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INFLUENCE OF PHOSPHORUS FERTILIZER ON GROWTH, FRUITING PARAMETERS AND FRUIT QUALITY OF PEACH TREES IRRIGATED BY ACIDIC WATER

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ABSTRACT

This investigation was carried out to study the effect of P fertilizer sources i. e superphosphate (15.0 % soluble water P_2O_5) at 2.0 kg/tree, rock phosphate (6.25% total P_2O_5) at 4.8 kg/tree and without P addition under irrigation by acidic water at three levels from sulphoric acid i.e., without, 5 and 10 L/fed., on some vegetative growth and fruiting measurements as well as fruit and leaf nutrient content of peach trees Florida Prins' cv. budded on Nemagard rootstock. The trees were 7 years old, grown at Sobk Village, Ashmoon, Monofia Governorate, Egypt, during 2012 and 2013 seasons. Obtained results reveal that the two tested P sources super or rock phosphate induced significant increases in vegetative growth, fruit yield and fruiting measurements as well as fruit and leaf nutrient content compared to without P addition (control) with superiority for superphosphate fertilizer which yielded more fruit yield / tree and yield/ fed., than rock phosphate in both seasons. Also, data show that the fruit quality including fruit physical properties and fruit chemical characteristics as well as fruit and leaf nutrient content were significantly improved as a result of the irrigation by acidic water compared to non acidic one. Furthermore, fruit yield quantity and quality as well as 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 adding sulphoric acid to irrigation water for both P fertilizer sources super or rock phosphate from the standpoint of statistic during both 2012 and 2013 seasons.

Keywords: Peach – rock phosphate – superphosphate – Acidic water – Fruiting – Fruit quality

INTRODUCTION

In Egypt, peach is one of the most imperative deciduous fruit trees. Peach (*Prunus persica L*.) is native to family Rosaceae. In Egypt, Peach acreage has been increased rapidly to reach 80609 feddan (Ministry of Agriculture, A.R.E., 2010). This rapid extension is devoted mainly to the potentiality of cultivars to produce early season fruit with low water requirement, high economic value and good potential for exportation (El-Kosary, *et al.,* 2013).

Phosphorus is a necessary nutrient required by plants for normal growth and development. The availability of P to plants for uptake and utilization is decreased in alkaline soil because of the formation of inadequately soluble calcium phosphate minerals. Adding P fertilizer at normal levels and with conventional methods may not result in optimal yield and crop quality in these soils common in arid and semi-arid regions (Hopkins and Ellsworth, 2006). Pasandideh, *et al.,* (2010) found that the addition of phosphate fertilizers is a common practice to right P-deficiency in plants. For a long time, rock phosphate has been a major source to P fertilizer production. Solubility of rock phosphate in soils and its succeeding effect depends on soil availability such as soil pH, particle size of rock phosphate, and concentrations of Ca and P in soil solution (He *et al.,* 2005). The efficiency of P fertilizers in alkaline soils is generally very low because P applied to the soil reacts with Ca forming minerals such as dicalcium phosphate dihydrate, octacalcium phosphate, and ultimately hydroxyl-apatite (Leytem and Mikkelsen, 2005). Consequently, rock phosphate is chemically processed with sulphuric acid or phosphoric acid into soluble phosphate fertilizers (Van Straaten, 2002). The production of P-soluble fertilizers, such as superphosphate requires higher energy consumption, specific strategies, and conduction of researches for the establishment of efficient and economic use of rock phosphates (Stamford *et al.,* 2003).

Water pH is still important for crop and tree management because of it affects on solubility of fertilizers and the efficiency of insecticides. Application of sulfuric acid to irrigation water increased soil acidity, available P, other macro and micronutrients and crop yield. The change in soil pH is the most important cause of improved nutrient availability and thus crop yield. Leaching after acid application is highly beneficial in decreasing salinity throughout germination and seedling stages and therefore has a direct impact on the yield. Kafkafi and Tarchitzky, (2011) stated that the high soil pH limits nutrient supply and plant growth. The objective of soil acidification is to decrease soil pH to improve crop performance and increase economic returns. In fertigation, phosphoric acid is used to clean fertigation lines from inorganic precipitates as well as opening clogs in drippers, and at the same time supplying P to growing plants.

So, the aim of this investigation was to study the effect of three P fertilizer sources super or rock phosphate and without P fertilization (control) with irrigation by acidic water on growth, yield, nutritional status and fruit quality of "Florida Prins" peach cultivar trees grown in clay loam soil, to find out the best one.

MATERIALS AND METHODS

The current study was undertaken in special farm at Sobic Village, Ashmoon, Monofia Governorate, Egypt. This study has been extended for two consecutive seasons of 2012 and 2013 on 7- year- old peach trees 'Florida Prins' cv. budded on Nemagard rootstock, planted at 5 meters in a square system and grown in clay loam soils. Irrigation system used was flood irrigation. Selected trees were healthy, nearly uniform as possible in their vigour and use exporters of phosphate fertilizer and different rates of acidic water irrigation. 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 Tables (1a and 1b)

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

Seasons	pH*	EC dS m^{-1}**	OM	$CaCO_3$	C. sand	F. sand	Silt	Clay	Soil texture
			%						
2012:2013	8.15	1.25	1.70	3.97	1.35	30.85	33.50	34.30	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)		
2012:2013	3.99	2.85	4.95	0.66	0.00	3.98	4.45	4.02	38.45	7.65	324.25

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, in which the main treatments were devoted for P fertilizer sources while the sub-ones included irrigation by acidic water. Twenty seven trees were devoted and the split design was used, each replicate was represented by a single tree. Such treatments were as follows:-

1-Phosphorus fertilizer sources was tested as follow:

a-Superphosphate (15.0 % soluble water P_2O_5) at 2.0 kg /tree.

b- Rock phosphate (6.25% total P_2O_5) at 4.8 kg /tree.

c- Without phosphorus fertilization (control).

Phosphorus fertilizers were added once a year at the third week of January in both seasons of study .

2-irrigation by acidic water:

Irrigation by acidic water was practiced with three levels i.e., irrigation with 5 and 10 litter's sulphoric acid/fed., as well as irrigation without sulphoric acid.

Nitrogen at 1250 g/ tree as ammonium sulphate (20.6 % N) and potassium at 550 g/ tree as potassium sulphate (48 % K_2O) were divided and applied in three portions in the third week of October, second week of February and mid- April with 250, 750 and 250 for ammonium sulphate and 250, 150 and 150 g/ tree for potassium sulphate, respectively. Four main branches well distributed around the periphery of tree (one branch on each direction) were selected and tagged for the following measurements:

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

2-Fruiting aspects: a- fruit set: Percentage number of flowers and set fruitlets on the tagged branches were counted and recorded in all treatments where fruit set % was calculated to according the following equation to (Westwood, 1978) as follows:

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

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

3-Fruit quality: at harvesting time (maturity stage), ten fruits from each treated tree were randomly sampled and the following fruit characteristics were determined: average values of fruit weight (g), fruit size (cm^3), fruit dimensions (fruit length and width in cm.), fruit shape index (fruit length/fruit width ratio) and fruit firmness (Ib/inch2) was determined using pressure tester with 7/18 inch plunger according to Magness and Taylor (1925). Furthermore, fruit chemical properties were also estimated including average percentage of fruit juice (TSS %) by hand refractometer, according to A.O.A.C (1985), fruit juice acidity (%)as malic acid (mg/100 mg juice) according to Vogel (1968), TSS/ acid ratio was calculated and total sugars content was determined as mg/100 g pulp of fresh fruit according to Dubasit *et al.,* (1956).

Leaf and fruit samples were 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. Obtained data during the two studied seasons of 2012 and 2013 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

1-Vegetative growth and fruit parameters

Available data in Table (2) show that the highest significant values of fruit size and dimensions were recorded by superphosphate compared to without P addition in both seasons. The same treatment led to significant increase in number of fruits /tree, fruit weight and firmness in the second season only, while, number of leaves / shoot and fruit shape index were in the first one. The same trend was observed by rock phosphate for number of leaves /shoot, fruit size, fruit weight, fruit firmness and fruit shape index in the first season, and fruit dimensions in the 2^{nd} one only. On the other hand, the lowest ones were obtained without applying phosphorus fertilizer in both seasons. Also, results reveal that, same trend was observed by rock phosphate for fruit firmness, fruit weight and number of fruits /tree in the 2^{nd} season, and fruit dimensions in the 1^{st} one only. Oppositely, shoot length wasn't affected by P addition in both seasons, while, number of fruits /tree in the 1^{st} season and number of leaves / shoot and fruit shape index were increased in the second one. The positive effect of phosphorus fertilizer addition on the aforementioned studied vegetative growth and fruit parameters may be attributed to the fact that phosphorus is an essential of several necessary cell components like nucleotides, nucleic acids, and phospholipids as well as P promote root development, early flowering and ripening. Pasandideh, *et al.,* (2010) suggested that the application of phosphate fertilizers is a common practice to correct P-deficiency in plants.

Presented data in Table (2) illustrate that the addition of sulphoric acid to irrigation water at both rates gave the highest significant values of the previously mentioned parameters compared to without application of sulphoric acid to irrigation water in both seasons. Whereas, fruit dimensions wasn't affected significantly by adding sulphoric acid to irrigation water in the first seasons only. Such results may be due to the fact that soils of high pH, calcium are the main element involved. The rate at which calcium phosphate compounds release P to growing plants depends on the chemical nature of these compounds as well as the texture and soil surface area. Irrigation by acidic water seems to play a significant function in decreasing soil pH values, so it may be helpful in increasing the solubility of P from native supply or P fertilizer sources.

With regard to the interaction effect between P sources and irrigation by acidic water on some growth parameters of peach tree, in most cases, results show that the addition of sulphoric acid to irrigation water with super or rock phosphate gave the highest significant values of shoot length, number of leaves / shoot, fruit size, weight, dimensions and fruit shape index compared to without acidic water with super or rock phosphate or without P addition in both seasons. Fruits number /tree was significantly improved by adding low level of acidic water to superphosphate in both seasons, while, the lowest one was recorded by superphosphate without acidic water with in the first season and without P addition in the second one. Fruit firmness was significantly increased with irrigation by acidic water combined with rock phosphate or without P fertilizer in the first season, while, the lowest one was recorded by super or rock phosphate with acidic water in the first one. In the second season, irrigation by acidic water with super or rock phosphate led to the highest significant value of fruit firmness, while, it was decreased by adding 2^{nd} level of acidic water to super or rock phosphate. Rock and/or superphosphate combined with sulphoric acid, will release phosphorus from them and can replace P-fertilizer. In addition, irrigation by acidic water, which in turns converts unavailable soil P to available forms. In this connection, Sheng and Huang, (2002) found that direct application of rock phosphate may be agronomical more useful and environmentally more feasible than soluble P.

2-Yield and fruit quality

Presented data in Table (3) illustrate that the two P sources induced significant increases in fruit yield / tree, yield, TSS (%),Fruit juice acidity (%), and fruit length relative to without P addition (control) in favor of superphosphate fertilizer which out yielded more fruit yield (kg) / tree and yield t/ fed., than rock phosphate in both seasons. The same trend was obtained with fruit set % and TSS/acid ratio compared to control in the second season only. Total sugars % was significantly improved by adding rock phosphate, while the lowest one was recorded by control treatment (without P fertilizer) in the first season only. On the other hand, fruit set % and total sugar % weren't affected by P sources addition in the first and second seasons, respectively. This might be due to that P is necessary for production of high quality fruits, since it occurs as co-enzymes involved in energy transfer reactions, energy utilization in photosynthesis in form of ATP and NADP, this energy is then used in photosynthesis of lipids and other essential organic compounds. Also phosphorus is considered as a component of nucleic acids, which are necessary for protein synthesis. Similar finding was obtained by He *et al.,* (2005) and Hopkins & Ellsworth, (2006) T 2

T3

Concerning the effect of irrigation by acidic water on peach yield and its quality, results in Table (3) show that the fruit set % , fruit yield (kg)/tree and fruit yield t/fed., were increased significantly with adding both levels from sulphoric acid to irrigation water relative to without acid addition in both seasons. At the same time, both levels gave the highest significant values of fruit juice acidity % and TSS/acid ratio compared to without acid addition in the second season only, while total sugar % was significantly increased with or without low level from applying sulphoric acid to irrigation water relative to the highest level in the second season. Whereas, the highest level of acid addition gave significant increases of fruit length compared to low level in the first one. On the other hand, other parameters weren't affected by irrigation with acidic water. The aforementioned results may be due to the fact that the addition of acidic water is very important for ensuring sufficient nutrient supply to the peach trees. If it is found suitable conditions for their growth, they can be very efficient in dissolving macro and micronutrients and making them available to trees.

As for the interaction effect between factors under study on peach yield and its quality, available data in Table (3) reveal that the addition of sulphoric acid to irrigation water at two rates with superphosphate gave the highest significant values of fruit yield kg / tree, yield t/ fed., fruit set %, TSS %, total sugar %, and fruit length in both seasons, fruit juice acidity % in the first season only, TSS/acid ratio in the second one. The same trend was observed by both level of acidic water with rock phosphate for TSS % and total sugar % in both seasons, fruit juice % in the first season as well as TSS/acid ratio and fruit length in the second season. Conversely, in most cases, the lowest significant values of all parameters were detected without sulphoric acid and without P fertilizer in both seasons. Irrigation by acidic water seems to play an important role in reducing soil pH values; consequently it can be supportive in increasing the solubility of P from rock phosphate. In this respect, Tibbett and Diaz, (2005) reported that the combining phosphate rock with elemental sulphur is resulted in the production of mineral acids which will create a localized high acidity in the immediate vicinity of rock phosphate.

3-Macro and micronutrients of peach fruit

Results in Table (4) demonstrate that superphosphate gave the highest significant values of P and K (%) as well as Fe, Mn and Cu (ppm) of peach fruit in both seasons, the same trend was observed for N % in the first season only. Alternatively, the lowest ones were obtained by using rock phosphate in both seasons. N % and Zn ppm weren't affected significantly by P sources addition in the second season only. Phosphorus is one of the major elements in plant nutrition and crop productivity, contributing in many biochemical processes and energy translocation. Also, P is a constituent of cell nucleic acids (Pasandideh, *et al.,* 2010).

Tabulated data in Table (4) show that in most cases, the two levels of sulphoric acid added to irrigation water gave the highest significant values of the studied parameters compared to without addition of acidic water in both seasons. This may be due to fixation of the initially dissolved P by calcium which was dissolved by the acid treatment. The results indicated that the potential use of sulfuric acid with irrigation water for increasing P availability and hence plant growth on P deficient soils.

Regarding the interaction effect between factors under study on macro and micronutrients content of peach fruit, data reveal that in most cases, adding two levels of acidic water with super phosphate or without P fertilizer gave the highest significant values of all parameters compared to without addition of acidic water with or without P fertilizer in both seasons. The sulphuric acid applied to irrigation water reacted with the rock phosphate increased the available P and lowered pH near plant roots. The advantages of using sulfuric acid for improving P availability are further enhanced macro and micro element occurs in soils. The beneficial effects of rock phosphate application along with sulphuric acid improved nutrient availability (P, Fe, Zn and other nutrients) and in turn uptake of these nutrients by plants. It is needed to evaluate and compare the effects of sulphuric acid application in plant growth and in soil reaction to P soluble fertilizers and rock phosphate, because the sulphuric acid produced reaction could act in the rock phosphate solubilization and in the soil reaction reducing soil pH, and that could hamper plant growth (Stamford *et al.,* 2003).

4-Macro and micronutrients of peach leaves

Results in Table (5) reveal that the highest significant values of leaves N, P and K % as well as Fe ppm were obtained with superphosphate followed by the rock one in both seasons, while, Mn and Zn ppm were increased significantly by using rock phosphate followed by the super one in both and the second season, respectively. On the other hand, the lowest ones were recorded without addition of P fertilizer in both seasons. Zn and Cu ppm weren't affected by adding P fertilizer in the second and both seasons, respectively. Phosphorus seems that it stimulates young root development and earlier fruiting. It is essential in several bio-chemicals that control photosynthesis, respiration, cell division, and many other plant growth and development processes. P is concentrated in the fruit, and strongly affects fruit formation. Since the main functions of P involve energy and growth regulation, deficiencies affect vegetative growth and yield more than quality, but in fruit crops, quality can also be affected.

Macro and micronutrients content of peach leaves were increased significantly with irrigation of two acidic water levels compared to without acidic one in both seasons. The advantages of using sulfuric acid with irrigation water for improving P availability are further enhanced when micro element deficiencies occur in soils.

T 4

T5

Respecting the interacted factors effect under study on macro and micronutrients content of peach leaves, results show that the N, P and K % as well as Fe ppm content of peach leaves improved significantly by adding two acidic water levels with superphosphate in both seasons. While, Mn and Zn ppm increased significantly by using two acidic water for rock phosphate in both ones, whereas, adding two acidic water levels to super or rock phosphate or without P fertilizer gave the highest significant value of Cu ppm of peach leaves. Vice versa, in most cases, the lowest ones were recorded without acidic water addition with super or rock phosphate or without P fertilizer in both seasons. This may be due to the favorable effect of such acids in increasing the solubility of P from rock phosphate. In this respect (Marschner *et al.* 1995) pointed out that plant excrete organic acids such as citric, oxalic and tartaric acid vicinity in root zone to improve phosphorus solubility and availability in rhizosphere.

CONCLUSION

From the above mentioned results, it can be conclude that the amount of available P from rock phosphate could be increased by adding sulphoric acid to irrigation water. The applications of such acid could be successfully used for increasing P-availability from rock phosphate as well as improving peach yield and its fruit quality.

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تـأثير التسـميد الفوسـفاتى علـى النمـو والمحصـول و جـودة ثمـار اشـجار الخـوخ المروية بالماء المحمض

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اقيمت هذه التجربة خلال موسمى ٢٠١٢ و ٢٠١٣على اشجار الخوخ صنف فلوريدا برنس المطعوم على اصول النيماجارد ، كان عمر الاشجار سبع سنوات نامية فى قرية سبك مركز اشمون محافظة المنوفية –مصر وتهدف هذه التجربه لدراسة تاثير اضافة مصادر مختلفة من التسميد الفوسفاتى: السوبر فوسفات ١٥فو٢ أ٥ % ذائب فى الماء بمعدل ٢ كجم /شجرة من و صخر فوسفات ٦,٢٥فو٢ أ٥ % كلى بمعدل ٤,٨كجم /شجرة من و بدون اضافة اسمدة فوسفاتية مع رى الاشجار بماء محمض بمعدلات مختلفة من حامض الكبريتيك (بدون و ٥ و ١٠ لتر للفدان مع ماء الرى) وذلك على بعض صفات النمو وقياسات الثمرة ومحتوى العناصر الغذائية فى الثمار والاوراق والمحصول وجودة الثمار لاشجار الخوخ صنف فلوريد برنس. وكانت اهم النتائج كما يلى: اعطى كل من مصدرى الفوسفات السوبر والصخر اعلى زيادة معنوية فى بعض صفات النمو وقياسات الثمرة ومحتوى العناصر الغذائية فى الثمار والاوراق لاشجار الخوخ مقارنة بمعاملة الكنترول (بدون اضافة اسمدة فوسفاتية) مع وجود افضلية للسوبر عن صخر الفوسفات حيث اعطى افضل محصول للشجرة وللفدان فى كلا الموسمين٠ ايضا تشير النتائج الى تحسن فى جودة الثمار (الخواص الطبيعية والكيميائية للثمرة) ومحتوي الثمار والاوراق لاشجار الخوخ من المغذيات الكبرى والصغرى نتيجة للرى بالماء المحمض مقارنة بغير المحمض (الرى العادى) ٠ بالاضافة الى زيادة معنوية فى كمية ونوعية الثمار ومحتواها هى والاوراق من المغذيات الكبرى (نيتروجين – فوسفور – بوتاسيوم) والصغرى (حديد – منجنيز – زنك – نحاس) نتيجة اضافة حامض الكبريتيك مع مياه الرى لكل من السوبر والصخر من خلال التحليل الاحصائى للموسمين ٢٠١٢ و٢٠١٣ ٠

وبناءا على نتائج هذه الدراسة فانه يفضل تسميد اشجار الخوخ صنف فلوريد برنس بالفوسفور فى صورتيه تحت الدراسة مع الرى بالماء المحمض للحصول على هعلى انتاجية للاشجار مع تحسين فى صفات جودة الثمار.

قام بتحكيم البحث

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Table (2) Effect of P sources and irrigation by acidic water on some vegetative growth and fruit parameters of peach tree (2012 and 2013 seasons)

Treatments	shoot length (cm)		number of leaves / shoot		number of fruits /tree		fruit size (cml^3)		fruit weight (gm)		fruit dimensions		fruit shape index		fruit firmness ($lb/inch^2$)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Without P addition (W P)	13.92	13.77	18.04 B	25.39	346.8	362.0 B	92.40 B	74.50C	97.19 B	68.88 B	3.95 B	5.22B	0.972 B	0.969	12.76 A	11.90AB
Superphosphate (S P)	15.36	14.39	19.29 A	26.66	368.4	399.1 A	108.8 A	103.7A	96.16 B	101.5 A	5.20 A	5.43AB	1.049AB	0.992	10.69 B	13.27A
Rook phosphate (R P)	14.42	14.31	18.94 A	24.49	369.3	360.4 B	106.6 A	90.62B	103.1 A	80.91 B	4.09 B	5.60 A	1.089 A	1.014	11.58AB	11.18 B
LSD at 5%	NS	NS	0.67	NS	NS	31.36	10.72	9.402	4.365	14.47	0.185	0.307	0.1014	NS	1.182	1.503
Without acidic water (N W)	13.06 B	12.96 B	17.03 B	21.06B	309.6 B	310.7 C	89.67 B	74.64 C	86.51 B	65.12 C	4.344	5.27B	1.009 B	0.968 B	10.67 B	11.52B
2.5 L/ fed., sulphoric acid	15.48 A	14.82 A	19.78 A	28.07 A	403.9 A	429.3 A	110.3 A	102.9 A	106.1 A	99.43 A	4.478	5.58A	1.033 B	1.036 A	12.09 A	11.54B
5 L /fed., sulphoric acid	15.17 A	14.69 A	19.47AB	27.41 A	371.1 A	381.6 B	107.9 A	91.28 B	103.9 A	86.78 B	4.422	5.41AB	1.068 A	0.972 B	12.27 A	13.28A
LSD at 5%	1.158	1.009	2.489	2.777	40.15	20.58	5.998	5.935	4.176	8.219	NS	0.260	0.03248	0.056	0.9749	0.8426
(W P) + (N W)	12.83 D	13.03C	16.77 AB	19.03 B	331.3 B	303.7 FG	91.00 B	75.67DE	97.00 C	60.40E	3.900 B	5.10D	0.910 E	0.907D	11.60BC	12.17B
(W P)+ 2.5 L/ fed	14.60BCD	14.17ABC	18.87 AB	29.33 A	359.0 B	379.0 CD	95.00 B	81.00 D	97.50 C	77.07CD	4.067 B	5.43BCD	1.000 D	1.007ABC	13.17AB	10.60C
(W P) + 5 L/ fed	14.33 CD	14.10ABC	18.50 AB	27.80 A	350.0 B	403.3 BC	91.20 B	66.83 E	97.07 C	69.17DE	3.900 B	5.13 D	1.007 CD	0.993ABCD	13.50 A	12.93AB
(S P)+ (N W)	12.83 D	12.67C	16.33 B	25.00 A	257.0 C	277.0 G	88.00 B	75.40DE	65.53 D	66.63DE	5.100 A	5.63ABC	1.030 CD	0.957BCD	9.533 D	12.67AB
(S P) + 2.5 L/ fed	16.63 A	15.33A	20.97 A	27.53 A	468.7 A	505.3 A	120.0 A	120.0 A	113.9 A	132.2 A	5.367 A	5.47ABCD	1.057 BC	1.037ABC	11.47 C	13.90A
(S P) + 5 L/ fed	16.60 AB	15.17A	20.57 AB	27.43 A	379.7 B	415.0 B	118.5 A	115.7AB	109.0AB	105.8 B	5.133 A	5.20 CD	1.060 BC	0.983ABCD	11.07 CD	13.23AB
(R P) + (N W)	13.50 CD	13.17BC	18.00 AB	19.13 B	340.3 B	351.3 DE	90.00 B	72.87DE	97.00 C	68.33 DE	4.033 B	5.07D	1.087 AB	1.040AB	10.87 CD	9.733C
(R P)+ 2.5 L/ fed	15.20ABC	14.97A	19.50 AB	27.33 A	384.0 B	403.7 BC	116.0 A	107.7 B	106.8AB	89.00 C	4.000 B	5.83AB	1.043 BCD	1.063A	11.63 BC	10.13 C
(R P) + 5 L/ fed	14.57CD	14.80AB	19.33 AB	27.00 A	383.7 B	326.3 EF	113.9 A	91.33 C	105.6 B	85.40 C	4.233 B	5.90 A	1.137 A	0.940CD	12.23ABC	13.67 A
LSD at 5%	2.006	1.748	4.311	4.810	69.54	35.64	10.39	10.28	7.234	14.24	0.356	0.45	0.056	0.097	1.689	1.459

N W = normal water
A W = Acidic water

Table (3) Effect of P sources and irrigation by acidic water on yield and some fruit quality parameters of peach tree (2012 and 2013 seasons)

Treatments	fruit yield kg / tree		yield (tons/fed)		fruit set %		TSS (%)		Fruit juice acidity (%)		TSS/ acid ratio		total sugars %		fruit length	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Without P addition (W P)	29.66 C	24.23 C	7770 C	6349 C	44.74	48.67 B	8.40 B	8.61 B	0.130 C	0.2333A	64.93 A	38.53B	12.33 C	13.78	4.278 B	5.056 B
Superphosphate (S P)	45.34 A	43.51A	11880 A	11400 A	49.07	54.57 A	9.28 AB	9.94A	0.220 A	0.1989AB	43.98 B	50.14 A	13.52 B	14.22	5.056 A	5.522 A
Rook phosphate (R P)	37.87 B	32.48 B	9921 B	8509 B	49.03	51.21 AB	9.67 A	9.34AB	0.201 B	0.1678 B	51.98 B	53.98 A	14.44 A	14.39	4.300 B	5.667 A
LSD at 5%	1.526	3.030	399.8	793.9	NS	5.723	1.05	0.796	0.001	0.04139	9.567	3.912	0.7896	NS	0.3487	0.2927
Without acidic water (N W)	27.29 B	21.92 C	7150 B	5744 C	39.29 B	40.77 B	9.08	9.22	0.180	0.1678 C	53.73	42.59 B	13.24	14.72 A	4.511AB	5.400
2.5 L/ fed., sulphoric acid	43.09 A	43.10 A	11290 A	11290 A	54.06 A	59.16 A	9.41	9.11	0.201	0.2378A	50.22	50.06 A	13.22	14.00 AB	4.456 B	5.600
5 L /fed., sulphoric acid	42.49 A	35.20 B	11130 A	9222 B	49.50 A	54.52 A	8.86	9.61	0.170	0.1944 B	56.93	50.01 A	13.83	13.67 B	4.667 A	5.244
LSD at 5%	3.866	4.048	1013	1061	6.212	5.493	NS	NS	NS	0.001	NS	7.421	NS	0.821	0.1894	NS
(W P) + (N W)	16.70 D	18.43 E	4375 D	4830 E	38.90 CD	44.67 D	8.40 B	8.50 B	0.130 C	0.167F	64.67 AB	31.47 C	12.67 B	15.33 A	4.233 BC	5.133CD
(W P)+ 2.5 L/ fed	34.97 BC	29.30CD	9161 BC	7677 CD	49.03 BC	51.47CD	8.90 AB	9.00 B	0.130 C	0.327A	69.13 A	43.57BC	12.17 B	14.00 A	4.200 BC	4.933 D
(W P) + 5 L/ fed	37.30 BC	24.97 DE	9772 BC	6541 DE	46.30 BC	49.87CD	7.90 B	8.33 B	0.130 C	0.207C	61.00 AB	40.57BC	12.17 B	12.00 B	4.400 BC	5.100CD
(S P)+ (N W)	33.03 C	23.97 DE	8655 C	6279 DE	33.10 D	31.53 E	9.50 AB	9.83AB	0.180 BC	0.200 D	55.00 BC	49.60AB	13.23 B	14.50 A	5.133 A	5.800AB
(S P) + 2.5 L/ fed	53.37 A	64.03 A	13980 A	16780 A	62.20 A	70.13 A	9.00 AB	9.00 B	0.230 AB	0.187 E	39.00 D	48.33AB	13.67AB	14.00 A	4.933 A	5.667 ABC
(S P) + 5 L/ fed	49.63 A	42.53 B	13000 A	11140 B	51.90 AB	62.03AB	9.33 AB	11.00 A	0.250 A	0.210 B	37.93 D	52.50AB	13.67AB	14.17 A	5.100 A	5.100 CD
(R P) + (N W)	32.13 C	23.37DE	8419 C	6122 DE	45.87 BC	46.10 D	9.33 AB	9.33AB	0.230 AB	0.137 G	41.53 D	46.70AB	13.83AB	14.33 A	4.167 C	5.267BCD
(R P)+ 2.5 L/ fed	40.93 B	35.97 BC	10720 B	9423 BC	50.93 B	55.87 BC	10.33 A	9.33AB	0.243 A	0.200 D	42.53 CD	58.27 A	13.83AB	14.00 A	4.233 BC	6.200 A
(R P) + 5 L/ fed	40.53 B	38.10 B	10620 B	9982 B	50.30 B	51.67CD	9.33 AB	9.50AB	0.130 C	0.167 F	71.87 A	56.97 A	15.67 A	14.83 A	4.500 B	5.533BCD
LSD at 5%	6.696	7.011	1754	1837	10.76	9.515	1.673	1.978	0.056	0.001	12.80	12.85	2.086	1.422	0.3280	0.629

Table (4) Effect of P sources and irrigation by acidic water on macro and micronutrients content of peach fruit (2012 and 2013 seasons)

Treatments	N %		P %		K %		Fe ppm		Mn ppm		Zn ppm		Cu ppm	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Without P addition (W P)	1.403 AB	1.378	0.232 B	0.229 B	0.196 C	0.198 B	85.27 A	85.16 A	4.009 A	3.978 A	7.672 A	7.411	3.928AB	4.344 A
Superphosphate (S P)	1.451 A	1.443	0.243 A	0.242 A	0.220 A	0.221 A	84.90 A	84.68 A	3.801 A	3.756 A	7.571 A	7.522	4.206 A	4.078 A
Rook phosphate (R P)	1.377 B	1.348	0.228 C	0.228 B	0.199 B	0.189 C	81.04 B	81.38 B	2.866 B	2.922 B	7.183 B	7.578	3.649 B	3.600 B
LSD at 5%	0.072	NS	0.001	0.001	0.001	0.0019	0.893	1.617	0.307	0.7240	0.245	NS	0.315	0.403
Without acidic water (N W)	1.180 C	1.166 C	0.211 C	0.226 C	0.192 C	0.190 B	80.23 B	80.90 B	2.641 C	2.644 B	5.681 C	5.544 C	3.432 C	3.533 C
2.5 L/ fed., sulphoric acid	1.398 B	1.374 B	0.249 A	0.242 A	0.223 A	0.229 A	86.06 A	85.72 A	3.753 B	3.756 A	8.729 A	9.000 A	3.740 B	3.978 B
5 L /fed., sulphoric acid	1.653 A	1.629 A	0.243 B	0.231 B	0.199 B	0.189 C	84.93 A	84.59 A	4.281 A	4.256 A	8.017 B	7.967 B	4.610 A	4.511 A
LSD at 5%	0.001	0.056	0.001	0.001	0.001	0.001	1.354	1.960	0.4083	0.5774	0.195	0.518	0.181	0.3951
(W P) + (N W)	1.183 H	1.167 C	0.210 H	0.213 G	0.173 F	0.177 G	83.77 C	83.10BC	2.560DE	2.600 D	6.023 E	5.833 E	3.027 F	3.300 C
(W P)+ 2.5 L/ fed	1.247 F	1.220 C	0.233 E	0.227 F	0.210 C	0.227 B	87.68 A	87.02 A	4.490 AB	4.467 AB	8.057 C	7.700 D	3.580 DE	4.667 A
(W P) + 5 L/ fed	1.780 A	1.747 A	0.253 B	0.247 B	0.203 D	0.190 F	84.37 BC	85.37AB	4.977 A	4.867 A	8.937 B	8.700 BC	5.177 A	5.067 A
(S P)+ (N W)	1.197 G	1.193 C	0.210 H	0.233 D	0.193 E	0.193 E	80.73 D	82.07 BC	2.957 DE	2.900 CD	5.970 E	5.733 E	3.980 C	3.833 BC
(S P) + 2.5 L/ fed	1.447 E	1.427 B	0.270 A	0.260 A	0.233 A	0.243 A	86.15 AB	85.15 AB	3.837 BC	3.733 BC	8.820 B	8.867 B	4.037 C	3.900 BC
(S P) + 5 L/ fed	1.710 B	1.710 A	0.250 C	0.233 D	0.233 A	0.227 B	87.82 A	86.82 A	4.610 A	4.633 AB	7.923 C	7.967 CD	4.600 B	4.500 AB
(R P) + (N W)	1.160 I	1.137 C	0.213 G	0.230 E	0.210 C	0.200 D	76.20 E	77.53 D	2.407 E	2.433 D	5.050 F	5.067 E	3.290 EF	3.467 C
(R P)+ 2.5 L/ fed	1.500 C	1.477 B	0.243 D	0.240 C	0.227 B	0.217 C	84.33 BC	85.00 AB	2.933 DE	3.067 CD	9.310 A	10.43 A	3.603 D	3.367 C
(R P) + 5 L/ fed	1.470 D	1.430 B	0.227 F	0.213 G	0.160 G	0.150 H	82.60 CD	81.60 C	3.257CD	3.267 CD	7.190 D	7.233 D	4.053 C	3.967 BC
LSD at 5%	0.002	0.097	0.002	0.002	0.002	0.002	2.345	3.395	0.707	1.000	0.338	0.896	0.313	0.684

Table (5) Effect of P sources and irrigation by acidic water on macro and micronutrients content of peach leaves (2012 and 2013 seasons)

Treatments	N %		P %		K %		Fe ppm		Mn ppm		Zn ppm		Cu ppm	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Without P addition (W P)	2.27 C	2.31 C	0.308 B	0.301 C	2.299 B	2.314 B	212.7 B	215.6 C	23.98 B	25.03 B	36.29	36.08 A	14.15	13.58
Superphosphate (S P)	3.05 A	3.08 A	0.361 A	0.354 A	2.583 A	2.497 A	245.3 A	246.2 A	24.93 B	25.83 B	33.90	34.33 B	14.07	13.58
Rook phosphate (R P)	2.89 B	2.90 B	0.311 B	0.319 B	2.180 B	2.246 B	212.8 B	224.9 B	27.00 A	28.01 A	35.81	36.56 A	13.87	13.52
LSD at 5%	0.15	0.041	0.041	0.001	0.176	0.124	9.788	3.61	1.292	1.303	NS	1.50	NS	NS
Without acidic water (N W)	2.66 B	2.62 C	0.252C	0.238 C	2.221 B	2.172 C	221.0 B	217.4 C	24.45 B	24.68 C	32.38 B	31.64 C	12.59 B	10.67 B
2.5 L/ fed., sulphoric acid	2.83 A	2.88 A	0.362 B	0.361 B	2.419 A	2.370 B	229.0 A	239.1 A	25.41AB	26.50 B	35.99 A	37.17 B	14.13AB	14.61 A
5 L /fed., sulphoric acid	2.72 AB	2.78 B	0.366 A	0.376 A	2.422 A	2.514 A	220.8 B	230.1 B	26.06 A	27.68 A	37.63 A	38.16 A	15.36 A	15.41 A
LSD at 5%	0.12	0.032	0.001	0.001	0.1027	0.0563	3.825	3.275	1.457	0.95	1.793	0.889	1.646	0.891
(W P) + (N W)	2.26 C	2.29 E	0.250 G	0.240 H	2.183 CD	2.170 D	210.7 D	213.3 DE	21.24 E	23.08 E	34.40C	33.63 D	12.45BC	10.95B
(W P)+ 2.5 L/ fed	2.27C	2.31 E	0.347 D	0.327 F	2.343 BC	2.253 CD	211.3 D	215.0 D	24.15 CD	24.87 D	35.10BC	35.83 C	14.50AB	14.58A
(W P) + 5 L/ fed	2.28 C	2.32 E	0.327 E	0.337 E	2.370 B	2.520 B	216.0 D	218.3 D	26.55 ABC	27.15 BC	39.37 A	38.77 B	15.50A	15.22A
(S P)+ (N W)	2.89 B	2.87 C	0.270 F	0.227 I	2.357 BC	2.157 D	242.7 B	231.0 C	26.77 AB	25.32 D	32.47 CD	31.47 E	13.68ABC	11.07 B
(S P) + 2.5 L/ fed	3.10 A	3.22 A	0.393 B	0.403 B	2.727 A	2.637 A	260.0 A	266.3 A	25.04 BCD	26.05 CD	34.87 C	36.17 C	13.85ABC	14.50 A
(S P) + 5 L/ fed	3.15 A	3.15 B	0.420 A	0.433 A	2.667 A	2.697 A	233.3 C	241.3 B	23.00 DE	26.12 CD	34.37 C	35.37 C	14.67AB	15.17 A
(R P) + (N W)	2.83 B	2.71 D	0.237 H	0.247 G	2.123 D	2.190 D	209.7 D	208.0 E	25.33 BCD	25.65 CD	30.27 D	29.83 F	11.65 C	10.00 B
(R P)+ 2.5 L/ fed	3.12 A	3.10 B	0.347 D	0.353 D	2.187 CD	2.220 D	215.7 D	236.0 BC	27.04 AB	28.58 AB	38.00AB	39.50 AB	14.03ABC	14.73 A
(R P) + 5 L/ fed	2.72 B	2.88 C	0.350 C	0.357 C	2.230BCD	2.327 C	213.0 D	230.7 C	28.63 A	29.78 A	39.17 A	40.33 A	15.92 A	15.83 A
LSD at 5%	0.21	0.056	0.002	0.002	0.1779	0.097	6.625	5.672	2.52	1.638	3.106	1.540	2.850	1.543