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Water Harvesting Through Utilization of Wild Almond as Rootstocks for Production of Peach, Apricot and Plum under Dry Land Farming in Sulaymaniyah Region

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ABSTRACT

This study was carried out at Goizha mountains, Sulaymaniyah city, Kurdistan region-Iraq, under dry farming (rain fed) condition in June, 2011 for the purpose of utilizing wild almond as a rootstock for production of apricot, peach and plum by utilizing shallow, rocky and eroded soils which comprises more than 20% of the lands of Iraqi Kurdistan region. Moreover, dryland area comprise more than 85% of agricultural lands, therefore utilization of this area is of great Importance. The results show that it is possible to graft some orchard fruits such as apricot, peach and plum which give yield only under regular irrigation with weekly irrigation of 500 m^3/ha or about 700 mm rainfall/year or 7000 m^3water /ha/year on natural wild almond rootstock under dry farming conditions without irrigations which means entirely depending on rainfall. Consequently the grafting results in water harvesting of about 7000 m3 water /ha/year and makes people more interested in using wild almond rootstocks which resist severe ecosystems of the above mentioned types of soils for fruit production under dry farming conditions .At the same time, it helps in retarding desertification and facing drought years which are considered as one of the greatest problems of current time and in the distant future in the region which result in low production and loss of vegetation. Moreover, planting grafted wild almond rootstocks provides the facility of a forestation for exploitation of the above mentioned types of soils in marginal areas as well as retarding desertification and even expanding the orchard area under supplementary irrigation in the plains.

Keywords: Water harvesting, Rootstocks, Wild almond, Dry land farming,

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INTRODUCTION

Wild almond is one of the rare native plants which grows under severe ecosystem in Iraqi – Kurdistan region. Wild almond in such ecosystem undergoes severe stress during summer season because precipitation is absent, climate is very hot; (Fig,1)and dry with low relative humidity in the summer season(Fig,2) and with high evapotranspiration 6-9 mm/ day in hot months (Mohamed Ali, 2008).

In spite of such severe conditions, wild almond can survive water shortage; due to some anatomical characteristics such as defoliation of leaves during hot season, and higher ability of roots (a deep root which is penetrating far below the soil overlying bed) to store and absorb water at high soil moisture potential.

Field observations in Iraqi Kurdistan region have shown that wild almond has root system far below the lower boundary of shallow soils into fracture bed rocks. Some types of rocks have appreciable porosity such that of some sites in Kurdistan region: Penjwen, Dokan, Goizha and Qaradagh (Photo 1). These types of rocks do indeed store and supply water, meanwhile, this phenomenon indicates that fractured or weathered rocks can be regarded as rooting medium via storing available water for plant use (Karim *et al.*, 2000).

Most of the Mountains in Iraqi – Kurdistan region have rough, broken and stony lands with shallow soil (Guest, 1966). Rocky and barren lands in the mountains are long with gullied lands in Iraqi – Kurdistan region. They comprise 15-20% of the region and are classified as marginal or waste lands (Buringh, 1960).In addition to more than 5 million hectare of forests, grazing and agricultural lands transform gradually to waste lands (Morgan, 1966). The percentage waste lands increases unless soil conservation measures are put into effect.

In Iraqi – Kurdistan region, it has been found that the majority of the studied ecosystems include shallow soils and barren rocks. Not only these soils are shallow but they are often coarse textured, particulary, those on sandstone and conglomerate formation. Wild almonds grown on limestone rocks were found in Goizha, Kalawanan, Haibat Sultan and Atrosh. High fractured bedrocks with large cracks, within which plant roots were compressed, were also observed in Goizha, Kalawanan, Dokan, Tawela and Duhok. Also limestone rocks laminated with heavy textured soils (silly clay soil) were observed in some sites of Goizha and Tawela (Karim *et al.*,

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2000). Moreover, wild almond is also found in some Middle East countries only like Turkey, Syria, Iran and Lebanon (Guest 1966). Photo (1, A,B,C,D) shows Some ecosystems onto which wild almond growing.

Wild almonds are among the rare trees that are naturally grown in shallow, rocky and eroded soils which comprises more than 20% of the lands of Iraqi Kurdistan region. Moreover, dryland area comprise more than 85% of agricultural lands.Under irrigation system Orchard growing areas are still very limited due to rainfall shortage and non organizing of water resources in the region Therefore utilization wild almond as root stock in this area for fruit production is of great importance for increasing the rain fed growing orchard area to challenge fruit deficiency.

The objectives of this study are for water harvesting by utilizing wild almond species as one of the rare natural flora of the region as rootstocks through its grafting with apricot, peach, and plum for fruit production under rain fed condition . Moreover encouraging and make farmers more interesting in utilizing marginal areas through increasing the productivity of these areas and enhancing re-vegetation through grafting irrigated fruits which are still growing in limited area on wild rootstocks under severe prevalent ecosystem conditions in the region for fruits production.

MATERIALS AND METHODS

Wild almond species in the region:

There are many demonstrated species of wild almonds in Iraqi Kurdistan region :*Amygdalus arabica*, *Amygdalus spartioides*, *Amygdalus korschinski and Amygdalus argentea*.(Guest, 1966 and *Shibly et al*, 1997). Fig (3) shows the location and geological map of the studied area, (Ali, 2008). Photo (3) shows field photo of wild almond as it is in nature on Kometan formation. The top right photo shows grafting of plum on wild almond.

This study deals with grafting of **Amygdalus arabica** to make this native plant more interested for aforestation and/or reforestation under dry farmingconditions which helps in fruit production under severe ecosystem and consequently water harvesting .

The plant species, Amygdalus arabica is considerd as an element of Irano–Turanian group.It is woody and shrub by plant with prostrate stem and tap roots(Photo2c). The branches are green

and have few sub-divisions. The leaves are oblong linear with crenulated–serrate margins. The flowers are single and scattered along the branches and appear before the leaves in February.The fruits are compacted schizocarp and have ovate elliptic shapes (Shibly,*et al*., 1997 (Photo 2,A,B).

Climatological conditions of the studied area:

The climate of the region is characterized by continental arid climate with dry hot summer and cooler winter climate. The rainfall ranges from about 500 mm to about 1300 mm. It is sufficient to support winter crops without irrigation. Extra rain is observed during March and April in some years. The evaporation is high in summer due to high temperature (Table1) and low relative humidity.

Grafting:

On 20th Jun, 2011 natural rootstocks of Amygdalus arabica *at Goizha and Azmer mountains,* Sulaymaniyah *city,Kurdistan region-Iraq* were grafted with common local cultivars of Apricot, peach and plum using Shield budding method (Hartmann *et al.*, 1997). The grafted Buddings were connected with raffia.

RESULTS AND DISCUSSION

Table (1) shows the average annual precipitation and temperature for the last 10 years and F-parameter suggested by (Lang). The results indicate that F-parameter ranges from 23.16 in Chamchamal weather station to 80.96 in Penjwen. The small value of F-parameter indicates more aridity.

Figure (3) shows the distribution of annual precipitation from 1942-2013 as recorded in Sulaymaniyah meteorological station which indicates the probability of coming1-3 drought years every 5-7 years in which precipitation declines to less than 500 mm and in some years to less than 400mm which is considered as drought years. (Mohamad Ali, 2008)

Fig(4) shows that there are 13 years among 73 years, in which the precipitation is low and not enough for re-activation the springs and Ghanats which is still the main source of irrigation orchard fields in the region. Therefore, Finding new root stocks in rained area under dry land farming which comprises more than 90% of agricultural lands in the region. In addition to that providing supplementary irrigations in plains area might be considered as effective mean toward expanding the orchard growing area.

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The severe ecosystem and climatological conditions suggest that pioneer native plants should be put in afforestation program for facing the desertification in the region.

Wild almond has numerous advantages such as increasing ground water through retarding surface water flow and shielding the shallow soils from rain drops which results in reducing soil erosion hazard, improving the climate, using its seeds as food for wild birds, animals and even human especially after purification from alkaloids (Khoshnaw *et al*., 1999) and finally its flowers for honeybee activities for more than two months (Guest, 1966., *Shibly et al.*, 1997).

The succeeded grafting buds for peach , plum and apricot remained green and in dormant stage without any growth up to first week of spring in which growth started.

Table (2) shows bud shoot length (cm) and bud shoot diameter (mm) from the budding of common plum cultivar onto wild almond rootstocks (Amygdalus arabica) during spring season 2011 at Goizha Mountains. Six budding was succeeded from the total of 10 budding with 60% budding success. This is considered as a good percent for budding success (Hartmann *et al.*, 1997).Photo 4,shows the common plume cultivars budded onto Wild almond rootstock in the second year of grafting bearing fruits.

According to the data in Table (2) , the average of plum bud shoot length is 103,33 cm with a standard deviation10.50 and the average for plum bud shoot diameter is 38.17cm with SD 2.13 mm. The coefficient of variation for both bud shoot length and bud shoot diameter is low indicating that experiment efficiency is high and the dispersion of plum bud shoot diameter is less than in bud shoot length.(Photo4),shows the common plum cultivars in the second year of grafting onto Wild almond rootstock

The budding plum set fruits in the second year of budding as indicated in photo,4 which mean budding of plum onto wild almond gave fruits in earlier year in this study in comparison to growing plums under regular irrigations.

Grafting orchard fruits like plum and cherry onto wild rootstock *Amygdales Arabica* for the first time encourages and makes people more interested in utilizing wild almond and shallow rocky and eroded soils.

Table (3) shows that among 10 grafting's of common peach cultivar onto wild almond rootstock in 20 the Jun , 2011 at Goizha Mountains. Seven budding had succeeded with 70% success. Grafted buds stayed dormant without growth up to march of the second year that mean up to

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middle march and after that growth started. No literature was cited about using wild almond as a rootstock for cherry under rain fed conditions. This is considered as a high percentage for cutting grafting method (Hartmann, *et al*, 1997).

Grafting of Plum onto wild almond rootstock for fruit production under dry farming conditions could be considered as a new finding step toward utilization of rocky, shallow soils and marginal lands.

According to the data in Table (3) , the average of peach bud shoot length is 111 cm with standard deviation 7.2 cm .while the peach bud diameter is 39.14 mm with standard deviation of 2.4 mm.. According to the coefficient of variation (C.V %), the dispersion of the plum bud shoot length is less than in the bud shoot diameter and both cv are low meaning that high efficiency of the experiment .Photo (5) shows the common peach cultivar grafted onto wild almond rootstock in the third year of grafting.

Table (4), shows bud shoot length (cm) and bud shoot diameter (mm) of common Apricot cultivar onto wild almond rootstocks (Amygdales arabica)after 3 year of budding at Goizha Mountains.7 budding were succeeded from 10 budding with70% budding success. This is considered as a high percentage for grafting (Hartmann *et al.*, 1997).Photo,6 shows the common local variety of apricot cultivars grafted on to Wild almond rootstock bearing fruits in the second year of budding. It is clear from

table the average of bud shoot length is 105.7 cm with SD 7.86 cm , while the average of bud shoot diameter is 39.42 cm with SD 3.1cm. The coefficient variation of both traits is low meaning high efficiency of the experiment.

The average bud shoot length was ranged from 100cm for plum to 111cm for peach and bud shoot diameter ranged from38.12 m for plum to 39.42mm for apricot .

Growing orchard fruits under regular irrigations require about 700 mm rainfall /season or 7000 m^3 water /ha/year. while production of plum via budding onto wild almond rootstock may reduce the necessity of this huge amount of water through depending entirely on Precipitation. Thus, harvesting of about 7000 m^3 water /ha/year could be achievable (Mohamed Ali, 2008, FAO, 2004). In addition, this should be considered as a good step for facing drought years which have been forecasted to be occurred 6 years within the period from 2008 to 2018.

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The results show that it is possible to graft some orchard fruits such as peach, apricot and plums which require about 700 mm rainfall or 7000 m^3 water/ha/year onto natural wild almond rootstock under dry farming conditions without irrigations that is depending entirely on rainfall. Therefore, farmers might be more interested in using wild almond rootstocks which resist severe ecosystems of rocky and shallow soils and the marginal areas for economical fruit production. Thus this helps in utilization dry land area which forms more than 85% of agriculture area and help in retarding desertification which is one of the greatest problems of current time and in the distant future in the Mediterranean region . Further investigations are necessary for using different wild almond species as new rootstocks for production of different fruits under supplementary irrigations to ensure an economical production of fruit and challenging reciprocal climatic conditions.

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Table 1. Some climatological data for weather stations in mountainous regions of Sulaymaniyah governorate.

Site	Meaan annual precipitation (mm)	Mean annual temperature (C°)	F-parameter * F= P/T
Bazyan	720.1	17.16	41.96
Halabja	640.0	17.8	35.95
Penjwen	1255.0	15.5	80.96
Sulaymaniyah	658.0	18.5	35.57
Chamchamal	458.5	19.8	23.16
Dokan	719.0	18.9	38.04
Darbandekhan	458.0	19.0	24.01

*F is a parameter proposed by (Lang)

Lang- parameter calculated according to formula, F=P/T , in which P= mean of annual precipitation and T = mean of annual temperature.

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Table 2. Bud shoot length (cm) and bud shoot diameter (mm) of common plum cultivar onto wild almond rootstock during spring season 2011 at Goizha and Azmer mountains.

Bud shoot length (cm)	**Bud shoot diameter (mm)**
105	40
112	39
118	35
100	40
95	36
90	39
$\bar{X}$ = 103,33 Cm SD = 10.50 Cm C.V = 10.16% SE = 4.29 Range = 28	$\bar{X}$ = 38.17mm SD = 2.13mm C.V = 5.58% SE =0.87 Range=5

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Table 3. Bud shoot length (cm) and bud shoot diameter (mm) of common Peach cultivar onto wild almond rootstock after 3 years of budding at Goizha mountain.

Bud shoot length (cm)	**Bud shoot diameter (mm)**
115	40
110	37
120	39
115	40
118	41
105	42
100	35
$\bar{X}$ = 111 cm SD = 7.2 cm SE =2.72 C.V = 6.4% Range = 20	$\bar{X}$ = 39.14mm SD = 2.4 mm SE = 0.91 C.V =6.13% Range = 7

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Table 4. Bud shoot length (cm) and bud shoot diameter (mm) of common apricot cultivar onto wild almond rootstock.

Bud shoot length (cm)	Bud shoot diameter (mm
110	43
115	34
105	37
135	39
95	41
115	40
100	42
$\bar{x}$= 105.71 SD = 7.86 SE =2.65 C.V= 7.4% Range = 20	$\bar{x}$= 39.42 SD = 3.1 SE = 1.17 C.V=7.8 % Range = 9

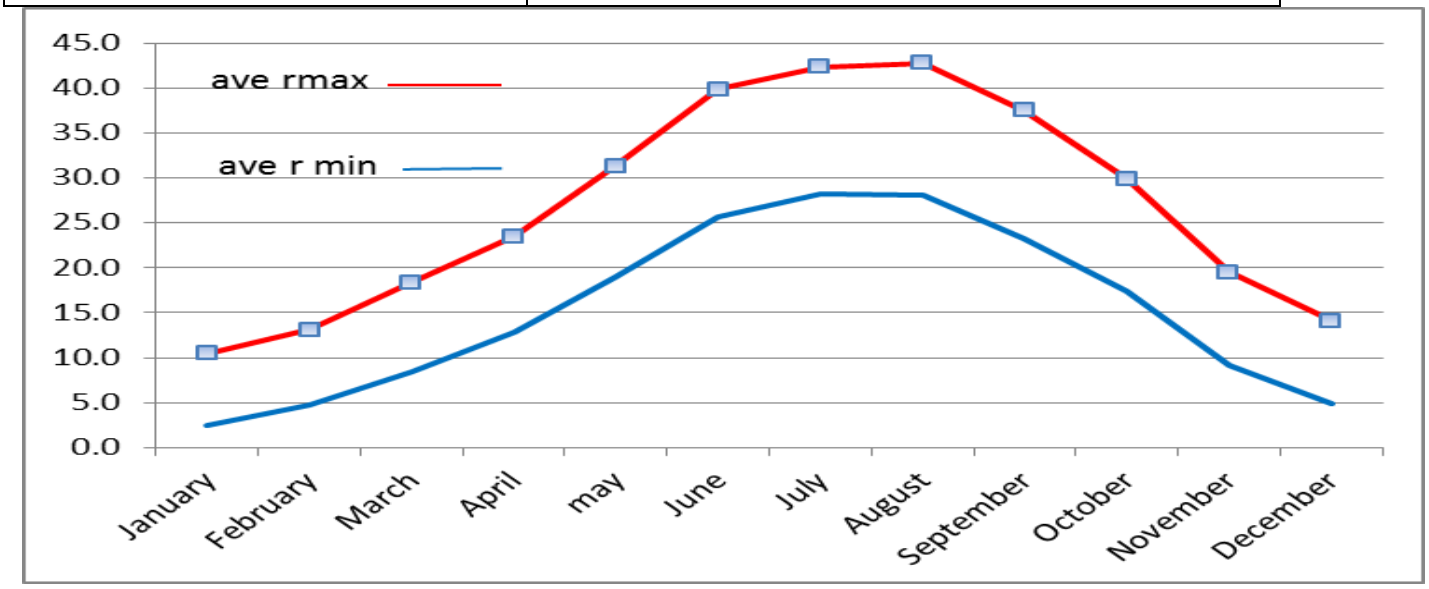

Fig. 1. Monthly average of maximum and minimum temperature as recorded in Meteorological station of Sulaymaniyah during 1973 - 2012.

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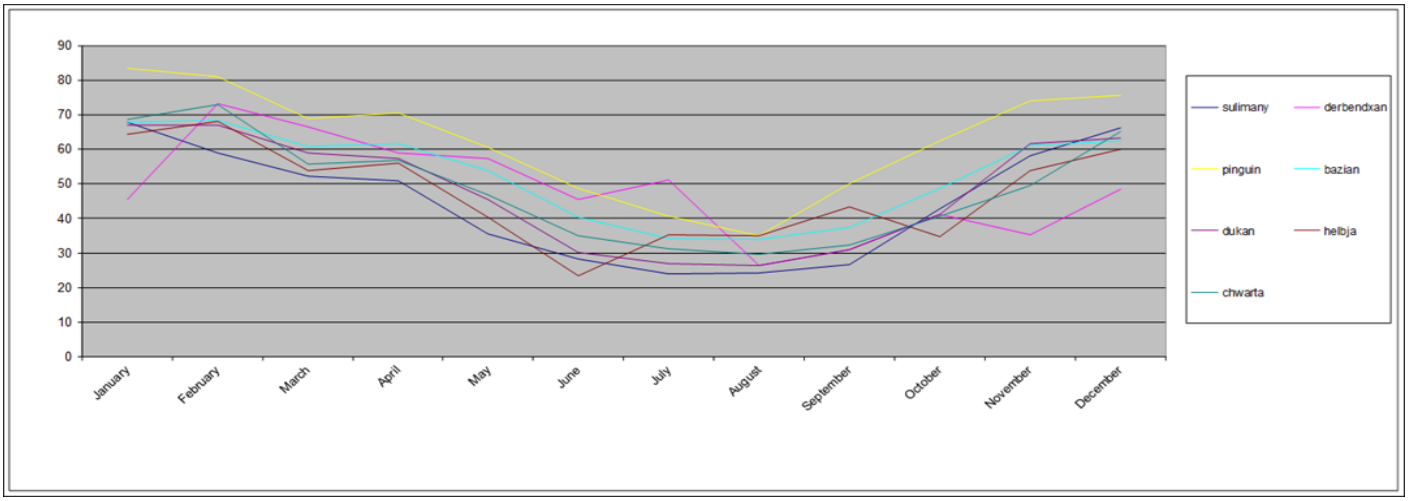

Fig. 2. Monthly average of relative humidity distribution of Sulaymaniyah Meteorological station during 1973-2012.

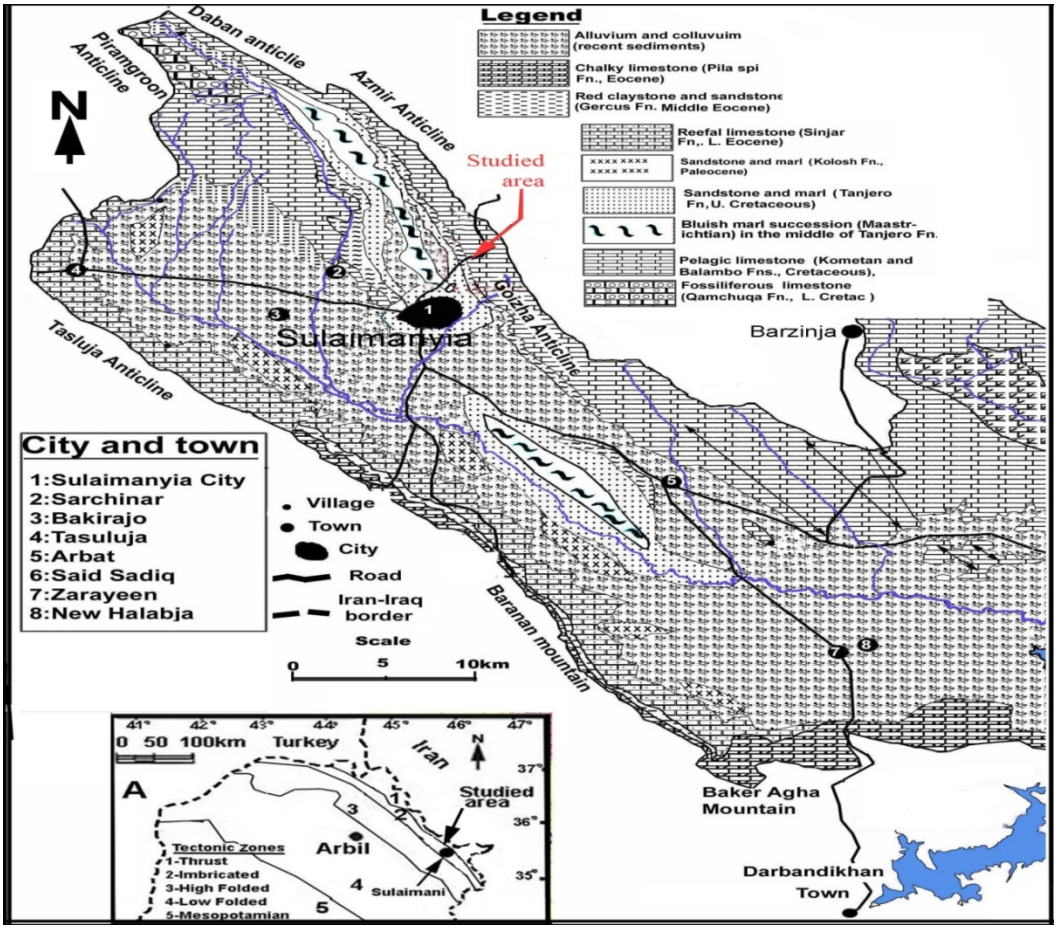

Fig. 3. Shows the location and geological map of the studied area (Ali , 2007).

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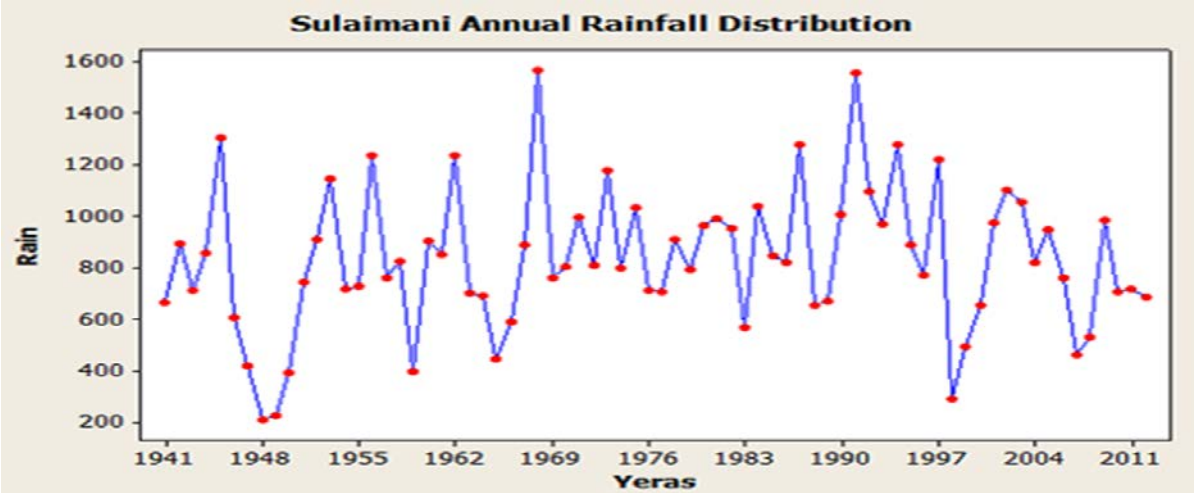

Fig. 3. Annual rainfall distribution in Sulaymaniyah Governorate during 1941 – 2013.

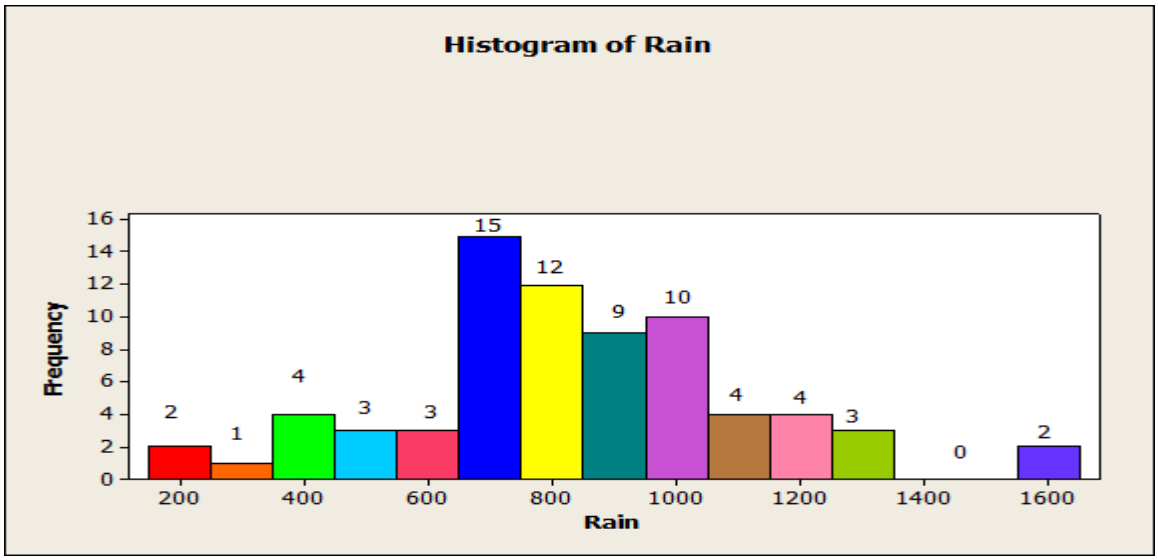

Fig. 4. Frequency of rainfall distribution in Sulaymaniyah governorate during 1941- 2013

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A B

C D

Photo 1. Some ecosystems onto which wild almonds are naturally grown. Photos - A and B ,wild growing on limestone rocks and kometan formation .A- Ranya area. B- Goizha mountains. Photos C and D wild almonds growing on sandstone and calcareous and Tanjero formation , Dokan area

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Photo 2. A. The vegetative parts of the wild almond plant duringSeed shattering in early summer (25 Jun)

Photo 2B. The vegetative parts of the wild almond plant during early spring in May.

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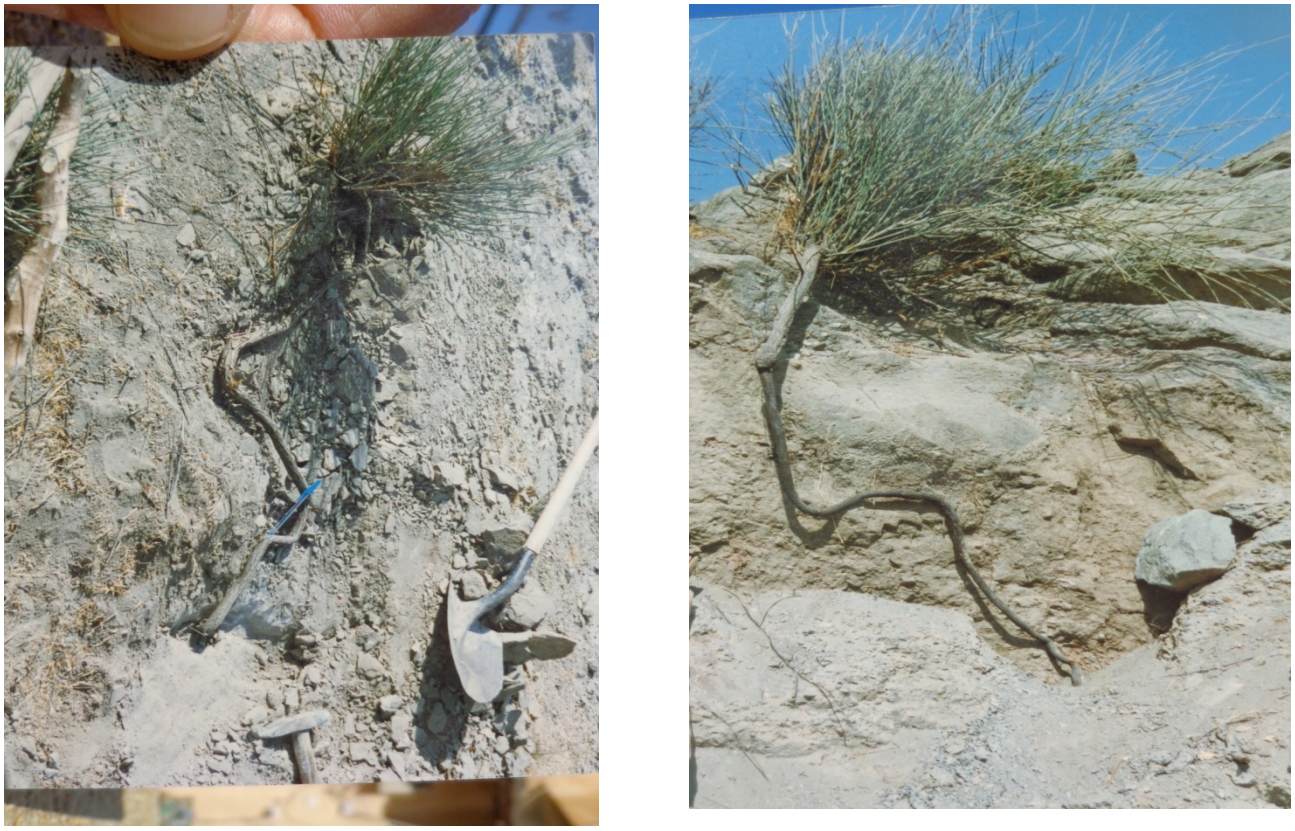

Photo 2c. Show apart of tap root of wild almond beneath bed rocks and within the rock fractures.

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Grafting of apricot on wild almond

Photo 3. Shows field photo of wild almond as it is found in nature on Kometan formationin the studied area.

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Photo 4. Shows the common plum cultivars grafted on to Wild almond rootstock.

Photo 5. Shows the common peach cultivar grafted onto wild almond rootstock in the third year of the grafting.

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Photo 6. Shows the common apricot cultivars grafted on to Wild almond rootstock bearing fruits in the second year of budding.

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Photo 7. Show Budding area In the third year of budding apricot onto wild almond in Jan,7 ,2015 showing non inflation between the scion and root stock up to the third year of grafting.