

## Effect of Different Phosphorus Sources and Urea on Flowering, Foliage Chemical Composition, Fruit Yield and Quality of Mango “Langra” Cultivar

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### ABSTRACT

Two field experiments were conducted during 2016/2017 and 2017/2018 seasons on mango trees “Langra” cv. of 15 years old planted at El Baramoon Horticulture Research Farm, Dakahlia Governorate. The trees grown in clay loamy soil at 5 x 5m apart received the same annual agriculture practices program of mango orchard. The present study include 7 foliar spray treatments of different P sources at concentration of 1000 ppm P<sub>2</sub>O<sub>5</sub> with or without foliar urea spray at concentration of 2000 ppm N, all sprayed 4 times before and after flowering during the two seasons. The 7 treatments were mono-ammonium phosphate (MAP) (NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>) + urea, MAP, mono-potassium phosphate (MPP) KH<sub>2</sub>PO<sub>4</sub> + urea, MPP, phosphoric acid (PA) H<sub>3</sub>PO<sub>4</sub> + urea, phosphoric acid (PA) H<sub>3</sub>PO<sub>4</sub> and untreated control (sprayed water only). These treatments were applied to mango trees uniform in size and vigour arranged in RCBD with 3 replicates (one tree / replication). This study aimed to investigate the effect of these treatments on the flowering characteristics, foliage chemical composition characteristics of mango Langra cultivar. The important obtained results were as follows: All the applied treatments were superior significantly the control and gave the highest values of all the studied flowering, chemical composition of mango tree foliage, fruit yield and quality with exception of male flower number / panicle, seed weight %, peel weight % and fruit acidity. Those were at the significant highest values in the control treatment. Adding urea with all P- sources spray gave considerable enhancement to their profounded effect on all the studied parameters. Absolutely, treatment of MAP + urea gave significantly the highest values of all the studied parameters except that of number of female flowers, fruit seed weight %, fruit peel weight % and fruit total acidity compare with the control and all the applied treatments. The reminder treatments also, significantly superior the control one in descending order( MAP, MPP + urea, MPP, PA + urea, PA and at least the control in their beneficial effect on all parameters. This treatment effect order was completely reversed dealing with number of male flowers / panicle, fruit peel weight %, fruit seed weight % and fruit acidity, the control was of their significantly and non - beneficially highest values. While, MAP + urea was of the significantly and beneficially lowest values.

**Keywords:** Mango, mono ammonium phosphate, mono potassium phosphate, phosphoric acid, urea, yield, fruit quality.

### Introduction

Mango (*Mangifera indica* L.) a member of genus *Mangifera* and *Anacardiaceae* family is known as the king of fruits in many countries (Purseglove, 1972). Mango is successful commercial fruits in tropical and subtropical regions (Millington 1984). Flowering periods of mango trees are related to environmental conditions (Litz 1997). Mango has become popular in the world and is praised due to its attractive flavor, delicious taste and therapeutic values. It is an excellent source of vitamin C, vitamin A, minerals, carbohydrates, antioxidants and polyphenols (Meadows, 1998). In tropical conditions the flowering of mango induction occurs in response to age of previous year shoot, while cool inductive conditions are vital to floral induction under sub - tropical conditions (Murti and Uprti, 2000). Under Egyptian conditions mango production faced serious problems of climate / temperature and the internal nutritional and reserves state of tree. Insufficient floral inductive cool temperature in winter, which lead to insufficient floral bud differentiation (FBD)( induction), low carbohydrate reserves, low C/N ratio, low minerals content (NPK) and hormonal disturbances and imbalances, those which tightly related with low number of hermaphrodite flowers, and low sex ratio, thereby low anthesis , low fruit setting, poor flowering and fruiting. Prevailing of higher temperatures during flowering and fruit setting stages

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in summer causes poor fruit setting and fruit abscission, irregular fruit bearing and low fruit productivity. Optimizing the internal N, P, K, carbohydrate, C/N ratio could be optimize the onset of floral induction, floral bud differentiation (FBD), sex ratio, fruit set, regular fruit bearing, fruit yield and quality. All of these chemical, biochemical and physiological components / processes found to be in closed interrelation and associated with the best flowering and fruiting of mango (Chadha, 1993; Corbesier *et al.*, 2002; Kumar *et al.*, 2013 and Geetha *et al.*, 2016).

Spraying mango tree with some P containing compounds at pre and post flowering periods enhance floral induction, differentiation and hasten floral bud break and panicle emergence. Improve mango flowering characteristics and fruit productivity.

In this connection, Reddy and Majumber (1988) obtained the highest mango fruit yield by spraying trees with  $H_3PO_4$  0.5 % + urea 2 %. Srihari and Rao (1998) induced more flowering on Alphonso mango axillary shoots by spraying  $KH_2PO_4$  1 % + urea 1%. Raj Kumar *et al.*, (2005) illustrated that, spraying chemical inductive agents ( $KH_2PO_4$  and  $H_3PO_4$ ) on mango trees increased number of perfect flowers / panicle, fruit set % and improved all flowering and fruiting characters as well as mango fruit yield. Raj Kumar *et al.*, (2007) used  $H_3PO_4$ ,  $KH_2PO_4$ ,  $K_2HPO_4$ ,  $KNO_3$  and  $P_{333}$  for chemical flowering induction and improvement of mango, they found that, spraying  $H_3PO_4$  and  $KH_2PO_4$  were superior in induction of early flowering, panicle length and diameter and flowering intensity.

Ashok Kumar and Reddy (2008) stated that, foliar spray of mango trees with  $H_3PO_4$  and  $KH_2PO_4$  each alone gave the highest values of new laterals, which gave flowers, perfect flowers number was highest with  $KH_2PO_4$ , highest fruit yield was recorded with  $H_3PO_4$  or  $K_2HPO_4$ , average fruit weight and titrable acidity were highest with  $KH_2PO_4$  treatment. Nimisha *et al.*, (2017) found that, the best early mango tree flowering induction, highest values of panicle length and diameter obtained by  $H_3PO_4$  and  $KH_2PO_4$  sprays. Also, it was reported that drenching mango tree with  $NH_4 H_2PO_4$  (MAP) induced early flowering, increased hermaphrodite flowers / panicle, increased fruit set % and increased number and size of fruits also reduced frost adversity compared with control treatments (Nehad, 2017). Similar results about the positive effects of  $KH_2PO_4$ ,  $K_2HPO_4$  and  $H_3PO_4$  on mango flowering performance and characters, fruiting behaviors and fruit yield were obtained by Raj Kumar and Siva Shamkar (2017) and Manoj Kumar *et al.*, (2019).

Meanwhile, Saheda *et al.*, (2019) pointed out that mango fruit set % and fruit retention and yield were increased as a result of increasing number of hermaphrodite flowers / panicle relative to number of staminate flowers / panicle percentage. On the other hand, it was reported that urea spray increased mango fruit retention, fruit yield and quality (Amor *et al.*, 2016 and Zaeneldeen, 2017).

Moreover, it was known that P is a fundamental nutrient element for flowering (Marschner, 2002), stimulate floral initiation and increase number of perfect flowers (Oosthuysen, 1996), this via its involvement in nucleic acids (DNA & RNA) synthesis and Mg absorption and content, those that important for flowering (Agusti, 2003). Also, K from  $KH_2PO_4$  could stimulate photosynthesis, which is very important for the formation of flowers (Swietlik, 2003). In addition, N containing compounds as urea and MAP increase levels of arginine which promote flowering (George *et al.*, 2003).

The present work aimed to improve mango flowering characteristics, chemical composition carbohydrate reverse, C / N ratio and mineral status of mango tree thereby fruit yield and quality. By spraying the trees with  $H_3PO_4$ ,  $KH_2PO_4$ ,  $NH_4 H_2PO_4$  with or without urea before flowering during floral initiation period and after floral panicle emergence and fruit setting periods.

## Materials and Methods

The present study was conducted during two seasons 2016/2017 and 2017/2018 at El Baramoon Horticulture Research Farm, Dakahlia Governorate, on 15 years old “Langra” mango trees grafted on seedling rootstocks. The trees are grown in clay loamy soil (the physical and chemical properties of the experimental soil are presented in Table (1)).

The trees were planted at 5 x 5 meters apart, received a basal recommended fertilizer and subjected to the annual agricultural practices. The selected trees were uniform in growth and vigor and irrigated flood irrigation system. Fertilization program and other agricultural practices were the same for all trees. Randomized complete block design (RCBD) with three replicates were adopted. Each one tree represent one experiment unite / one replicates.

The trees were sprayed with mono-ammonium phosphate (MAP)  $\text{NH}_4\text{H}_2\text{PO}_4$ , mono potassium phosphate (MPP)  $\text{KH}_2\text{PO}_4$  and phosphoric acid (PA)  $\text{H}_3\text{PO}_4$  at the same concentration of 1000 ppm  $\text{P}_2\text{O}_5$  with or without urea  $\text{CO}(\text{NH}_2)_2$  at concentration of 2000 ppm. N added to the untreated control (water sprayed only).

**Table 1:** Main physical and chemical properties of the study soil.

Parameter	Value	
	2016	2017
Sand	27.1	26.9
Silt	32.1	32.1
Clay	40.8	40.9
Soil Texture (USDA Classification)	Clay	Clay
pH (1: 2.5 w/v soil : water suspension)	7.7	7.6
EC $\text{dS m}^{-1}$ (paste extract)	0.7	0.7
$\text{CaCO}_3$ ( $\text{g kg}^{-1}$ )	21	22
Cation Exchange Capacity ( $\text{cmolc kg}^{-1}$ )	293	297

**The spray treatments were as follows:**

- 1- Control (water sprayed).
- 2- MAP 1000 ppm  $\text{P}_2\text{O}_5$  + urea 2000 ppm N.
- 3- MAP 1000 ppm  $\text{P}_2\text{O}_5$ .
- 4- MAP 1000 ppm  $\text{P}_2\text{O}_5$  + urea 2000 ppm N.
- 5- MAP 1000 ppm  $\text{P}_2\text{O}_5$ .
- 6- PA  $\text{H}_3\text{PO}_4$  1000 ppm  $\text{P}_2\text{O}_5$  + urea 2000 ppm N.
- 7- PA  $\text{H}_3\text{PO}_4$  1000 ppm  $\text{P}_2\text{O}_5$ .

All trees were sprayed four times i.e. (20 October, 20 November, full bloom stage and are month later in the two seasons. Triton B at 1 ml/l used as wetting agent with all spray treatments. The following parameters were determined during two seasons:

**1- Flowering characteristics:**

At full bloom stage panicle length (cm) was determined, number of panicles per tree, number of hermaphrodite and male flowers number / panicle were counted and recorded then sex ratio, number of hermaphrodite flowers / panicle / number of male flowers / panicle) was calculated in each seasons, number of total flower / panicle were also calculated.

**2- Foliage chemical characteristics:**

Total N %, K %, P%, Total carbohydrate % and C/N ratio were determined in mango trees foliage (leaves sample) according to methods of (Pregle, 1945; Brown and Lilleand, 1946, Chapman and Pratt, 1961 and Dubois *et al.*, 1956), respectively.

**3- Fruit yield and its components:**

At harvesting, fruit average weight (g), number of fruits / tree and fruit yield / tree (kg) were determined in the two seasons.

**4- Fruit physical quality characteristics:**

In fruit ripe stage samples of 20 ripe fruits from each tree were taken, fruit volume ml<sup>3</sup>, fruit length (L) (cm), fruit diameter(D)(cm), fruit shape index (L/D), seed weight %, seed peel weight %, flesh weight % and flesh / seed ratios were determined in both seasons.

**5- Fruit chemical quality characteristics:**

In the same fruit sample taken at rip stage, flesh TSS %, total titrable acidity % were determined according to the methods described by AOAC (2000), then TSS / acidity ratios were calculated in each season.

### Statistical analysis

All data obtained during both seasons of study were subjected to analysis of variances (ANOVA) according to the method described by Snedecor and Cochran (1980) and significant differences among means were determined according to Duncan's Multiple Test Range (Duncan, 1955).

### Results and Discussion

#### 1- Flowering parameters

The data presented in Table (2) show that, all flowering parameters of Langra mango trees expressed as panicle length, total number of flowers / panicle, male flowers number, perfect flowers number and sex ratio ( number of perfect flowers / number of male flowers ) were significantly affected by the applied chemicals (different P sources) in the two seasons.

**Table 2:** Effect of  $\text{NH}_4\text{H}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{KH}_2\text{PO}_4$  with or without urea on flowering parameters of Langra mango trees during 2016/2017 and 2017/2018 seasons.

Treatments	Panicle length (cm)		Total number of flowers/ Panicle		Male flowers number /panicle		Perfect flowers number /panicle		Sex ratio (%)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
$\text{NH}_4\text{H}_2\text{PO}_4$ + urea	8.89 a	8.38 a	390.00 a	384.00 a	176.33g	178.80 f	213.66a	205.20a	1.21 a	0.15 a
$\text{NH}_4\text{H}_2\text{PO}_4$	6.89 b	7.11 ab	376.00b	374.66b	184.60 f	189.93e	191.40 b	184.70b	1.04 b	0.97 b
$\text{KH}_2\text{PO}_4$ + urea	6.33 bc	6.66 b	318.00 c	314.00 c	193.83e	201.00d	124.16c	113.00 c	0.64 c	0.56 c
$\text{KH}_2\text{PO}_4$	6.13bcd	6.66 b	305.00 d	302.00 d	225.96d	233.23c	79.03 d	68.76d	0.35 d	0.33 d
$\text{H}_3\text{PO}_4$ + urea	6.05 cd	6.11 bc	294.00 e	289.00 e	236.33c	240.00b	57.16 e	52.00 e	0.24 e	0.21 e
$\text{H}_3\text{PO}_4$	5.55 d	5.00 cd	290.00 e	286.00 e	241.00 b	242.65b	49.00f	43.33f	0.20 f	0.17 f
Control	4.44 e	4.00 d	280.00f	276.00f	243.10 a	247.80a	36.90g	28.40 g	0.15 g	0.11 g

Means in the same column followed by the same letters during each season are not significantly differ at 5% level of probability.

Treatment of MAP + urea followed by MAP without urea gave the highest significantly values of all the mentioned flowering characteristics, significant differences among them were detected only in the first season. Also, all the applied P – sources were significantly superior the control. Treatments of  $\text{KH}_2\text{PO}_4$  + urea,  $\text{KH}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$  + urea and  $\text{H}_3\text{PO}_4$ , respectively in descending order were of beneficial effect on flowering parameters with significant differences among them in most cases for all flowering parameters expect for panicle length, which affected in similar fashion but with less pronounced differences in the two seasons. In addition, it was observed from the same data that number of male flowers / panicle was affected by the applied P – sources in reverse fashion, the control treatment gave significantly the highest values followed by  $\text{H}_3\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$  + urea,  $\text{KH}_2\text{PO}_4$ ,  $\text{KH}_2\text{PO}_4$  + urea, MAP and at least MAP + urea, respectively in descending order with significant differences between them at both seasons. The superiority of MAP + urea and MAP and the beneficial effect of other treatments may be explained based on the fundamental role of P in bud metabolism, DNA, RNA and ATP synthesis, Mg absorption and content, those which known as an essential component and factors for flower formation and flowering (Marschner, 2002 and Agusti, 2003). N containing compounds (MAP and urea) known to be increased levels of arginine, the essential amino acid that important for flowering (George *et al.*, 2003). In addition, Swietlike (2003) proved that K from  $\text{KH}_2\text{PO}_4$  stimulate and increase photosynthesis rate and production, which important for flower formation and the whole flowering processes. In addition, the obtained profound effect of P- sources in the mentioned trend especially on number of hermaphrodite flowers and sex ratio as well as number of fruits and fruit yield (Table 2 and 4) could be expected under the present work conditions. Since the same treatments (P – sources) were in similarity increase total carbohydrate, P and C / N ratio and decrease N contents of mango tree foliage (Table 3). In this connection, strong interrelation was detected between carbohydrate reserves and content, N, P and C/ N ratio from one side and perfect flower number, sex ratio, number of flower and fruit yield as well as floral induction and flower bud differentiation from other side. Carbohydrate reserve in mango tree foliage known to be a precursor for synthesis of floral hormonal stimulate

(florogen), which migrate from leaves to the terminal bud, switching the onset of floral induction events and starting the flower bud differentiation and floral initiation, and transformation of tree vegetative phase to generative one, besides to their energy involvement in induction advancements. During this critical period C, P and C / N ratio were increased up ward lead to similar increase in hermaphrodite flowers number, sex ratio, bud swelling and breaking, anthesis, fruit set and regulator fruit yield (Goldschmide and Golomberg, 1982; Chadha, 1993; Corbesier *et al.*, 2002; Humayun and Srihari Babu, 2002; Kumar *et al.*, 2013; El- Khishen, 2015 and Geetha *et al.*, 2016). The present results were in agreement with those obtained by Srihari and Rao (1998); Raj Kumar *et al.*, (2005); Raj Kumar *et al.*, (2007); Zaenldeen (2014); Amor *et al.*, (2016); Nehad (2017); Raj Kumar and Siva Schambar (2017) and Manoj Kumar *et al.*, (2019).

## 2- Foliage chemical characteristics:

The data of Table (3) illustrat that, treatment of MAP + urea gave significantly the highest values of foliage N % followed by MAP without urea with significant differences among them at both seasons. Those followed by H<sub>3</sub>PO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub> + urea, KH<sub>2</sub>PO<sub>4</sub> without urea, KH<sub>2</sub>PO<sub>4</sub> + urea and at least the control, respectively in descending order with significant differences between them in the two seasons. The same data revealed that mango tree foliage P %, C % and C/N ratio were significantly differed and increased as a results of applied different P – sources compared with the control of the lowest significantly values in the two seasons.

**Table 3:** Effect of NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub>, KH<sub>2</sub>PO<sub>4</sub> with or without urea on some chemical analyses of mango Langra leaves during 2016/2017 and 2017/2018 seasons .

Treatments	N (%)		P (%)		C (%)		C/N ratio (%)	
	2016	2017	2016	2017	2016	2017	2016	2017
<b>NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> + urea</b>	1.28 a	1.29 a	0.59 a	0.49 a	20.81 a	20.70 a	16.22 a	16.02 a
<b>NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub></b>	1.25 b	1.26 b	0.47 b	0.42 b	18.89 b	18.77 b	15.07 b	14.86 b
<b>KH<sub>2</sub>PO<sub>4</sub> + urea</b>	1.09 f	1.13 f	0.44 c	0.37 c	16.40 c	16.15 c	15.04 b	14.58 b
<b>KH<sub>2</sub>PO<sub>4</sub></b>	1.11 e	1.18 e	0.40 d	0.30 d	15.78 d	15.71 d	14.22 c	13.31 c
<b>H<sub>3</sub>PO<sub>4</sub> + urea</b>	1.20 d	1.21 d	0.36 e	0.25 e	15.69 e	15.54 e	13.08 d	12.82 d
<b>H<sub>3</sub>PO<sub>4</sub></b>	1.23 c	1.23 c	0.33 f	0.21 f	15.52 f	15.40f	12.62 e	12.44 d
<b>Control</b>	1.01 g	1.03 g	0.29 g	0.18 g	12.36 g	12.26 g	12.20 f	11.82 e

Means in the same column followed by the same letters during each season are not significantly differ at 5% level of probability.

## 3- Fruit yield and its components

The data in Table (4) show the effect of the applied different P- sources on Langra mango number of fruits / tree, fruit weight and fruit yield / tree in 2016 and 2017 successive seasons. This data revealed that, the most superior treatment of the significantly highest values was MAP + urea and in descending order followed by MAP without urea, KH<sub>2</sub>PO<sub>4</sub>+ urea, KH<sub>2</sub>PO<sub>4</sub> without urea, H<sub>3</sub>PO<sub>4</sub> + urea, H<sub>3</sub>PO<sub>4</sub> without urea and at least the control respectively with significant differences between them in the two seasons. Under the present work conditions these results could be expected, since the same treatments gave approximately similar effect on the foliage N %, P %, carbohydrate % and C / N ratio (Table 3), panicle length, total number of flower / panicle, hermaphrodite flowers number and sex ratio (hermaphrodite flowers number / male flowers number).Those which known to be in closed interrelation with each other (Goldschmide and Golomberg, 1982; Chadha, 1993; Corbesier *et al.*, 2002; Geetha *et al.*, 2016). Moreover, the beneficial roles and involvement of P in different P – sources and their other ions reduced N (MAP), urea reduced N and K of (KH<sub>2</sub>PO<sub>4</sub>) in ATP, DNA and RNA, amino acids and carbohydrate synthesis and metabolism, those which reflect on flowering and fruit yield (Marschner, 2002; Agusti, 2003; George *et al.*, 2003; Seietlike, 2003). The results were in accordance with the finding of Ashok Kumar and Reddy (2008); Nahed, (2017); Manoj Kumar *et al.*, (2019).

The data also show that, the significantly highest values were of MAP + urea followed by MAP, KH<sub>2</sub>PO<sub>4</sub> + urea, KH<sub>2</sub>PO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub> + urea, H<sub>3</sub>PO<sub>4</sub> and at least the control respectively in descending order (all treatments were significantly differed at both seasons). The present effect of different P- sources on mango tree leaves N, P, C (%) and C / N ratio was greatly explained their similar effect on flowering

parameters Table (2). Similar results were obtained by Ashok Kumar and Reddy (2008) and Amor *et al.*, (2016).

**Table 4:** Effect of  $\text{NH}_4\text{H}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{KH}_2\text{PO}_4$  with or without urea on Langra mango yield and its components during 2016/2017 and 2017/2018 seasons.

Treatments	Fruits number/ tree		Fruit weight (g)		Yield / tree (Kg)	
	2016	2017	2016	2017	2016	2017
$\text{NH}_4\text{H}_2\text{PO}_4$ + urea	116.65 a	111.00 a	355.66a	350.67 a	41.49 a	38.92 a
$\text{NH}_4\text{H}_2\text{PO}_4$	106.66 b	101.66 b	281.00b	275.67 b	29.97 b	28.03 b
$\text{KH}_2\text{PO}_4$ + urea	104.00 c	100.00 c	270.33 c	265.33 c	28.11 c	26.53 c
$\text{KH}_2\text{PO}_4$	99.66 d	94.33 d	255.00 d	252.67 d	25.41 d	23.83 d
$\text{H}_3\text{PO}_4$ + urea	95.00 e	90.00 e	250.00 e	248.67 e	23.75 e	22.38 e
$\text{H}_3\text{PO}_4$	90.66 f	86.66 f	246.00f	244.33 f	22.30 f	21.18 f
Control	78.33 g	40.00 g	205.67 g	203.67 g	16.11 g	8.15 g

Means in the same column followed by the same letters during each season are not significantly differ at 5% level of probability.

#### 4- Fruit quality characteristics

The data exhibited in Table (5) reveal that the entire applied chemical (P- sources) increased significantly all mango fruits physical characteristics (fruit length, fruit diameter, fruit shape index and fruit volume) over the control of the significant lowest values in the two seasons. The most superior treatment was MAP + urea, the rest P – sources were of beneficial effect and they behave in descending order MAP,  $\text{KH}_2\text{PO}_4$  + urea,  $\text{KH}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$  + urea,  $\text{H}_3\text{PO}_4$  and at least the control of the significant lowest values at both seasons. This results could be explained based on the similar effects of the same P –sources on the fruit N % , P % , carbohydrate % , C / N ratio and fruit weight (Table 3 and 4), those which greatly reflection fruit size and contents. Similar results were obtained by Ashok Kumar and Reddy (2008); Amor *et al.*, (2016) and Nehad (2017).

**Table 5:** Effect of  $\text{NH}_4\text{H}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{KH}_2\text{PO}_4$  with or without urea on the physical characteristics of the fruits of Langra mango trees during 2016/2017 and 2017/2018 seasons.

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit length/fruit diameter (cm)		Fruit volume ( $\text{ml}^3$ )	
	2016	2017	2016	2017	2016	2017	2016	2017
$\text{NH}_4\text{H}_2\text{PO}_4$ + urea	13.33 a	13.06 a	7.00 a	7.10 a	1.90 a	1.84 a	185.90 a	155.56 a
$\text{NH}_4\text{H}_2\text{PO}_4$	12.33 ab	12.03 b	6.63 b	6.73 a	1.86 a	1.79 a	137.75 b	134.44 b
$\text{KH}_2\text{PO}_4$ + urea	11.33 bc	11.03 bc	6.01 c	6.11 b	1.88 a	1.80 a	132.23c	128.90 c
$\text{KH}_2\text{PO}_4$	10.33 cd	10.03cd	5.70d	5.80 bc	1.81 ab	1.72 a	115.57 d	112.23 d
$\text{H}_3\text{PO}_4$ + urea	9.33 de	9.03 de	5.43 e	5.53 cd	1.72 ab	1.63 a	112.23 e	108.90 e
$\text{H}_3\text{PO}_4$	8.33 e	8.03 e	5.1 f	5.2 d	1.63 b	1.67 a	10.8.9 f	105.56 f
Control	6.33 f	5.93 f	4.80 g	4.56 e	1.32 c	1.23b	91.77 g	91.13 g

Means in the same column followed by the same letters during each season are not significantly differ at 5% level of probability.

The data in Table (6) indicate that, the significantly lowest seed weight % was of MAP + urea followed by MAP and  $\text{KH}_2\text{PO}_4$  + urea with insignificant differences among the latter two treatments in the two seasons. While, the highest values were of the control followed by  $\text{H}_3\text{PO}_4$  and  $\text{H}_3\text{PO}_4$  + urea treatments with significant differences between them in the two seasons. While the highest significant values of fruit peel weight % was of the control followed by MAP + urea with insignificant differences among them at both seasons. The lowest values were of MAP + urea was of the significant highest flesh weight % and flesh / seed ratio followed by MAP treatment, while the lowest significant values were of the control one in the two seasons. Also, the same data revealed that all the applied P - sources were significantly superior the control in fruit flesh weight % and flesh / seed ratio quality parameters in the two seasons. The obtained results were confirmed by the findings of Ashok Kumar and Reddy (2008); Amor *et al.*, (2016) and Nehad (2017).

**Table 6:** Effect of  $\text{NH}_4\text{H}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{KH}_2\text{PO}_4$  with or without urea on the physical characteristics of the fruits of Langra mango trees during 2016/2017 and 2017/2018 seasons.

Treatments	Fruit weight (g)		Seed weight (%)		Peel weight (%)		Flesh weight (%)		Flesh/seed ratio	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
$\text{NH}_4\text{H}_2\text{PO}_4$ + urea	135.23 a	133.56a	8.94e	8.78 e	10.69a	14.97 a	80.52a	80.59a	9.03 a	8.85 a
$\text{NH}_4\text{H}_2\text{PO}_4$	110.33b	108.66b	9.53 d	9.37 d	10.61f	13.71b	79.85b	80.13b	8.37 b	8.55 b
$\text{KH}_2\text{PO}_4$ + urea	110.33b	108.66b	9.96c d	9.47 d	11.16e	12.79 c	78.87c	79.91b	7.91bc	8.36 b
$\text{KH}_2\text{PO}_4$	101.60 c	100.00c	10.01c	9.82cd	11.26d	11.11d	78.73c	79.06c	7.86bc	8.04 c
$\text{H}_3\text{PO}_4$ + urea	101.23cd	99.56 c	10.26 c	10.10c	12.70c	12.79 c	77.03d	77.11d	7.51 c	7.63 d
$\text{H}_3\text{PO}_4$	99.83 d	98.66 c	10.97b	10.82b	13.40b	13.71b	75.62e	75.46e	6.89 d	6.97 e
Control	85.23 e	84.56 d	11.64 a	11.50a	14.69a	14.97 a	73.67f	73.53f	6.33 e	6.39 f

Means in the same column followed by the same letters during each season are not significantly differ at 5% level of probability.

### 5- Fruit chemical quality characteristics:

The data presented in Table (7) prove that, MAP + urea treatment was of the significantly highest values of fruit TSS % and TSS / acidity followed by MAP,  $\text{KH}_2\text{PO}_4$  + urea,  $\text{KH}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$  + urea,  $\text{H}_3\text{PO}_4$  and at least the control, respectively in descending order with significant differences between them in the two seasons. It was evident from the same data that, fruit acidity % behave completely in reverse fashion, the highest significantly values were of the control and the lowest values were of MAP + urea treatment in the two seasons. Meanwhile, all the applied P – sources could reduce significantly the fruit acidity % compared with the control at both seasons. This could be explained based on the same effect of the same P sources on N, P, carbohydrate and C/N ratio foliage contents (Table 3), there by stimulation of all biosynthesis and bio translocation processes, which reflect on fruit contents and quality. Similar results were of Ashok Kumar and Reddy (2008) and Amor *et al.*, (2016).

**Table 7:** Effect of  $\text{NH}_4\text{H}_2\text{PO}_4$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{KH}_2\text{PO}_4$  with or without urea on the chemical properties of the fruits of Langra mango trees during 2016/2017 and 2017/2018 seasons.

Treatments	TSS (%)		Acidity (%) g/100 ml juice		TSS /Acidity ratio	
	2016	2017	2016	2017	2016	2017
$\text{NH}_4\text{H}_2\text{PO}_4$ + urea	16.55 a	15.67 a	0.09 b	0.09 g	172.40 a	164.44 a
$\text{NH}_4\text{H}_2\text{PO}_4$	15.91 b	15.35 b	0.11 f	0.10 f	144.45b	143.96 b
$\text{KH}_2\text{PO}_4$ + urea	15.53 c	15.17 c	0.12 e	0.12 e	120.70 c	118.61 c
$\text{KH}_2\text{PO}_4$	15.15 d	15.09 d	0.15 d	0.14 d	98.20 d	101.29 d
$\text{H}_3\text{PO}_4$ + urea	14.77 e	14.98 e	0.17 c	0.17 c	84.16 d	86.62 e
$\text{H}_3\text{PO}_4$	14.39 f	14.89 f	0.19 b	0.19 b	74.69 f	77.56 f
Control	13.95 g	13.98 g	0.23 a	0.23 a	59.28 g	59.57 g

Means in the same column followed by the same letters during each season are not significantly differ at 5% level of probability.

### Conclusion

The present study concluded that spraying Langra mango trees with MAP + urea (1000 ppm  $\text{P}_2\text{O}_5$  + 2000 ppm N) 4 times (20 October, 20 November, at full bloom stage and one month latter) gave the best flowering and foliage chemical composition, the highest fruit yield and the best fruit qualities.

### References

- Agusti, M., 2003. Ctricultura Edition Mundi Prensa Editions, Madrid, 422.  
 Amro, S.M.S., A. A.A. Osama, H.M. El Gammal, 2016. Effect of Gibberellin and Urea Foliar Spray on Blooming, Fruiting and Fruit Quality of Mango Trees cv. Fagri Kalan. OSR Journal of Agriculture and Veterinary Science, 9(3): 9-19.

- AOAC, 2000. Association of Official Agricultural Chemists; Official Methods of Analysis 12<sup>th</sup> Ed., Benjamin Franklin Station, Washington D.C., U.S.A., 490-510.
- Ashok Kumar, M.A. and Y.N. Reddy, 2008. Preliminary investigations on the effect of foliar spray of chemicals on flowering and fruiting characters of mango cv Baneshan. *Indian J. Agric. Res.*, 42 (3): 164 – 170.
- Brown, J.D. and D. Lilleland, 1946. Rapid determination of potassium and sodium in plant material and soil extract by flame photometer. *Proc. Amer. Soc. Hort. Sci.*, 48: 331-346.
- Chadha, K.L., 1993. Fruit drop in mango, p.1131 – 1166 in: K. L. Chadha and O. P. Pareek (eds.). *Advances in Hort.* Vol3. Malhotra Pubi. House, New Delhi, India.
- Champman, H.D. and P.E. Pratt, 1961. *Methods of Analysis for Soil, Plant and Water.* Davis Agric. Sci. Pull Office Calif. Univ., 220 -308.
- Corbesier, L., G. Bernier, and C. Perilleux, 2002. C / N ratio increase in the phloem sap during floral transition of the long day plants *sinapis alba* and *Arabidopsis thaliana*. *Plant and Cell Physiol.*, 43 (6): 684 – 588.
- Ding, C.K., C.Y. Wang, K.C. Gross and D.L. Smith, 2001. Reduction of chilling injury and transcript accumulation of heat shock protein genes in Tomatoes by methyl jasmonate and methyl salicylate. *Plant Science*, 161: 1153-1159.
- Dubois, M., Gilles, M.A., Hamilton, J.K., Rebers, P.A. and Smith, F. (1956). Colorimetric method for determination of sugar related substances. *Anal. Chem.*, 28: 350-356.
- Duncan, B.D., 1955. Multiple test range and multiple F tests. *Biometrics.* 11-142.
- El- Khishen, M.A., 2015. Effect of pruning severity on flowering and fruiting of mango cv Alphonis in off year season. *Egypt. J. Hort.*, 42(2): 785 – 794.
- Geetha, G. A., K. S. Shivashankara, and Y.T. N. Reddy, 2016. Varietal variations in temperature response for hermaphrodite flower production and fruit set in mango. *South Africa J. Botany*, 106: 196 – 203.
- George, A.P., R.H. Broadly, R.J. Nissen and G. Ward, 2003. Effect of chemicals on breaking new rest flowering shoot production and yield of subtropical tree crop. *Acta Hort.*, 275: 835 – 840.
- Goldschmide, E.F. and A. Golomberg, 1982. The carbohydrate balance of alternate bearing citrus trees and the significance of reserves for flowering and fruiting. *J. Amer. Soc. Hort. Sci.* 107 (in press).
- Humayun, M. and R.S. Baby, 2002. Studies on fruit bud differentiation in mango under South India condition. *J. App. Hort.*, 4(1):27-29.
- Kumar, P., R.R. Kennedy, and S. Saraswathy, 2013. Studies on influence of season for biochemical parameters in mango cvs. *African J. Agric. Res.*, 8(49): 6394 – 6400.
- Litz, R.E., 1997. *The Mango Botany, Production and Uses*, First Ed., CAB International Univ. Press. Cambridge. N.Y., 84 - 85.
- Manoj, K.S., S.V. Bahadur and S.A. Kumar, 2019. Floral biology and fruit set of mango (*Mangifera indica* L.) as influenced by different chemicals. *Inter. J. Curr. Microbio. Appli. Sci.*, 8(1): 1106 – 1117.
- Marschner, H., 2002. *Mineral Nutrition of Higher Plants.* Acad. Press, London. 889 p.
- Meadows J., 1998. *Florida food fair.* Cooperative Extension Service for Sarsota Country. University of Florida: Extension Institute of Food and Agriculture Sciences.
- Millington, A.J., 1984. *The Mango a review of the world scene.* Proceeding of First Australian Mango Research Workshop, Melbourne: CSIRO, Australia, 14.
- Murti, G.S.R. and K.K. Upti, 2000. *Plant Hormones.* In: *Advances in Plant Physiology.* 3:109-148 (ed. A. Hemantaranjin), Sci. Publishers, Jodhpur (India).
- Nehad, M.A. Abdel Gawad, 2017. Effect of some treatments for overcoming frost injury and improving productivity, also fruit quality of mango (*Mangifera indica* L.) cv. Hindi khasa. *Middle East J. App. Sci.*, 7(2): 373 – 384.
- Nimisha, S., K.S. Sarjay, P. Jat, S. Manish, K.M. Ajay, and K.S. Nagendra, 2017. Understanding bearing habit in mango. *Curr. Trends Biomedical Eng. & Biosci.*, 4(2): 30-32.
- Oosthuyes, S.A., 1996. Effect of KNO<sub>3</sub> to flowering mango trees on fruit retention, fruit size, tree yield and fruit quality. *Acta Hort.*, 455: 33 – 36.
- Pregl, E., 1945. *Quantitative Organic Micro Analysis.* 4<sup>th</sup> Ed. Chundril, London, 53.
- Purseglove, J. W., 1972. Assessing the Flowering and Fruiting Behaviour in Some Important Cultivars of Mango (*Mangifera indica* L.) Mangoes west of India. *Acta. Hort.*, 24: 170-174.

- Raj Kumar, M., Y.N. Reddy, R. Chandrashckar and D. Srihari, 2005. Effect of foliar application of chemical and plant growth regulators on flowering of unpruned mango trees of cv Baneshan J. Res. ANGAU, 33(2): 6-11.
- Raj Kumar, M., Y.N. Reddy, R. Chandrashckar and D. Srihari, 2007. Effect of pruning, pachobutrazol and chemical on the induction of flowering on new lateral in mango (*Mangofera indica* L.) cv Baneshan J. Res. ANGAU, 35 (11): 22 – 26.
- Raj Kumar, M. and S.A. Siva, 2017. Foliar chemicals application impact on flowering and yield of mango cv Banganpalli. Int. J. Pure App.Bio. Sci., 5(3): 657 – 666.
- Reddy, S.E. and A.M. Majumber, 1988. Fruit Fertil. Res., 4: 281 – 285.
- Saheda, M.D., M.B. Ramaiah and M. Balakrishna, 2019. Study on morpho-physical characters of mango flower varieties hybrids in Kodar agro climatic conditions. Int. J. Curr. Microbiology App. Sci., 8(3): 28- 38.
- Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 6<sup>th</sup> ed. The Iowa state, Univ. Press, Amer, Iowa, U.S.A., 593.
- Srihari, D. and M.M. Rao, 1998. Preliminary investigations on the effect of foliar spray of chemicals on flowering and fruiting characters of mango cv. Baneshan Karmatoko J. Agric. Sci., 11(1): 260 – 262.
- Swietlik, D., 2003. Plant Nutrition PP. 251 – 257. In: Baugher, T. A. and Singha S. (eds.). Concise. Encyclopedia of Temperate Tree Fruit Food Products Press, New York, 387.
- Zaeneldeen, E.M.A., 2017. Effect of urea, gibberellic acid foliar application and pinching early panicles on productivity of "Succary Abiad" mango trees under desert conditions. Middle East Journal of Agriculture Research, 3(2): 135-143.