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EFFECT OF DIFFERENT NPK FERTILIZERS ON GROWTH, FRUITING PARAMETERS AND FRUIT QUALITY ON SOME PLUM CULTIVARS

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ABSTRACT: *This study was carried out to cover the influence of NPK fertilizer rates on vegetative growth, fruiting measurements and leaf nutrient contents as well as fruit characteristics of some plum cultivars (Hollywood, Golden Japanese and Dorado) budded on Mariana rootstock. Trees were 20 years old grown at El-Kanater Horticultural Research Station and planted at 6 meters space as square system on clay loamy soil and flood system irrigation, during 2011 and 2012 successive seasons.*

Obtained data displayed obviously that most of treatments in this study exhibited a positive effect and a significant increase in all investigated vegetative growth measurements i.e., (shoot length and number of leaf per shoot). Moreover, fruiting parameters (fruit set % and tree yield either kg/tree or number of fruits/tree and yield as tons/fed.) were significantly increased with increasing the level of (NPK) soil applied. Furthermore, the second level of soil application rates gave highest yield. Furthermore, Golden Japanese cv. gave the highest yield followed by Dorado and Hollywood.

Furthermore, fruit quality including fruit physical properties i.e.: fruit weight, volume, length and diameter) were significantly improved as a result of the highest soil application rates of (NPK), the second level gave the best result of dimension of fruits. Whatever, the highest soil application rates of (NPK) gave the best weight and volume of fruit; fruit chemical characteristics i.e.: TSS %, acidity % and total sugar content were significantly improved as a result of the lowest soil application rates of (NPK) when compared to the highest level. Furthermore, fruit and leaf nutrient composition of some macro elements (N, P and K) and some micro nutrients (Fe, Mn, Zn and Cu) were improved by the different treatments under study from the standpoint of statistic during both 2011 and 2012 seasons.

In general, it could be concluded that most of studied treatments of (NPK) soil application resulted in a positive and a significant influence on most investigated measurements and characteristics of some plum cultivars (Hollywood, Golden Japanese and Dorado). Since, the second level (1.5, 1.5, 0.75 kg/tree) from (NPK) was the most effective treatment for increasing growth measurements, fruiting parameters and improving both leaf nutritional status and the most of physical and chemical fruit properties of some plum cultivars trees grown under Qalyoubia Governorate condition.

Key words: *Plum, growth, fruit quality, yield, nitrogen, phosphorus, potassium.*

INTRODUCTION

Plum (*Prunus domestica L.*) is one of the most important deciduous fruits grown in Egypt for fresh consumption. Although plum trees are grown in Egypt for a long time ago and many cultivars were introduced in 1980, plum area is still limited and decreased as a result of insufficient chilling requirements. Plum trees area in Egypt decreased from 8155 Feddans in 1993 to 3645 Feaddans in 2010 as a result of tree decline and unfruitfulness.

In plant production, fertilization is one of the most significant cultural practices. Regardless of its major role in tree productivity and soil fertility, the application of nitrogen fertilizers may induce a series of unhelpful consequences, from the microbiological, economic and ecological phases (Acosta-Martinez & Tabatabai 2000 and Jemcev & Djukic 2000). Fertilizer is an imperative tool used by the most farmers in order to improve crop yield. However, excessive fertilization has been established,

particularly on the horticultural enterprises, where the fertilizer costs represented less than 10% of the variable crop costs (Huett and Dirou, 2000). Moreover of the economic aspects, excessive fertilization has been associated to ground water contamination (EPPA, 2005), as well as causing an increase of pest (Marschner, 1995) and diseases occurrence (Tratch *et al*., 2010). The rising of the public apprehension about environment aspects caused by more fertilization renew the interest on evaluating the sufficient fertilization recommended on field to preserve productivity and fruit quality with less environment impact. It is well known that the fertilizer quantity applied by growers influences the fruit quality. Plant nutrition has been reported affecting fruit appearance (Kays, 1999), texture (Sams, 1999), and taste (Mattheis and Fellman, 1999). In many cases, the interaction between nutrients at plant and balanced supply by application of fertilizer is more important than to analyzed isolated rates. Such as, the fruit red color development showed to be powerfully affected by balance between nitrogen and potassium (Taylor, 2009). N and K levels for stone fruit trees depend on factors such as cultivar (Taylor, 2009), tree status (Vitanova, 1990), soil characteristic (Vitanova, 1990). N rate from 112 to 168 kg/ha/year is usually considered sufficient for stone fruits (Johnson and Uriu, 1989).

This principally refers to the improved presence of easily driven forms of nitrate nitrogen that contaminates the surface and underground waters (Pešaković & Mikrobiološka 2007, and Solovova, *et al*. 2001), and the accumulation of nitrates in plants above the allowed level – not only of those used in human diet but for animal feed as well (Marinković, and Grčić 1993). Somewhat safer are phosphorous fertilizers which, added at higher levels, lead to unwanted accumulation of a series of the other elements in soil, for instance stable strontium, normal radioactive composites of uranium, radium and thorium. The harmful effect of potassium fertilizers is reproduced in the fact that these introduce a great quantity of chlorine which can cause a series of unwanted effects (e.g. chlorine effect) among in plant, water and soil. The intensity of the stated processes is governed by the source and rate of fertilizers application (Pešaković *et al*., 2008). Furthermore, the reducing of both production coasts and environmental pollution are the vital and important aims of researchers.

These considerations lead us to the current study for investigating the effect of the different levels of minerals NPK fertilizers on vegetative growth, fruiting parameters, leaf nutrient contents and fruit quality of fruiting plum trees (Hollywood, Golden Japanese and Dorado cvs.) grown under El-Kanater region conditions.

MATERIALS AND METHODS

The present investigation was conducted at the experimental orchard located at El-Kanater Horticultural Research Station, Qalyoubia Governorate, Egypt, located at lat. 30.11, long 31.60 and 14.00 m above the mean sea level. The experiment had been extended for two seasons of 2011 and 2012 on fruitful trees cultivars (Hollywood, Golden Japanese and Dorado) as a main plot and the selected trees were about 20-years-old budded on Mariana rootstock plum and planted at 6 meters space as square system on clay loamy soil. Soil of the experimental field was sampled to make particle size distribution and chemical analysis before treatments according to the standard methods (Ryan *et al*., 1996) and the results are presented in Table (1)

Table (1a): Some physical and chemical properties of the studied soils.

Seasons	pH*	EC**	OM	$CaCO_3$	C. sand	F. sand	Silt	Clay	Soil texture
			%						
2011:2012	7.9	1.1	1.70	3.97	1.1	34.0	33.50	31.40	Clay loam

*Soil suspension 1:2.5
**Soil paste extract

Table (1 b): Cations, anions and nutrients concentration in a paste extract of the studied soil.

Seasons	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	N	P	K
	meq/L								Avail. (ppm)		
2011: 2012	3.07	2.63	4.10	0.42	0.00	3.85	3.70	2.67	35.45	6.33	292.90

Mineral fertilizers (NPK) as a sup-plot were added as a form; ammonium sulphate (20.6% N), super phosphate (15 % P_2O_5) and potassium sulphate (48% K_2O) were applied as three levels as follows:

Level 1 = 1Kg. ammonium sulphate, 1 Kg. calcium mono super phosphate and 0.5 kg potassium sulphate /tree.

Level 2 = 1.5 Kg. ammonium sulphate, 1.5 Kg super phosphates and 0.75 Kg. potassium sulphate /tree.

Level 3 = 2 Kg. ammonium sulphate, 2 Kg. calcium mono super phosphate and 1 Kg. potassium sulphate /tree.

Each of nitrogen (N) and potassium (K) rate was divided and applied in three equal portions in the first week of March, late April and med-June, whereas phosphorus rate was added once a year at the third week of January in the two seasons of study.

The investigated treatments were performed in a complete randomized block design in split plot, with three replicates for each treatment, whereas each replicate was represented by a single tree.

At the beginning of the growing season of both seasons four limbs well distributed on the tree (one on each direction) were selected and labeled and the following parameters were determined:

1- Vegetative growth measurements: were evaluated through determining the average shoot length (cm.) and number of leaves per shoot.

2- Fruiting aspects:

2-a. Percentage of fruit set: The total number of flowers at full bloom and the initial number of fruits at the end of blooming stage on the labeled limbs in all treatments were counted and recorded then the percentage of fruit set was calculated as the following equation according to Westwood (1978) as follows:

$$\text{Fruit set (\%)} = \frac{\text{Number of set fruitlets}}{\text{Number of flowers at full bloom}} \times 100$$

2-b. Tree yield was recorded at the time of harvesting; (at maturity stage) the average yield per tree in kg for each treatment and yield (tons/fed.) were determined. Also, the yield as number of fruits/tree for each treatment was counted.

3- Fruit characteristics: samples of matured ten fruits at harvesting time from each replicate were collected and the following fruit characters were determined: fruit physical properties including the average values of fruit weight (gms), fruit volume (ml), fruit dimensions (both fruit length and width in cm.), fruit shape index (fruit length/fruit width ratio) and fruit firmness ($lb/inch^2$) was determined using Magness and Taylor (1925) pressure tester with 7/18 inch plunger. In addition, fruit chemical properties were also estimated including average percentage of fruit juice TSS (%) by hand refractometer, according to A.O.A.C (1990) fruit juice titratable acidity (%) according to Vogel (1968) was calculated. Also, total sugars content was determined as mg/100 gm pulp of fruit fresh according to Dubaist *et al.*, (1956).

4- Leaf and fruit samples, dried at 70ºC; ground, digested and assigned for analyzing N, P, K, Fe, Mn, Zn and Cu. Nitrogen was determined using modified Kjeldahl method, phosphorous was determined colourimetrically according to the procedure outlined by Ryan *et al.*,

(1996). Potassium was determined using the flame spectrophotometry method (Black, 1982). Fe, Mn, Zn and Cu were determined by using Atomic absorption. All the obtained data in the two seasons of 2011 and 2012 were statistically analyzed using the analysis of variance method according to Snedecor and Cochran (1990), whereas differences between means were compared using Duncan's multiple range test at 0.5 level (Duncan, 1955).

RESULTS AND DISCUSSION

Some growth parameters

1. Shoot length and leaves number:

Effect of different levels of N, P and K fertilization on shoot length (cm) and leaves number of plum trees (Hollywood, Golden Japanese and Dorado cvs.) during 2011and 2012 seasons are presented in Table (2). Data show that the highest significant value of shoot length was recorded by Hollywood cv, while, the lowest one was observed with Dorado cv, in the second season only. On the other hand, the same parameter wasn't affected by plum varieties in the first one. The highest significant value of leaves number was obtained by Hollywood and Golden Japanese cvs., when compared with Dorado plum in the both seasons.

Shoot length (cm) was increased significantly by increasing mineral fertilizers of NPK up to third level (2 kg ammonium sulphate, 2 Kg super phosphate and 1 Kg sulphate potassium/tree). On the contrary, the lowest one was obtained when 1st level was practiced in the second season only. On the other hand, this parameter wasn't affected by adding mineral fertilizers in the first season. The second and third levels of NPK fertilizers gave the highest significant value of leaves number compared to other one in both seasons.

Table 2: Effect of different levels of NPK on shoot length and leaves number of some plum cultivars' during 2011 and 2012 seasons

plum cultivars	Shoot length (cm.)				No. of leaves			
	NPK Levels							
	1	2	3	Mean	1	2	3	Mean
	First season							
Hollywood	36.10ab	37.20a	34.20b	35.83A	19.53a-c	21.03ab	20.33ab	20.30A
Golden Japanese	34.63b	36.33ab	34.63b	35.2 0A	19.20bc	22.60a	18.80b-d	20.20A
Dorado	36.20ab	35.00ab	36.20ab	35.80A	13.20e	16.00de	17.10cd	15.43B
Mean	35.64A	36.18A	35.01A		17.31B	19.88A	18.74AB	
	Second season							
Hollywood	44.50b	43.50b	51.50a	46.50A	26.30ab	23.83bc	26.60ab	25.58A
Golden Japanese	37.70de	36.13e	40.60c	38.14B	23.80bc	26.50ab	28.13a	26.14A
Dorado	29.27f	39.50cd	37.13de	35.30C	14.30d	27.50a	21.83c	21.21B
Mean	36.85C	39.00B	41.46A		21.47B	25.94A	25.52A	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5%.

Level 1 = 1Kg. ammonium sulphate, 1 Kg. calcium mono super phosphate and 0.5 kg. potassium sulphate/tree.

Level 2 = 1.5 Kg. ammonium sulphate, 1.5 Kg. calcium mono super phosphate and 0.75 Kg. potassium sulphate /tree.

Level 3 = 2 Kg. ammonium sulphate, 2 Kg. calcium mono super phosphate and 1 Kg. potassium sulphate/tree.

Respecting the interaction effect between plum varieties and different rates of NPK fertilizers on shoot length (cm) and leaves number, data reveal that the highest significant value of shoot length was observed when Dorado plum treated by any rates from NPK fertilizers was practiced, also, any plum varieties with second level of NPK fertilizers was applied. Meanwhile the lowest one was recorded by the high NPK level for Hollywood and Golden Japanese cvs. in the 1st season only, the same trend was observed by Dorado plum with low level of NPK fertilizer in the 2nd one. Leaves number was increased significantly by adding the second level of NPK fertilizer for Hollywood and/or Golden Japanese, while, the lowest one was obtained by any rates of NPK to Dorado plum in the first season. On the other hand, the second and third levels of NPK with Hollywood and/or Golden Japanese varieties gave a high significant value of leaves number, while, the lowest one was recorded when Dorado plum with low level of NPK fertilizer was practiced in the second one.

2. Fruit set, fruits no. /trees as well as yield (kg/tree) and (ton/fed.):

Results in Table 3 illustrate that the Dorado cultivar gave a highest significant values of fruit set % and fruits no. /tree, while, fruit yield /tree and /or fed., were increased significantly when Golden Japanese cultivar was treated in both seasons. Oppositely, the lowest values of all parameters in this Table were recorded by Hollywood cultivars in both seasons.

The high level of NPK fertilizer increased significantly the fruit set %, while, the second level gave the best significant value of fruits no. /tree, meanwhile, both levels gave the highest significant values of fruit yield /tree and /or fed., in the both seasons. Vice versa, the lowest values of such parameters were obtained when the lowest level of NPK fertilizer was applied in both ones. Nitrogen, phosphorus and potassium dynamics in plum trees and revealed that such nutrients are needed to support growth and yield but such nutrients management should pursue the goal of promoting flowering and fruit set in non-vigorous trees with low NPK-fruit by adding such nutrients, trees can be managed for both optimum vigor and NPK concentration of various tissues. Pešaković *et al*. (2009) who stated that the effect of different mineral fertilizer rates of NPK + 3 % MgO on the yield of plum cv Čačanska Lepotica, had generally, the most significant increase in plum yield as a result of application high fertilizer rates.

For the interacted factors under this study, the high level of NPK fertilizer when added to Dorado cultivar gave a highest significant value of fruit set % in the both seasons; the same trend was obtained when the second level was applied for the same cultivar in the second season only. On the other hand, the lowest one was observed by the low level of NPK when added to Hollywood variety in both seasons; meanwhile, the second level with same cultivar gave the same trend in the 1st season only. Data also reveal that the second level of NPK fertilizer (1.5 kg ammonium sulphate, 1.5 Kg super phosphate and 0.75 Kg sulphate potassium/tree) when applied to Dorado cultivar gave a highest significant value of fruits no. /tree in both seasons. Conversely, the lowest one was observed when adding any rates from NPK fertilizers to Hollywood variety and /or the lowest level with all cultivars in both seasons. Generally, in most cases, the fruit yield /tree or fed., were increased significantly by adding the second and/or third rates of NPK fertilizers with Golden Japanese variety in the both seasons, while the lowest ones were recorded by the low level with Dorado cultivar and /or any rates with Hollywood variety in both one. On apricot (cv. Bergeron), high fertilization enhanced vegetative growth, yield and average fruit weight and aggravated fruit pit burn incidence. Increasing K fertilization enhanced fruit soluble solids and coloring, but did not affect pitburn (Bussi *et al*. 2003).

Table 3

3. Fruit weight and volume:

Available data in Table 4 demonstrate that the Golden Japanese variety gave highest significant values of fruit size and weight. Meanwhile, the lowest ones were obtained when Dorado cultivar was treated in both seasons, the same trend was observed by Hollywood variety for fruit size in the first season only.

With regard to the effect of mineral fertilizer rates on such parameters, data show that the highest significant values of fruit size and weight were recorded when the high level of NPK fertilizer was practiced in the both seasons. The same trend was showed by second level for fruit size in the first season only. Otherwise, the lowest ones were recorded by adding the first rate of NPK fertilizer in both seasons. The second level gave the same trend for fruit size in the 2nd season only. In this association, nitrogen deficiency was reported leading to small fruits with poor flavor (Taylor, 2009). Even though, nitrogen application did not affect the stone fruit quality in Brazil (Dolinski *et al*., 2005; Brunetto *et al*, 2007). Stone fruit trees nitrogen deficient can provide low yield (Taylor, 2009) as a result of shorter period of leaves maintenance, resulting in shorter reserves accumulation for the posterior cycle (Monte-Serrat *et al*., 2004, Tratch *et al*., 2010). Under potassium deficiency, stone fruit productivity, quality (Chatzitheodorou *et al*., 2004) are negatively affected. Johnson and Uriu (1989) reported that poor fruit color, either lacking color or having dirty looking was observed under potassium deficiency for peaches. High potassium level increases the fruit acidity (Kader and Rolle, 2004).

Regarding the interacted factors under study on fruit size and weight of same plum cultivars, results show that the highest significant values of such parameters were increased significantly by adding the high level of NPK fertilizer to Golden Japanese variety in the both seasons. The 2nd level with the same variety gave the same trend in the 1st one only. On the other hand, the lowest one was obtained by using the low level with Dorado cultivar in the both ones. Also, the Hollywood and Dorado cultivars with any rates from NPK gave the trend in the first season only. In this connection, Kevin *et al*. (2002) suggests that plums may not be as dramatically affected as peach and nectarine by high nitrogen rates. There is an additional school of thought that promotes the use of nitrogen to improve fruit size and/or tree cropping ability, since most plums by nature do no tend to grow in as shaded or vigorous a growth habit as peach. Compounding these opinions is the effect that nitrogen status may have on subsequent spur and flower development.

Table 4: Effect of different levels of NPK on fruit size and weight on some plum cultivars' during 2011 and 2012 seasons

Plum cultivars	Fruit size (ml)				F. weight (g.)			
	NPK levels							
	1	2	3	Mean	1	2	3	Mean
	First season							
Hollywood	28.70c	29.80c	30.57c	29.68B	32.33cd	32.50cd	36.00bc	33.61B
Golden Japanese	35.90b	30.07bc	40.83a	35.60A	38.20b	42.17a	44.30a	41.56A
Dorado	26.43c	28.00c	30.00c	28.14B	23.90e	31.03d	32.00d	28.98C
Mean	30.33B	29.29AB	33.80A		31.48C	35.23B	37.43A	
	Second season							
Hollywood	28.33c	31.10bc	32.97b	30.80B	30.43d	32.70d	34.63cd	32.59B
Golden Japanese	33.17b	34.00b	46.23a	37.80A	37.53bc	40.73b	53.63a	43.97A
Dorado	22.73d	24.20d	30.53bc	25.82C	22.70e	31.20d	32.20d	28.70C
Mean	28.08B	29.77B	36.58A		30.22C	34.88B	40.16A	

4. Fruit firmness, length, diameter and shape index:

Results presented in Table 5 show that fruit firmness increased significantly when Dorado cultivars was treated, while, the lowest one was recorded by Golden Japanese in the both seasons. Hollywood and Golden Japanese varieties gave a best significant value of fruit length compared to Dorado one in the both seasons. The highest significant value of fruit diameter was obtained from Golden Japanese and Dorado cultivars compared with Hollywood in the both seasons. Fruit shape index increased significantly when Hollywood variety was treated, while the lowest one was observed by Dorado cultivar in the both seasons.

With respect to the effect of NPK fertilizer levels on such parameters, data reveal that the low level of NPK fertilizer (1 kg ammonium sulphate, 1 Kg mono super phosphate and 0.5 Kg sulphate potassium/tree) gave the best significant value of fruit firmness, whereas, the lowest one was obtained by increasing fertilizer level up to the third level (2 kg ammonium sulphate, 2 Kg mono super phosphate and 1 Kg sulphate potassium/tree) in the both seasons. The fruit length increased by using the second and third level of NPK fertilizer compared to other ones in the both seasons. The best significant value of fruit diameter was shown when second and third levels of NPK were applied in the 1st and 2nd seasons respectively compared with the low level in both ones. The second level of NPK fertilizer gave a high significant value of fruit shape index compared with other ones in the 1st season only, but wasn't affected in the second one. In this connection, Nitrogen, phosphorus and potassium are among the principal nutrients needed by plants (Marschner, 1995). However, excessive nitrogen supply can cause negative impact on the stone fruits quality by reducing flesh firmness and sweetness (Rettke *et al.*, 2006).

Concerning the interacted factors under study on such parameters, results reveal that the highest significant value of fruit firmness was obtained by 1st and 2nd level of NPK fertilizer with Dorado cultivar, while, the lowest one was shown when adding any rates for Hollywood cultivar in the both seasons. The fruit length increased significantly by adding the second level of NPK fertilizer to Hollywood cultivar, also, by using the third level to Golden Japanese cultivar in the both seasons. On the other hand, the lowest one was recorded when the third level of NPK fertilizer was added to Dorado cultivar in the both ones.

The second level with any plum cultivars and /or 3rd level with Golden Japanese only gave the best significant values of fruit diameter in the first season, followed by the 3rd level with Golden Japanese and/ or the 2nd level with Dorado cultivar in the second one. The lowest one was observed by adding first level to Hollywood and Golden Japanese cultivars, as well as the 3rd level with Dorado cultivar in the both seasons. For fruit shape index, data show that the highest significant value was recorded by using any rates from NPK to Hollywood cultivar, but, the lowest one was obtained when the 1st and 2nd levels were added to Dorado cultivar in the both seasons.

5. Total soluble solids (TSS), fruit total acidity, TSS/acid ratio and total sugars:

Results tabulated in Table 6 show that the highest significant values of TSS % and TSS/acid ratio were obtained when Dorado cultivar was treated meanwhile, the lowest one were recorded by Golden Japanese in the both seasons. With regard to acidity %, data reveal that such parameter increased significantly by Golden Japanese cultivar, but Dorado cultivar gave the lowest value in the both seasons. Total sugars % improved significantly by Golden Japanese and Dorado cultivars in 1st and 2nd season, respectively, while, the lowest one was observed when Hollywood was treated in both ones.

Table 5

Table 6

With respect to the effect of NPK fertilizers rate on such parameters, results illustrate that the TSS % and TSS/ acid ratio were increased significantly with increasing NPK fertilizer rates up to third level in the both seasons. Meanwhile, the lowest one was obtained when the second level was applied in the both ones. Whereas, TSS/ acid ratio wasn't affected by using NPK fertilizer rates in the first season, as well as acidity % in the both seasons. On the contrary, the first and the second level of NPK fertilizers improved significantly the total sugar % in the first and second season respectively, while, the lowest one was recorded by adding the second and the third level of NPK fertilizers in the first season and third one in the second season only. In this respect, Soest (2012) on "Anna" apple showed that, fruit set%, yield, leaf minerals contents as well as physical and chemical characters of the fruit were positively affected by single or combined application of Fertifol Misr (N, P, K, Mg zn, Fe, Mu, Cu, Mo & B) and gibberellic acid compared to un fertilizing trees.

Regarding the interacted factors under study data reveal that, in most cases, the third and first levels of NPK fertilizers when applied to Dorado cultivar gave the best significant values of TSS % and TSS /acid ratio, meanwhile, the lowest one was recorded by using the first and second level on Golden Japanese cultivar in the both seasons. For acidity % , data show that the highest significant value was obtained by adding any rates from NPK fertilizers to Golden Japanese cultivar, meanwhile, the lowest one was recorded when the first level applied to Dorado cultivar in the both seasons, while, the third level gave the same trend in the second season only. The second level of NPK fertilizer with Golden Japanese and the high level with Dorado improved significantly total sugar %, while, the lowest one was recorded by adding any levels of NPK fertilizer to Hollywood variety in the first season and Golden Japanese in the second one.

N, P and K % of leaves and fruits:

Data presented in Tables 7 and 8 shows that the Dorado cultivar gave the highest significant values of N, P and K % of leaves and fruits, also, the same trend were obtained of P % of leaves only in the both seasons. On the other hand, the lowest one were recorded by Hollywood cultivar in the both seasons; the same trend was observed of N and K % of fruit only in the 2nd season only.

With regard to the effect of N, P and K fertilizer levels on contents of N, P and K in leaves and fruits of plum trees, results reveal that N % of leaves and P % of fruits increased significantly by adding the second level of NPK fertilizer, while, K % of fruits improved significantly by using 1st and 3rd level of fertilizer compared with other level in the both seasons. On the contrary, other parameters in this Table weren't affected significantly by applying the three levels of fertilizers in the two studied seasons. Nutrient uptake is affected by many orchard conditions and varies slightly from year to year, depending on the season. For optimum growth and fruit quality, all nutrients must be available in sufficient concentrations. In this respect, Paul and Qaiyyum (2009) stated that the importance of NPK fertilizers for both increased productivity and improved quality of mulberry leaves has been well recognized. The yield of mulberry is influenced more by the amount of nitrogenous fertilizer than phosphorus and potassium.

For the interaction effect between plum cultivars and NPK fertilizer levels on such parameters, in most cases, data illustrate that the N, P and K % of leaves as well as N and P % of fruit increased significantly when applying any rates from NPK fertilizers to Dorado cultivar in the both seasons. Vice versa, lowest values of such parameters were observed by Hollywood cultivar with any rates from NPK fertilizers in the both ones. On the other hand, the 1st and 3rd levels of NPK fertilizer were improving significantly K % of three plum cultivars fruit in the first season. also, the same trend were obtained when the first level of fertilizer with Dorado and/ or third one with Hollywood were practiced in the second season.

Table 7

Table 8

Conversely, the lowest one was recorded by adding the second rates to Golden Japanese in the both seasons. Same trend was observed in Hollywood with 2nd rates of fertilizer in the second season only. Those results agrees with those obtained by Sánchez (2002) who described briefly that nitrogen, phosphorus and potassium had dynamics in plum trees and revealed that such nutrients are needed to support growth and yield but such nutrients management should pursue the goal of promoting flowering and fruit set in non-vigorous trees with low NPK-fruit. By adding such nutrients, trees can be managed for both optimum vigour and NPK concentration of various tissues.

Fe, Mn, Zn and Cu content in leaves and fruits:

Available data in Tables 9 and 10 shows that the Fe content was increased significantly by Golden Japanese and Dorado cultivars when compared to Hollywood for leaves, while, Golden Japanese and Hollywood gave the highest values compared with Dorado cultivar for fruits in the both seasons. The highest significant values of Mn, Zn and Cu of leaves and fruits were improved significantly by Dorado cultivar, the same trend was recorded by Golden Japanese for Cu content of leaves only in the both seasons. On the other hand, the lowest ones were observed by Hollywood variety in the both ones. Zn content of leaves wasn't affected by plum cultivars in the both seasons.

Respecting the effect of NPK fertilizer rates on some micronutrients content of leaves and fruits, results reveal that the second level of NPK fertilizer gave a highest significant value of Fe content for leaves and fruits compared to other levels in the both seasons. Mn, Zn and Cu content of leaves and fruits were improved significantly when the high level of fertilizer was practiced in the both ones. The same trend of Mn and Cu content of leaves were obtained by applying the 2nd level of NPK fertilizer, while, the 1st and 3rd rates gave the highest significant value of Zn content of fruits in the both seasons. Vice versa, the lowest significant values of Mn and Cu content of leaves were observed when the lowest level of NPK fertilizer in the both seasons, while, the lowest Mn and Zn content of fruits were recorded by the second rates of fertilizer in the both ones. Meanwhile, Cu content of fruits was decreased significantly by adding 1st and 2nd rates in the both seasons. Zn content of leaves wasn't affected by applying NPK fertilizer rates in the both seasons.

Respect to the interacted factors under study on some micronutrients content of plum leaves and fruits, data show that the highest significant values of Fe content of leaves and fruits by applying the second level of NPK fertilizer to Hollywood and Dorado cultivars in the both seasons. In most cases, the Dorado cultivar with any rates from NPK fertilizer gave a highest significant value of Mn, Zn and Cu content of different parts of plum cultivars, while the lowest one were recorded by Hollywood cultivars with any rates fertilizer in the both seasons.

CONCLUSION

Nitrogen (N) is necessary for plum functions, which include growth, fruit bud formation, fruit set and fruit size. A mineral nutrient of Phosphorus (P) is an essential element for all life forms. Potassium is important for fruit color, winter hardiness, tree growth and resistance to disease, such as fire blight in pears. Excess potassium can lead to magnesium (Mg) deficiency, so avoid unnecessary application of potassium. Cultivars differ in NPK requirements. A cultivar grown for processing could receive more such nutrients than one for the fresh market. In situations where fruit tends to be small, more NPK may be needed. Generally, it could be concluded that the second level of NPK fertilizer (1.5, 1.5, 0.75 kg/tree) was the most effective treatment for increasing growth measurements, fruiting parameters and improving both of leaf & fruit nutritional status as well as the most of physical and chemical fruit properties of some cultivars plum trees grown under Qalyoubia Governorate condition.

Table 9

Table 10

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تأثير المعدلات المختلفة من اسمدة النيتروجين والفوسفور والبوتاسيوم على النمو وقياسات الإثمار وصفات جودة ثمار بعض أصناف البرقوق

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الملخص العربى

تم إجراء هذا البحث لدراسة تأثير التسميد المعدنى بالـ (ن، فو، بو) كإضافة أرضية بمستويات مختلفة على بعض قياسات النمو الخضرى والثمرى وكذلك الحالة الغذائية للأوراق وصفات جودة ثمار أصناف البرقوق (الهوليوود، اليابانى الذهبى والدورادو) والمطعومة على أصل الماريانا والمنزرعة فى ارض طينية طمييه بمحطة بحوث البساتين بالقناطر الخيرية على أشجار نامية عمر 20 عاما ومنزرعة على مسافات 6 × 6 متر وتروى بالغمر خلال موسمى 2011، 2012.

ولقد أشارت النتائج المتحصل عليها إلى أن معظم المعاملات فى هذه الدراسة أدت إلى تأثير إيجابى وزيادة معنوية فى كل قياسات النمو الخضرى المختبرة (طول الفرع – عدد الأوراق/الفرع) كذلك فإن القياسات الثمرية (النسبة المئوية) لعقد الثمار والمحصول الشجرة سواء قدر بالكجم/شجرة أو بالطن/فدان، وكذلك عدد الثمار/شجرة) فقد أزدادت هذه القياسات معنوياً بزيادة مستوى التسميد الأرضى من (ن، فو، بو) كما أعطى المستوى الثانى من التسميد أعلى محصول بالإضافة إلى ما سبق نجد أن صنف اليابانى الذهبى أعطى أعلى محصول يليه صنف دورادو ثم صنف الهوليوود.

بالإضافة إلى ما سبق فإن صفات جودة الثمار الطبيعية (وزن الثمرة – حجم الثمرة – طول وقطر الثمرة) قد تحسنت معنوياً نتيجة للإضافة الأرضية للمعدلات الأعلى من الأسمدة المضافة وأعطى المستوى الثانى أفضل نتيجة بالنسبة لأبعاد الثمرة.

بينما أعطى المستوى الثالث أفضل نتيجة بالنسبة لوزن وحجم الثمرة وبالنسبة للصفات الكيميائية للثمرة (النسبة المئوية السكريات الكلية الذائبة، النسبة المئوية للحموضة، النسبة المئوية للسكريات الكلية) قد تحسنت نتيجة للإضافة الأرضية للمعدلات الأعلى من الأسمدة المضافة إذا ما قورنت بأقل تركيز من هذه الأسمدة، هذا بالإضافة إلى محتوى الأوراق والثمار من بعض العناصر الكبرى (النيتروجين والفوسفور والبوتاسيوم) والعناصر الصغرى (حديد، منجنيز، زنك ونحاس) قد تحسنت عل المستوى المعنوى باستخدام المعاملات المختلفة تحت الدراسة خلال موسمى البحث 2011، 2012.

وبصفة عامة يمكن القول بأن معظم المعاملات من الأسمدة المستخدمة (ن، فو، بو) كإضافة أرضية أدت إلى تأثير إيجابى ومعنوى على معظم القياسات والصفات المدروسة على أصناف البرقوق تحت التجربة (هوليوود – يابانى ذهبى – دورادو)، وكان المستوى الثانى (1.5، 1.5، 0.75 كجم/شجرة) من كل من (ن، فو، بو على التوالى) أفضل مستوى فى هذا الخصوص من حيث زيادة القياسات الخضرية والثمرية وتحسين الحالة الغذائية للأوراق وكذلك معظم صفات جودة الثمار وذلك تحت ظروف منطقة القناطر الخيرية بمحافظة القليوبية.

Table 3: Effect of different levels of N, P and K on fruit set %and fruits no. /tree as well as fruit yield (kg/tree) and (ton/fed.) on some plum cultivars' during 2011 and 2012 seasons.

plum cultivars	Fruit set (%)				No. of fruits/tree				F. yield (kg/tree)				F. yield (ton/fed.)			
	NPK levels															
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
	First season															
Hollywood	5.43d	5.43d	6.13c	5.67C	530.0d	516.7d	523.3d	523.3C	17.30c	16.87cd	18.87c	17.68C	2.90ef	2.80ef	3.17d-f	2.96C
Golden Japanese	5.90c	6.20c	6.93b	6.34B	546.7d	783.3b	698.3c	676.1B	20.50c	33.13a	30.63a	28.09A	3.47de	5.63a	5.13ab	4.71A
Dorado	7.00b	6.90b	7.97a	7.29A	551.7d	875.0a	766.7b	731.1A	13.57d	27.00b	24.63b	21.73B	2.27f	4.53bc	4.13cd	3.64B
Mean	6.11B	6.18B	7.01A		542.8C	725.0A	662.8B		17.12B	25.64A	24.71A		2.88B	4.29a	4.14A	
	Second season															
Hollywood	5.43e	5.83d	6.53c	5.93C	550.0e	536.7e	548.3e	545.0C	16.60ef	17.63e	19.03de	17.76C	2.77ef	2.93ef	3.17ef	2.96C
Golden Japanese	6.00d	6.80bc	7.03b	6.61B	576.7de	813.3b	728.3c	706.1B	21.63d	33.47b	39.03a	31.38A	3.67de	5.60ab	6.53a	5.27A
Dorado	6.50c	7.50a	7.50a	7.17A	606.3d	913.0a	804.7b	774.7A	13.73f	28.60c	25.97c	22.77B	2.27f	4.80bc	4.37cd	3.81B
Mean	5.98C	6.71B	7.02A		577.7C	754.3A	693.8B		17.32B	26.57A	28.01A		2.90B	4.44A	4.69A	

Table 5: Effect of different levels of NPK on fruit firmness, fruit length, fruit diameter and fruit shape index on some plum cultivars' during 2011 and 2012 seasons

Plum cultivars	Fruit firmness (Inch^2)				Fruit length (cm.)				Fruit diameter (cm.)				Fruit shape index			
	NPK levels															
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
Hollywood	First season															
Golden Japanese	10.27c	11.83b	9.23d	10.44B	3.60c-e	3.97ab	3.80b-d	3.79A	3.40de	3.73a-d	3.57c-e	3.57B	1.060a	1.060a	1.067a	1.062A
Dorado	8.03e	6.60f	7.33ef	7.32C	3.60c-e	3.90a-c	4.17a	3.89A	3.3b-e	4.03ab	4.03ab	3.90A	0.993bc	0.967cd	1.030ab	0.997B
Mean	13.77a	13.57a	12.13b	13.16A	3.43e	3.53de	3.03f	3.33B	3.87a-c	4.13a	3.30e	3.77AB	0.857e	0.853e	0.913d	0.874C
	10.69A	10.70A	9.57B		3.54B	3.80A	3.67AB		3.63B	3.97A	3.63B		0.970B	0.960B	1.003A	
Hollywood	Second season															
Golden Japanese	12.10b	9.83c	11.27b	11.07B	3.47b	3.97a	3.97a	3.80A	3.37de	3.77bc	3.73b-d	3.62B	1.030ab	1.053a	1.063a	1.049A
Dorado	7.97d	7.27d	8.40d	7.88C	3.50b	3.60b	4.20a	3.77A	3.50c-e	3.63cd	4.37a	3.83A	0.990bc	0.990bc	0.960cd	0.980B
Mean	13.77a	13.47a	12.03b	13.09A	3.33b	3.43b	2.93c	3.23B	3.77bc	4.03ab	3.20e	3.67AB	0.887ef	0.850f	0.917de	0.884C
	11.28A	10.19B	10.57B		3.43B	3.70A	3.70A		3.54B	3.81A	3.77A		0.969A	0.964A	0.980A	

Table 6: Effect of different levels of NPK on TSS, acidity, TSS/acid ratio and total sugar (%) on some plum cultivars' during 2011 and 2012 seasons.

Plum cultivars	TSS %				Acidity (%)				TSS/acid ratio				Total sugars %			
	NPK levels															
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
	First season															
Hollywood	12.00cd	12.5b-d	11.93d	12.14B	0.907c	0.827c	0.933bc	0.889B	13.50c	15.70bc	13.10cd	14.10B	9.40e	9.50e	9.40e	9.43C
Golden Japanese	9.33e	9.83e	11.67d	10.28C	1.093a	1.060ab	1.093a	1.082A	8.53e	9.30e	10.70de	9.51C	10.23b	10.73a	10.00c	10.32A
Dorado	13.33ab	13.00bc	14.17a	13.50A	0.653d	0.893c	0.800c	0.782C	20.43a	14.70c	18.17ab	17.77A	9.73d	9.73d	10.73a	10.06B
Mean	11.56B	11.78B	12.59A		0.884A	0.927A	0.942A		14.16A	13.23A	13.99A		9.79	9.99A	10.04A	
	Second season															
Hollywood	13.10cd	10.87e	12.50cd	12.16B	0.947c	0.960c	0.973bc	0.960B	14.07b	11.30cd	13.10bc	12.82B	9.90b	9.50c	9.00d	9.47B
Golden Japanese	9.43f	9.93ef	12.10d	10.49C	1.113a	1.080ab	1.120a	1.104A	8.47f	9.20ef	10.77de	9.48C	9.00d	10.23a	9.00d	9.41B
Dorado	14.33b	13.67bc	16.83a	14.94A	0.773e	0.933cd	0.827de	0.844C	18.50a	14.73b	18.23a	17.16A	10.00b	10.33a	10.23a	10.19A
Mean	12.29B	11.49C	13.81A		0.944A	0.991A	0.973A		13.68A	11.74B	14.03A		9.63B	10.02A	9.41C	

Table 7: Effect of different levels of NPK fertilizers on N, P and K (%) in leaves on some plum cultivars during 2011 and 2012 seasons

Plum cultivars	N % leaves				P % leaves				K % Leaves			
	NPK levels											
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
First season												
Hollywood	2.44c	2.61bc	2.53bc	2.52C	0.243d	0.233d	0.280b-d	0.252B	2.34c	2.57c	2.53c	2.48C
Golden Japanese	2.88b	3.33a	2.75bc	2.99B	0.333ab	0.290a-d	0.270cd	0.298A	3.06b	2.96b	3.00b	3.01B
Dorado	3.43a	3.45a	3.42a	3.43A	0.310a-c	0.347a	0.320a-c	0.326A	3.43a	3.52a	3.52a	3.49A
Mean	2.92B	3.13A	2.90B		0.296A	0.290A	0.290A		2.94A	3.02A	3.02A	
Second season												
Hollywood	2.64c	2.81bc	2.72bc	2.72C	0.343b	0.333d	0.380ab	0.352B	2.54c	2.77c	2.73c	2.68C
Golden Japanese	3.08b	3.53a	2.95bc	3.19B	0.432a	0.390ab	0.370ab	0.398A	3.26b	3.16b	3.20b	3.21B
Dorado	3.63a	3.65a	3.63a	3.63A	0.410ab	0.446a	0.420ab	0.425A	3.63a	3.72a	3.72a	3.69A
Mean	3.12B	3.33A	3.10B		0.396A	0.390A	0.390A		3.14A	3.22A	3.22A	

Table 8: Effect of different levels of NPK fertilizers on N, P and K (%) in fruits on some plum cultivars during 2011 and 2012 seasons

Plum cultivars	N % fruits				P % fruits				K % fruits			
	Levels											
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
First season												
Hollywood	0.407d	0.423cd	0.430cd	0.420C	0.050de	0.060de	0.047e	0.052C	0.113a-c	0.090bc	0.167a	0.123A
Golden Japanese	0.467b-d	0.497ab	0.470bc	0.478B	0.063c-e	0.083ab	0.067b-d	0.071B	0.130ab	0.061c	0.123a-c	0.105A
Dorado	0.527ab	0.553a	0.543a	0.541A	0.080a-c	0.093a	0.083ab	0.086A	0.170a	0.084bc	0.150ab	0.135A
Mean	0.467A	0.491A	0.481A		0.064B	0.079A	0.066B		0.138A	0.079B	0.147A	
Second season												
Hollywood	0.507cd	0.523bc	0.530bc	0.520B	0.070d	0.080cd	0.067d	0.072C	0.143cd	0.120e	0.197ab	0.153B
Golden Japanese	0.567a-c	0.420d	0.570a-c	0.519B	0.083b-d	0.103ab	0.087b-d	0.091B	0.160c	0.133de	0.153c	0.149B
Dorado	0.627ab	0.653a	0.643a	0.641A	0.100a-c	0.113a	0.103ab	0.106A	0.200a	0.153c	0.180b	0.178A
Mean	0.567A	0.532A	0.581A		0.084B	0.099A	0.086B		0.18A	0.136B	0.177A	

Table 9: Effect of different levels of NPK fertilizers on Fe, Mn, Zn and Cu content in leaves of some plum cultivars during 2011 and 2012 seasons

Plum cultivars	Fe (mg/kg) leaves				Mn (mg/kg) leaves				Zn (mg/kg) leaves				Cu (mg/kg) leaves			
	Levels															
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
First season																
Hollywood	252.7b	267.0ab	252.7b	257.4A	25.00c	25.33c	25.33c	25.22C	44.33a	45.67a	45.67a	45.22A	15.33d	25.67a	21.67bc	20.89B
Golden Japanese	254.7b	271.0a	252.7b	259.4A	28.00c	36.33b	37.67ab	34.00B	46.67a	43.67a	48.33a	46.22A	18.33cd	25.33a	26.67a	23.44A
Dorado	217.0c	217.7c	216.0c	216.9B	40.67ab	39.67ab	41.33a	40.56A	46.67a	46.33a	47.33a	46.78A	23.33ab	21.67bc	25.67a	23.56A
Mean	241.8B	251.9A	240.4B		31.22B	33.78A	34.78A		45.89A	45.22A	47.11A		19.00B	24.22A	24.67A	
Second season																
Hollywood	250.7b	265.0ab	250.7b	255.4A	27.00c	27.33c	27.33c	27.22C	45.33ab	46.67ab	46.67ab	46.22A	17.33d	27.67a	23.67bc	22.89B
Golden Japanese	252.7b	269.0a	250.7b	257.4A	30.00c	38.33b	39.67ab	36.00B	47.67ab	44.67b	49.33a	47.22A	20.33cd	27.33a	28.67a	25.44A
Dorado	215.0c	215.7c	214.0c	214.9B	42.67a	41.67ab	43.33a	42.56A	47.67ab	47.33ab	48.33ab	47.78A	25.33ab	23.67bc	27.67a	25.56A
Mean	239.4B	249.9A	238.4B		33.22B	35.78A	36.78A		46.89A	46.22A	48.11A		21.00B	26.22A	26.67A	

Table 10: Effect of different levels of NPK fertilizers on Fe, Mn, Zn and Cu content in fruits of some plum cultivars during 2011 and 2012 seasons

Plum cultivars	Fe (mg/kg) fruits				Mn (mg/kg) fruits				Zn (mg/kg) fruits				Cu (mg/kg) fruits			
	Levels															
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
First season																
Hollywood	75.67d	78.63cd	82.43b-d	78.91B	3.80d	3.63d	5.70b	4.38C	10.10c	10.53c	10.10c	10.24B	3.92de	3.50e	5.13ab	4.18C
Golden Japanese	82.03b-d	96.93a	84.10b-d	87.69A	5.43bc	5.17bc	5.53b	5.38B	11.07bc	10.97bc	10.57c	10.87B	4.43cd	5.20b	4.77bc	4.80B
Dorado	87.33bc	100.7a	88.17b	92.08A	6.58a	4.90c	6.37a	5.95A	16.75a	12.0b	16.40A	15.25A	5.43ab	5.57a	5.50a	5.50A
Mean	81.68B	92.10A	84.90B		5.27B	4.57C	5.87A		12.64A	11.37B	12.3AB		4.59B	4.76B	5.13A	
Second season																
Hollywood	71.67c	74.3bc	58.65d	68.32B	4.90d	4.73d	6.80b	5.48C	11.40c	11.83c	11.40c	11.54B	5.12de	4.70e	6.33ab	5.38C
Golden Japanese	78.03bc	92.93a	80.10bc	83.9A	6.53bc	6.27bc	6.63b	6.48B	12.37bc	12.27bc	11.87c	12.17B	5.63cd	6.40ab	5.97bc	6.00B
Dorado	83.33b	96.73a	84.17b	88.08A	7.68a	6.00c	7.47a	7.05A	18.05a	13.90b	17.40a	16.55A	6.63a	6.77a	6.70a	6.70A
Mean	77.68B	88.10A	74.30B		6.37B	5.67C	6.97A		13.94A	12.67B	13.66AB		5.79B	5.96B	6.33A	