) and T7 (PK). Results regarding the peel weight was found to be consistent with the finding of Jagirdar and Sheikh (1970) who reported that combined fertilizer application plays very role in high yield and high peel and flesh weight.

Fruit weight of the treated plant showed the significant results with the application of different combinations of fertilizer. The treatment T8 (NPK) showed the maximum fruit weight followed by T4 (K) and T6 (NK), while lowest fruit weight was found in T4 (P) and control (T1), respectively. Application of T7 (PK) and T1 (N) did not influence the fruit weight. Fruit weight was found to be maximum with combined use of NPK fertilizer (Ahmed et al., 2001). Syamal and Mishra (1989) found maximum number of fruits (5.4 fruits/panicle) with the application of 1.0 Kg N, 2.0 Kg P_2O_5 and 1.0 Kg K_2O per tree. Our results were similar to those reported by Singh et al. (1987) who observed higher fruit weight 173.9 g, from 15-years old mango cv. Dusehri by spraying aqueous solution of NPK (1.0%) twice in the month of September and April.

3.5. Effect of different fertilizer combinations of N, P and K on chemical characteristic of mango cv. Dusehri

The on total soluble solids was indicates non-significant difference among the treatments (see Table 4). Maximum total soluble solids (24.53%) were present in T8 (NPK) which was statistically at par with the T6 (NK) (23.43%), while minimum total soluble solids were obtained from control (T1). Singh (1987) reported that foliar application of boric acid (500 to 5000 ppm) at the late bud-swelling stage significantly increased vegetative growth, length and breadth of the panicle, fruit retention, total soluble solids (TSS), TSS/acid ratio and total sugars of fruit compared with the control.

The data on total acidity indicates non-significant differences among treatments (see Table 4). The highest acidity (0.52%) was found in T1 (control) followed by T2 (N), T3 (K) while T4 (NP) was statistically at par with T5 (NK), while lowest acidity percent (0.26%) was observed in T8 (NPK). Taha et al. (2014) reported that potassium fertilizer enhances the yield and increases the acidity percentage in Zebda mango fruit.

Obvious increment in the TSS/acid ratio was seen in treated plants (Table 4). Highest TSS/acid ratio (73.53) was obtained from T8 (NPK) followed by T7 (NPK), T6 (PK), T4 (K), and T5 (NP) which were not significantly different not from each other, while lowest TSS/Acid ratio (22.43) was obtained from T1 (control). Our results are in consistence with finding of Khamis et al. (2017), which reported that high TSS/acid ratio with the application of NPK+ Compost on mango cv. Fajri Kalan.

Vitamin C is an important ingredient of human nutrition and act as powerful antioxidant. Amon the treatments, vitamin C contents did not vary significantly (see Table 4). However, data regarding the vitamin C was found to be affected by some treatment combinations. Maximum level of vitamin C (57.63 mg/100 mL) was obtained from T8 (NPK) and minimum (31.26 mg/100 mL) was obtained from the control treatment. Multiple factors could affect the vitamin C contents in fruit and vegetables such as climatic conditions, cultural practices, genotypic differences (Mozafar, 1993; Taha et al., 2014; Weston and Barth, 1997). It has many biological functions such as in reduction of cholesterol level; improve immunity, other free radicals' production, maintenance of healthy body and prevention of many diseases (Khamis et al., 2017). The data regarding the total sugar was non-significant regarding fertilizer treatments. Maximum total sugar (20.84%) was determined in the T8 (NPK) followed by T5 (NP), T4 (K), T3 (P), while minimum total sugar (13.5%) was observed in the control (T1) (see Table 4). Sugar is very important parameter for quality measurement in mango fruit and is chief source of energy in different pathways. Fruit quality and total sugar content improved with application of compost and foliar application of Kaolin (aluminum silicate) and silicon (potassium silicate) on four-year-old mango trees cv. Keitt (El-Deen et al., 2015). Moreover, it was found that foliar application of potassium silicate at 0.2% on mango fruit during development increased the fruit TSS, vitamin C and total sugar content (Abd El-Rahman, 2015; Baiea et al., 2015).

4. Conclusion

In this study results revealed that different fertilizer combinations showed different response during growth

and production. However, fertilizer in combination was found more effective rather than individual application to mango trees. Application of mango trees with NPK (1000 g Urea + 750 g TSP + 750 g SOP) was found to be effective for most of the parameters during vegetative growth, flowering and yield parameters. Therefore, above mention fertilizer combination could be recommended for obtaining high yield with good quality production and improvement of mango orchards.

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