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Quantitative and Qualitative Effects of Nutrient Applications and Irrigation Methods on Apricot

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Abstract: In order to realize how various nutrient applications as well as conventional irrigation methods influence the yield and quality of this crop, a factorial experiment in Randomized Complete Blocks Design (RCBD) base with three replications was conducted in two locations (in Sahand Horticultural Research Station and Marand region), which lasted for four years as of 2004 through 2008. The highest yield (47.2ton/ha) was produced during year 3 of the experiment in the presence of Nitrogen in Marand region. Similarly, application of Nitrogen, Phosphorus and Potassium to the soil in the same region led to highest yield during year 4. Furthermore, fruits produced in N-fertilizer treatment produced highest length by averaging 3.71cm, whereas during year 4 of the experiment in Marand, the longest fruit (4cm) produced in the presence of Phosphorus element. Interestingly, fertilizer use efficiency (FUE) was measured the highest with drip irrigation and with application of elements such as Phosphorus, Iron and Zinc. In addition, leaf area was significantly higher with drip irrigation method than with surface irrigation method. Last but not least, the highest leaf area and dissolved solids content were achieved during the year 1 of experiment at Sahand Station. Moreover, drip irrigation method proved more productive of dissolved solids in fruit than surface irrigation method. The highest fruit length (3.38cm) was measured during year 2 of the experiment in the presence of Nitrogen at Sahand Station; whereas the hardest fruit texture (10.53Kg/cm^2) was estimated during year 2-3 of the experiment in the presence of Zinc sulfate in Marand region. Furthermore, the highest chlorophyll content was estimated during year 1 of the experiment in the presence of iron chelate at Sahand Station. Nitrogen application produced the highest acidity. It also led to highest yearly longitudinal growth in year 2 of the experiment in Marand region. Finally, highest sugar content and leaf Nitrogen concentration were achieved in the presence of Nitrogen.

Key words: Apricot (*Prunus armeniaca* L.) · Drip irrigation · Iron · Nitrogen · Phosphorus · Potassium · Zinc and surface irrigation

INTRODUCTION

Apricot (*Prunus armeniaca* L.) is one of the most intensively cultivated horticultural crops in East Azerbaijan Province, Iran. The province have 10246ha under apricot cultivation (28% of overall land area under apricot cultivation in the country), which makes it first rank in the country. With up to 32000ha under apricot cultivation and production of 8.9ton/ha of apricot, Iran ranks fourth in the world after Greece, USA and Pakistan (1). Apricot's production increase can be greatly influenced by correct modifications on current methods of fertilizer application in the orchards of the region, endeavors for evermore balanced use of fertilizers and improved irrigation methods in horticulture. As a success story we can mention findings by Marinov (1995) who produced the highest yield of apricot by using 300Kg of N, 160Kg of P_2O_5 and 200Kg of K_2O per hectare. In addition, P application had the lowest increasing effect on yield (fruit) in these treatments.

Use of mineral fertilizer is the quickest way of increasing crop production, their ever increasing demand in Iran coupled with unprecedented price hike and their availability at proper time deter the farmers from using them in recommended quantities and balanced proportion. Using higher proportion of nitrogen along with improved

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varieties, the resulting higher yield also remove ever larger amount of soil nutrient if not replenished will reduce fertilizer use efficiency and will resulting in stagnating and even declining the yield [1, 2].

Apricot trees are highly sensitive to drought stress at particular phenological stages, such as stage III of fruit growth and during the 2 months after harvest (early postharvest). Apricot drought tolerance is mainly based on avoidance mechanisms, such as stomatal control, epinasty and limitation transpiration by reducing leaf area. Regulated deficit irrigation is the practice of reducing applied water at selected phenological stages less sensitive to water deficit, thus imposing plant water stress in a controlled manner and can be a feasible water saving practice for arid areas with a minimum impact on yield and fruit quality.

Moreover, Mahyoub *et al*. [1] and Ro, Jin- Myeon [3] in their experiment could successfully increase yield from 55.77 to 86.62Kg fruit per each tree in control treatment by using 1Kg of N + 350gr of Triple Superphosphate and 0.5Kg of potassium sulfate (K_2SO_4). Bussi and Amiot [4] and Wills *et al*. [5] produced the highest yield of apricot by using 150Kg/ha of ammonium nitrate. It is known that application of potassium and nitrogen in the soil significantly increases sugar content, titratable acidity as well as total dissolved solids (TDS). Furthermore, increased nitrogen through the application of NH_4NO_3 has a lowering effect on fruit Ca concentration, which in turn has a loosening effect on fruit texture.

Proper irrigation method contributes greatly to uptake and release of nutrients from soil into the roots. Drip irrigation method proves very effective in improving yield and fruit quality as well as increasing water use efficiency (WUE), as in this method water is made available in right time and right quantity to the plant and consequently the humidity within the development depth of the root is maintained in a desirable level [6]. With flooding irrigation, water distribution is mainly oriented by gravity force; whereas with drip irrigation, water distribution is three-dimensional and in all directions within the soil. Therefore, in drip irrigation elements with less mobility along the soil profile (P, K and Zn) become readily soluble in soil solution so that are readily absorbed by the root [2]. Abrisqueta *et al*. [7] and Araujo *et al*. [8] reported that in apricot cultivation, availability and uptake of elements such as phosphorus and potassium from the root development zone happens more easily with drip irrigation than with surface irrigation. Bernstein and Francois [9] in their studies concluded that in drip irrigation nutrient elements are absorbed most efficiently from the root zone as compared to other irrigation methods. Bryla *et al*. [10] argued that the absorption of phosphorus and potassium and microelements is significantly higher in drip irrigation than in surface irrigation, which is due to the optimal dissolution of these elements in wet bulb created within the root zone. Bussi *et al*. [11] reported that injection of 700gr potassium and 500gr phosphorus at the root zone of each apricot tree increased the yield by 35% as compared to control t reatment. Rettke *et al*. [12] and Radi *et al*. [13] concluded that application of 1Kg of N, 600gr of P and 500gr of K in an orchard that inherently contains 0.5% soluble organic substances as well as 8mg/Kg and 120mg/Kg of soluble phosphorus and potassium, respectively, increased yield by 28% and fruit size by 20% as compared to the control. Khamis *et al*. [14] argued that the effect of N on qualitative attributes of apricot shall come true only with sufficient coapplication of potassium. Joshi *et al*. [15] and Noe *et al*. [16] found that N application could significantly increase yearly longitudinal growth, yield, sugar rate and acidity rate of apricot; whereas it reduced the acidity of fruit's nectar. Eryuce *et al*. [17] argued that application of 2Kg of nitrogen, 0.5Kg of phosphorus and 1Kg of pure potassium per each fruit-bearing tree produced the highest effect on qualitative attributes of apricot. Eryuce [18] found that potassium and magnesium had an increasing effect on chlorophyll content and greening rate of leafs. Neilsen *et al*. [2] and Leinar, Burtoiu [6] concluded that N application at the order of more than 2.5Kg per each apricot tree had significantly loosened fruit texture. Furthermore, by addition of potassium, iron and zinc into the soil damages to 1 year-old seedling from frost were reduced by 35%. Chatzitheodorou *et al*. [19] reported that nitrogen and phosphorus had the highest effect on yield, dissolved solids content, acidity, fruit acidity of apricot; whereas potassium proved effective on increasing texture hardness and sugar content. These are consistent with findings of Aksoy [20]. Prenkic [21] argued that stone fruit trees need nitrogen more than any other nutrients, while increased amount of this element in growth environment leads to a significant increase in quantitative and qualitative factors of peach tree. Raina *et al*. [22] and Witherspoon *et al*. [3] reported that in drip irrigation the uptake of nutrients are more efficient than in surface irrigation. In drip irrigation, less water yet with required frequency is made available in root zone. This increases root ability to uptake and release mineral elements more efficiently in rhizosphere zone as a result of proper aeration in the zone. In contrast, during each time of surface irrigation waterlogging occurs at root zone and consequently poor aeration and biochemical conditions of root lead to slow availability and uptake of the elements [23, 24]. Based on forgoing discussion on the importance of abovementioned elements and irrigation systems in horticulture, in this paper the effect of elements such as N, P, K, Fe and Zn on the yield and quality of apricot under drip and surface irrigation conditions was evaluated in a four-year-long experiment.

MATERIALS AND METHODS

The experiments were conducted in two regions namely in Sahand Horticultural Research Station and Marand region as factorial in the form of RCBD with three replications, which lasted for four years. First factor was the nutrients including N, P, K, Fe, Zn and control, whereas second factor was drip and surface (flooding) irrigation methods. In total, experiment included 12 treatments, three replications and 36 experimental units. Trees used in the experiment were selected from 10 year-old Qirmiz Shahroud cultivar. Holes measuring 40 × 40 × 40 cm were dug in the orchards under the canopies. During March, before the trees began to grow, the fertilizers were added in required quantity to the holes.

Nutrients (N, P, K, Fe and Zn) found in both study regions have been listed in Table 1. The Table shows that soils of both regions are inherently deficient and poor in terms of nutrients being studied. Irrigation water of Marand region physicochemically was better than that of Sahand region (Table 2). Quantity of water required for irrigation was estimated based on evaporation rate in Class A basin and by factoring coefficients of basin and plant. Water requirement of the plant was made available in daily basis and by using water counter. During surface irrigation, water discharge rate was measured using 3-inch Parshall Flume. Irrigation cycles for drip and surface irrigation methods were one and ten days, respectively.

Fertilizers were used according to soil test (Table 2) for Sahand and Marand regions. Nutrient applications used for each fruit-bearing tree in Sahand region included 1Kg urea, 350gr triple superphosphate, 450gr potassium sulfate, 25gr iron chelate and 300gr Zn sulfate; whereas in Marand region included 1.5Kg urea, 400gr triple superphosphate, 500gr potassium sulfate, 35gr iron chelate and 350gr Zn sulfate (8 and 37). Fruits were picked in physiological maturity stage and weighed in order to estimate yield. Dissolved solids content was measured using refractometer (model usa). As many as 50 fruits were sampled in order to measure fruit size. Hardness of fruit texture was quantified by using pentameter. As many as 10, one-year old, shoots were selected randomly during fruit-picking in order to estimate yearly vegetative growth. Sugar content of fruit was measured by Fehling Method (4). Fruit acidity was measured by titration with 0.1N NaOH, pH by pH-meter, chlorophyll by Chlorophyll Meter (Model SPAD-502) (as of early June as many as 10 leaves selected from around the trees and from the same height and leaf green color intensity was estimated by using them). Mean values for length, diameter and leaf area were measured by using caliper and Leaf Area Meter. Element and nutrient analysis on leaf and fruit was conducted based on standard methods proposed by Soil and Water Research Institute (1). N- and P-fertilizers were used in all four years of the experiment, whereas potassium fertilizer and Fe and Zn fertilizers (with low quantity) were applied only during the first and third years. Statistical analysis was done using MSTAT-C software. Mean comparison was done using Duncan's multiple range test, while Excel was employed to draw the diagrams.

Table 1: Results from soil analysis in study areas

Region	Depth (cm)	pH	EC dS.m^{-1}	Neutralized substances (%)	Organic C content (%)	Clay content (%)	Sand content (%)	Silt content (%)	mg/Kg P	K	Fe	Mn	Zn
Sahand	0-30	8	0.96	2	0.32	6	86	8	11	140	2.2	4.6	0.86
	31-60	8.1	1.21	6	0.18	7	77	16	7	120	1.1	3.2	0.12
	61-90	8.2	1.24	13	0.09	6	85	9	3	97	0.77	0.96	0.08
Marand	0-30	7.9	0.49	5	0.21	12	62	26	9	130	2.7	3.9	0.46
	31-60	7.8	0.36	6	0.11	28	35	37	4	100	0.96	2.1	0.19
	61-90	7.9	0.58	7	0.04	30	41	29	2	89	0.21	1.1	0.04

Table 2: Results from irrigation water analysis in study areas

Region	pH	EC (µS/cm)	Milliequivalent/L Bicarbonate	Carbonate	Cl	Sulfate	Total anions	Ca	Mn	Na	K	Total cations
Marand	7.5	710	4.8	0	1.7	1	7.5	2	3	2.4	0.3	7.7
Sahand	7.8	1210	3.6	0	5.8	2.7	12.1	3.4	2.6	5.6	0.4	12

Table 3: Quantity and cycle of irrigation during four years of experiment in two study areas

		Water consumed ($m^3 . ha^{-1}$)	
Year of experiment	Region	Drip irrigation	Surface irrigation
Year 1	Sahand	4300	6400
	Marand	4400	6450
Year 2	Sahand	4530	6420
	Marand	4550	6450
Year 3	Sahand	5100	6720
	Marand	5200	6780
Year 4	Sahand	5120	6820
	Marand	5350	6850

Table 4: Effect of various fertilizer treatments on WUE and FUE between two irrigation methods

Treatment	WUE ($Kg.m^{-3}$)	FUE (Kg.Kg)
N × drip irrigation	10.3 A	72 CD
N × flooding irrigation	7.6 C	66.6 D
P × drip irrigation	9.6 AB	88 AB
P × flooding irrigation	6.7 D	70 CD
K × drip irrigation	8.5 B	76 C
K × flooding irrigation	5.4 D	D 60
Fe × drip irrigation	7.4 C	89 AB
Fe × flooding irrigation	6.5 D	76 C
Zn × drip irrigation	8 BC	96 A
Zn × flooding irrigation	7.2 CD	86 B
$LSD_{0.01}$	2.36	1.86

RESULTS AND DISCUSSION

Yield: Based on Table of analysis of variance, year, location and fertilizer treatment were significantly effective on the yield of apricot, at 1% probability level. The highest yield (47.16ton/ha) was produced in the presence of N during the third year of experiment in Marand Region (Table 7). In addition, application of elements such as N, P and K also led to highest yield in the same region during the fourth year. Based on Table 1 it appears that the physicochemical conditions of soil in Marand region have favored the absorption and availability of applied fertilizer elements. This means, concentration of elements was lower in this region than in Sahand Station, consequently trees have produced a comparatively significant response against the application of fertilizer elements. In general, effect of treatments on the yield, particularly during the third and fourth years of experiment, was significant as compared to the control. Moreover, the comparatively significant effect of fertilizer elements during years 3 and 4 was due to better status of root and chlorophyll growth as well as higher fruiting capacity of the tree. These are consistent with findings of Dimitrovski and Cevetkovic [25]. Leece [26] in his experiments produced the highest yield of apricot by using 1.5Kg urea, 0.5Kg triple superphosphate and 700gr potassium sulfate under drip irrigation condition.

Fruit Length: The highest fruit length (3.71cm) was measured for N fertilizer treatment (Table 5). In addition, the longest fruit (4cm) was produced in the presence of P during the year 4 of experiment in Marand (Table 7). Marinov [27] reported that nitrogen application leads to cell growth and development and increases fruit length.

As it can be seen from Table 5, the highest WUE was achieved in the presence of N and with drip irrigation method. In addition, the highest FUE was measured in the presence of elements such as P, Fe and Zn and with drip irrigation method.

Leaf Area: Effects of year, location and fertilizer treatment as well as the main effect of irrigation method on leaf area of apricot were significant, at 1% probability level. Furthermore, the highest leaf area was achieved with drip irrigation as compared to surface irrigation (Table 6). In addition, the highest leaf area ($38.66cm^2$) was achieved in the presence of N during the year 1 of experiment at Sahand Station (Table 6). As it can be seen from Table 1, Sahand Station was inherently poor in organic carbon, thus it appears that the significant increase in cell growth of leafs and leaf area during year 1 of the experiment have been due to N application. Neilsen and Neilsen argued that nitrogen had the most effect on specific leaf area of apricot as compared to nutrients such as N, P and K. Furthermore, with drip irrigation nitrogen use efficiency (NUE) becomes comparatively higher, whereas leaf area shows a significant increase [2].

Fruit Diameter: Effects of year, location and fertilizer treatment on fruit diameter were significant, at 1% probability level. The highest fruit diameter (3.38cm) was measured in the presence of N during year 2 of experiment at Sahand Station (Table 6). Nitrogen effect on fruit diameter may be attributed to the fact that soil in Sahand Station was inherently poor in N as compared to Marand region. Moreover, N application accelerated the synthesis of photosynthetic substances and increased fruit size.

Dissolved Solids Content: Interaction of year, location and fertilizer treatment as well as effect of irrigation method on total dissolved solids (TDS) content was significant, at 1% probability level. The highest DSC (31.83%) was achieved in the presence of N during year 1 of experiment at Sahand Station (Table 6). Furthermore, drip irrigation method produced higher DSC than surface

Table 5: Correlation of chlorophyll index, longitudinal growth of shoots and yield with concentration of nutrients in leaf

	Element concentration				
Variable	Nitrogen	Phosphorus	Potassium	Iron	Zinc
Yield (Kg/ha)	R = 0.82**	R = 0.12 ns	R = 0.42ns	R = 0.62 *	R = 0.59*
Yearly longitudinal growth (cm)	R = 0.88**	R = 0.14ns	R = 0.48*	R = 0.21ns	R = 0.11ns
Chlorophyll content	R = 0.11ns	R = 0.16ns	R = 0.52 *	R = 0.66*	R = 0.71*

Table 6: Mean comparison on quantitative and qualitative traits of apricot during the four years of experiment

	Variable																				
Fertilizer treatment	Yield (toh/ ha)	Fruit length (cm)	Leaf area (cm^2)	Fruit diameter (cm)	TDS (%)	Texture hardness (Kg/cm^2)	Chloro-phyll content	Titratable acidity (%)	pH	Yearly longitudinal growth of shoot (cm)	Fruit sugar content (%)	LNC (%)	LPC (%)	LKC (%)	LFC (mg/Kg)	LZnC (mg/Kg)	FNC (%)	FPC (%)	FKC (%)	FFC (mg/Kg)	FZC (mg/Kg)
Nitrogen	38.1	3.71	37.12	3.54	29.95	9.36	36	0.679	3.85	20.91	10.1	2.14	0.316	2.3	75.64	22.58	0.384	0.053	1.52	15.52	21.38
	A	A	A	A	A	E	B	A	A	A	A	A	B	E	B	B	A	B	C	C	C
Phosp-	37.2	3.5	36.18	3.44	27.81	9.62	35	0.625	3.79	19.70	9.47	1.94	0.34	2.68	74.96	22.10	0.354	0.08	1.52	15.59	21.42
horus	AB	B	B	B	B	D	C	B	B	B	BC	B	A	B	BC	B	B	A	C	C	C
Potas-	36.4	3.47	35.60	3.38	27.60	9.92	35	0.59	3.75	18.55	9.33	1.93	0.314	2.98	73.85	21.95	0.343	0.06	1.79	15.52	22.21
sium	AB	BC	C	C	B	C	C	C	B	C	C	B	B	A	BC	B	BC	B	A	C	B
Iron	36.9	3.46	35.60	3.39	25.81	10.06	36	0.566	3.69	17.54	9.45	1.93	0.315	2.46	84.33	21.89	0337	0.057	1.60	18.024	22.32
	AB	C	C	C	C	B	B	D	C	D	BC	B	B	C	A	B	BC	B	B	A	B
Zinc	35.8	3.48	35.62	3.40	25.06	10.40	37	0.532	3.62	16.49	9.50	1.91	0.311	2.39	76.56	29.9	0.331	0.054	1.56	16.075	25.32
	B	BC	C	C	C	A	A	E	D	E	B	B	B	CD	B	A	C	B	BC	B	A
Control	30.24	3.35	35	3.33	21.83	9.38	33	0.515	3.67	15.81	9.13	1.92	0.318	2.34	72.58	22.33	0.327	0.052	1.52	15.32	21.39
	C	D	D	D	D	E	D	E	C	F	D	B	B	DE	C	B	C	B	C	C	C
$L.S.D_{0.01}$	1.8260	0.02911	0.329	0.03759	0.8359	0.1324	0.65	0.0238	0.0238	0.4947	0.143	0.044	0.016	0.077	2.742	0.964	0.0168	0.0168	0.0628	0.4338	03035

Leaf nitrogen content=LNC,
Leaf phosphor content=LPC, Leaf potassium content=LKC, Leaf zinc content=LZC

irrigation (Table 6). Curiously, the effect of nitrogen on increased DSC was due to increased synthesis of carbohydrates in apricot [12].

Texture Hardness: The highest texture hardness (10.53Kg/cm^2) was achieved in the presence of Zn sulfate during year 1 of experiment in Marand Region (Table 6). Such a hardening effect of Zn on the fruit texture may be through the bonding together of phosphates and Carboxylate groups as well as proteins content in surface of cell membrane, which has led to their stability [13].

Chlorophyll Content: The highest chlorophyll content (41.66) was achieved in the presence of iron chelate during year 1 of the experiment at Sahand Station (Table 6). As the soil of Sahand Station was inherently poorer in absorbable iron than that of Marand region, application of iron chelate led to significant increase in leaf green color intensity, followed by increased chlorophyll content, nevertheless this effect degraded in the following years. Results from this study are consistent with findings of Bussi *et al*. [11].

As it can be seen from Table 5, elements such as N, Fe and Zn have produced the highest correlation with the yield. Furthermore, elements such as N and Zn were of highest effect on yearly longitudinal growth, whereas the highest correlation with chlorophyll content based on chlorophyll index was measured for elements such as K, Zn and Fe.

Titratable Acidity: Effects of year, location, replication, fertilizer treatment on fruit acidity was significant, at 1% probability level. The highest fruit acidity (0.68%) was achieved in the presence of N (Table 7). Considering the contribution made by nitrogen to the structure of organic acids, it appears that acidity rate was highly correlated with the application of N [24]. Raina *et al*. [28] reported that N application led to a significant increase in concentrations of citric and salicylic acids in the nectar of apricot.

Acidity: Effects of year, replication and fertilizer treatment on acidity of apricot fruit was significant, at 1% probability level. The highest pH was measured in N application treatment (Table 7).

Yearly Longitudinal Growth: Effect of irrigation method and interaction of “year × location × fertilizer treatment” on yearly longitudinal growth was significant, at 1% probability level.

Table 7: Quantitative and qualitative effect of irrigation methods on apricot during the four years at Sahand Station and Marand region

	Parameters				
Irrigation methods	Leaf area (cm^2)	Dissolved solids content (%)	Longitudinal branch growth (cm)	Leaf Zn concentration (mg/Kg)	Yield (ton/ha)
Surface irrigation (flooding	35.77 B	25.73 B	17.82 B	23.39 B	35.10 B
Drip irrigation	35.96 A	26.97 A	18.52 A	23.52 A	38.22 A
$LSD_{0.01}$	0.342	0.842	0.483	0.982	-
$LSD_{0.05}$	-	-	-	-	1.72

The highest yearly longitudinal growth was achieved in the presence of N (Table 7). Furthermore, yearly longitudinal growth of apricots was higher with drip irrigation than with surface irrigation (Table 8). The highest yearly longitudinal growth was measured in the presence of N during year 2 of the experiment in Marand region (Table 6). It appears that increased N leads to higher photosynthetic capacity as well as increased production of carbohydrate, which in turn increases leaf area and shoot length. Treder *et al*. [29] argued that vegetative growth of trees directly relates to quantity of nitrogen used as fertilizer. It appears that N had a uniform distribution in wet bulb surrounding the rhizosphere, thus the plant gradually absorbed and used it as needed. However, with surface irrigation, nitrogen is quickly leached away from the availability zone; and with a 10-days long irrigation cycle, the plant frequently suffers from nitrogen deficiency, which has a negative impact on both growth and yield of the crop [3].

Fruit Sugar Content: Effects of year, location, replication and fertilizer treatment on sugar content of apricot's fruit were significant, at 1% probability level. The highest sugar content of fruit (10.1%) was measured in the presence of N (Table 7). Increased nitrogen led to increased sugar content of fruit through higher carbohydrate production as well as through increased starch production and its subsequent transformation into sucrose, glucose and fructose [16]. Sharaf *et al*. [30] reported that increasing N application to as much as 2Kg of pure N per each 10 year-old fruit-bearing apricot tree resulted in increased sugar content.

Leaf Nitrogen Concentration: Effects of replication, fertilizer treatment on leaf N concentration (LNC) of apricot were significant, at 1% probability level. The highest LNC (2.14%) was measured in the presence of nitrogen (Table 7).

Leaf Phosphorus Concentration: Effects of year, location, fertilizer treatment on leaf P concentration (LPC) were significant, at 1% probability level. A decreasing trend was observed in LPC from year 1 through year 4 of the experiment. LPC of the trees at Sahand Station was comparatively higher. More specifically, the highest LPC was measured as much as 0.34% (Table 7).

Leaf Potassium Concentration: Effects of year, location, replication and fertilizer treatment on leaf K concentration (LKC) were significant, at 1% probability level. The highest LKC (2.98%) was measured in potassium application treatment (Table 7). Furthermore, the other treatments did not differ significantly in terms of the effect of the nutrients on LKC.

Leaf Iron Concentration: Effects of year, location, replication and fertilizer treatment on leaf Fe concentration (LFC) were significant. The highest LFC (84.33mg/kg) was measured in Fe application treatment (Table 7).

Leaf Zinc Concentration: Effects of year, location and fertilizer treatment on leaf Zn concentration (LZC) were significant, at 1% probability level; whereas the effect of replication on it was significant at 5% probability level.
LZC was measured higher in year 1 and 3 of the experiment than the other years and in Marand than Sahand Station. Furthermore, application of Zn sulfate significantly increased Zn concentration in the leaf (Table 7).

Fruit Nitrogen Concentration: Effects of year, location, replication and fertilizer treatment on fruit N concentration (FNC) were significant, at 1% probability level. N concentrations of fruits produced during years 2 and 3 were higher, though not significantly, than that of fruits produced during years 1 and 4. Moreover, application of nitrogen to the soil significantly increased its concentration in the fruit (Table 7).

Fruit Phosphorus Concentration: Effects of year and location on fruit P concentration (FPC) was significant at 5% probability level; whereas effects of replication and fertilizer treatment on it was significant at 1% probability level. P concentration in fruit was measured higher during

Table 8: Variations of nutrient concentrations in leaf and fruit of apricot during the four years of experiment

	Cariable					
Year	LNC (%)	LPC (%)	LKC (%)	LFC (mg/Kg)	LZC (mg/Kg)	FNC (%)
First	1.96 AB	0.323 A	2.33 C	75.33 C	22.86 C	0.345 AB
Second	1.95 B	0.322 A	2.48 B	76.77 B	24.25 AB	0.341 C
Third	1.96 AB	0.318 B	2.52 AB	77.37 AB	23.09 B	0.342 B
Fourth	1.98 A	0.319 AB	2.58 A	77.69 A	24.9 A	0.356 A
$LSD_{0.01}$	0.086	0.012	0.096	3.86	0.826	0.023

year 2 than other years. Furthermore, application of phosphorus to the soil significantly increased its concentration in the fruit (Table 5). The highest FPC (0.41%) was achieved in the presence of phosphorus during year 4 of the experiment in Marand region (Table 6).

Fruit Potassium Concentration: Effect of replication and interactions of "year × location × fertilizer treatment" on fruit K concentration (FKC) were significant, at 1% probability level. The highest FKC (1.79%) was measured with the application of potassium to the soil (Tables 7 and 8).

Fruit Iron Concentration: Effects of location, replication and fertilizer treatment on fruit Fe concentration (FFC) was significant, at 1% probability level. The highest FFC (18mg/Kg) was measured with the application of iron chelate to the soil (Table 5).

Fruit Zinc Concentration: Effects of location, replication and fertilizer treatment on fruit Zn concentration (FZN) was significant, at 1% probability level. The highest FZN (25.32mg/Kg) was achieved in the presence of Zn sulfate (Table 5).

Based on the Table 8, throughout the four years of experiment value of LNC was almost unchanged, while the highest value was obtained in the fourth year. Furthermore, the LPC value was comparatively higher during years 1 and 2 of the experiment, whereas values of LKC, LFC, LZC as well as FNC increased throughout the four years of experiment. This may be due to gradual uptake of the elements through the holes containing fertilizer elements [31].

CONCULUTION

In conclusion, it may be said that employing under pressure irrigation systems in orchards of the province influences the uptake and use of nutrients by trees from the soil. Moreover, absorption trend of the elements varied for different regions throughout the years of experiment. The highest yield was produced during year 3 in the presence of N in Marand region. Similarly, application of N, P and K to the soil in the same region led to highest yield during year 4. Furthermore, the highest fruit length was measured in N-fertilizer treatment. The highest value for this trait was also achieved during year 4 of the experiment in the presence of P in Marand. Interestingly, fertilizer use efficiency was measured the highest with drip irrigation and with application of elements such as P, Fe and Zn. In addition, with drip irrigation leaf area was significantly higher than with surface irrigation. Last but not least, the highest leaf area and dissolved solids content were achieved during the year 1 of experiment at Sahand Station.

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REFERENCES

1. Mahyoub, A.W., S.A. Hussain and N. Ali, 1993. Boron and nitrigen effect on vigour and yield of apricot " Trevatt" sarhad. Journal of Agriculture (Pakistan), 9(4): 309-311.
2. Neilsen, D. and G.H. Neilsen, 1999. Effects of irrigation management on nitrogen availability in high density apple orchards. III International Symposium on Mineral Nutrition of Deciduous Fruit Trees.
3. Ro, H.M. and P. Jin-Myeon, 2000. Nitrogen requirements and vegetative growth of pot lysimeter-grown " fuji" apple trees fertilized by drip irrigation with three nitrogen rates. Journal of Horticultural Science and Biotechnology, 75(2): 273-242.
4. Bussi, C. and M.J. Amoit, 1998. Effect of nitrogen and potassium fertilization on the growth. Yield and pitburnof apricot (C.V. Bergeron). Journal of Horticultural Science and Biotechnol., 73(3): 387-392.

5. Wills, R.B., F.M. Scriven and H. Greenfield, 1983. Nutrient Composition of stone fruit. J. Sci. food Agric., 34: 1383-1389.
6. Leinar, S. and M.C. Burtoiu, 2002. Effect of irrigation methods on apricot growth and friting. XXVI th International Horticulture Congress.
7. Abrisqueta, J.M., A. Ruiz. and J.A. Franco, 2001. Water balance of apricot trees (*Prunuse armeniaca* L.) Under Drip Irrigation. Agricultural Water Management, 0(3).
8. Araujo, F., L.E. Williams and M.A. Matthews, 1995. A Comparative study of young grapevines (*Vitis vinifera* L.) under drip and furrow irrigation. Scientia Hort., 60: 251-265.
9. Bernstein, L.E. Francois, 1973. Comparisons of drip, furrow and sprinkler irrigation. Soil Sci., 115(1): 73-86.
10. Bryla, D.R., T.J. Trout. J.E. Ayars and R.S. Johnson, 2003. Growth and production of young peach trees irrigated by furrow, microjet, surface drip. Hortscience, 38: 1112-1116.
11. Bussi, C., J. Besset and T. Girard, 2003. Effect of fertilizer rates and dates of application on apricot (CV. Bergeron) cropping and pitburn. Sci. Hort., 98: 139-147.
12. Rettke, M.A.T.R. Pitt, N.A. Majer and J.A. Jones, 2006. Quality of fresh and dried fruit of apricot (Moorpark CV) in response to soil applied nitrogen. Australian Journal of Experimental Agriculture, 40(1): 123-129.
13. Radi, M.M. Mahrouz, A. Jaouad and M.J. Amoit, 2003. Influence of mineral fertilization (NPK) on the quality of apricot (CV. Canino). Agronomine, 23: 737-745.
14. Khamis, M.A., A.H. Gomaa, M.M. Sharaf and E.A. Kandil, 1994. Comparative studies on mineral fertilization of some deciduous fruit rootstocks: III. Potassium fertilization. CAB. Abstracts, 1996-7, pp: 970.
15. Joshi, V.K., V.P. Bhutani and R.S. Sharma, 1990. The effect of dilution and addition of nitrogen source on chemical, mineral and sensory qualities of wild apricot. Am. J. Enol. Vitic., 41(3): 229-231.
16. Noe, N., T. Eccher, R. Stainer, D. Porro and M. Tagliavini, 1995. Influence of nitrogen phosphorous and magnesium fertilization on fruit quality and storability og golden delicious apple. Acta. Horticulturac, 383: 439-4470.
17. Eryuce, Yagmur B. and S. Colak, 2002. Nutrient status of malatya Region Apricot orchards. 13th International fertilizer symposium. Gaziosmanpasa Uni. Turkey, pp: 406-410.
18. Eryuce, N., H. Colakoglu, S. Aydin and B. Cokuysal, 1995. The effects of K and Mg fertilization on some quality characterstic and mineral nutrition of Apricot. Acta Hort., pp: 379.
19. Chatzitheodorou, I.T., T.E. Sotiropoulos and G.I. Mouhtaridou, 2004. Effect of nitrogen, phosphorus, potassium fertilization and manure on fruit yield and fruit quality of the peach cultivars spring time and Red Haven. Agronomy Research, 2(2): 135-143.
20. Aksoy, U., S. Kara, A. Misirli, H.Z. Can and G.seferoglu, 1995. Effect of potassium nitrate and hydrogen dyanamide on apricot. Acta Hort., pp: 384.
21. Prenkic, R., 1994. The effect of different nitrogen rates on peach yield and quality. CAB. Abstract, 1996-7. pp: 970.
22. Raina, J.N., B.C. Thakur, S. Suman and R.S. Spehia, 2000. Effect of Fertigation Through Drip System on Nitrogen Dynamics, Growth, Yield and Quality of Apricot. Acta Hort., pp: 696.
23. Ruggiero, C., 1988. Effect of water regime on apricot (CV. CAFONA) in vesuvian area. Acta Horticulturae, 203: 443-449.
24. Maula, F., I. Mohammad and M. Noor, 1996. Effect of nitrogen along and in combination with iron (Fe) on the yield and quality of apple cultivar, " Red Delicious". CAB Abstract, 1996-7. pp: 970.
25. Dimitrovski, T. and D. Cevetkovic, 1981. The effect of NPK on the growth, yield and quality of the apricot fruit. Hortic., 85(a): 481-489.
26. Leece, D.R., 2006. Effects of fertilizer nitrogen, phosphorus and potassium on leaf composition of peach. Australian Journal of Experimental Agriculture, 16(82): 775-779.
27. Marinov, P.M. and M.D. Chokoeva, 2006. Studying of some factors for an intensification of apricot production. XI International Symposium on Apricot Culture. Italy.
28. Raina, J.N., B.C. Thakur, S. Suman and R.S. Spehia, 1999. Effect of fertilization through drip system on nitrogen dynamics, growth, yield and quality of apricot. Acta Hort., pp: 696.
29. Treder, W., T. Olszewski and G. Cieslinski, 1997. Changes of physico-chemical soil properties as a effect of a drip irrigation of plum trees. Acta Horticulturae, 448: 247-250.
30. Sharaf, M.M., A.H. Gomaa, M.A. Khamis and E.A. Kandil, 1994. Comparative studies on mineral fertilization of some deciduous fruit rootstocks: I. Nitrogen fertilization CAB Abstracts, 1996-7. pp: 970.

31. Witherspoon, J.M. and J.F. Jackson, 1993. Analysis of Fresh Dried Apricot Modern Method of Fruit Analysis, 18: 111-131.
32. Dichio, B., C. Xiloyannis and M. Ventimiglia, 2006. Fertirrigation of apricot trees to improve quality and minimize environmental impact. Acta Horticulturae, 701: 643.
33. Marinov, P.M., 1995. Influence of the mineral fertilization on the productivity of apricot trees of long- term field experiment. CAB Abstract, 1996-7, pp: 970.