Irrigation is a cultural process which is certainly required to do so as to obtain more yields from the unit area. The history of the irrigation is at least as old as the history of the agriculture. While human being was irrigating by means of driving water to the agricultural areas with appeal for hundreds of years, many irrigation methods were developed by using the means of technology today. One of these is the drip irrigation system.

DRIP IRRIGATION METHOD

The basic principle in drip irrigation is to apply irrigation water at frequent time intervals and with less amount of water. Irrigation is started at the high soil moist level. Thus, a tension originated from the moist lack in the soil is not created in the grown plant. Exclusively, water is given to the environment to ensure the growth of the plant roots at the sufficient level. Generally, the daily or a few days' water requirement of the plant is met with this method. The irrigation water which is taken from the source is refined from sand, sediment, floating substances and very small particles in the filtering unit. When needed, the plant nutriment element is mixed into the irrigation water via fertilizer injection unit. Furthermore, system flow and system pressure is examined. The irrigation water is conveyed to the drips which are placed close to the plant through pressured pipe network. Water which is given to soil surface in drops form under the low pressure and low flow penetrates into soil by infiltration from here and diffuses with the effects of gravity and capillary forces and wets the soil volume where the plant capillary roots are grown. Generally, a wet strap is obtained along with the plant rows and not-wet dry area remains between the rows deep infiltration or surface flow is never the case with a well-designing and application. Thus, the existing water source is effectively benefited.

1) THE ADVANTAGES OF DRIP IRRIGATION METHOD

The advantages of drip irrigation method over the other irrigation methods can be listed as in the following;

a. The evaporation from the soil surface and thus plant water consumption is generally at very low level with the drip irrigation method in comparison with the irrigation methods wetting all area. The reason for this is that there are dry areas remaining between the plant rows and the wet section is generally shadowedby the plant. Also, an equal water distribution is provided all parts of the area which is well-designed and well-operated irrigation and a high water application extraction is obtained. All these factors result a low irrigation water requirement for the unit area. Depending on this, unit area system flow decreases and much wider area can be irrigated in the manner to meet full water requirement especially at the limited water source conditions.

b. In the drip irrigation method, the irrigation is started when less amount of the available water capturing capacity in the effective plant root depth is consumed (generally 30-40%). In another word, irrigation is carried out when high soil damp is available in the root zone. Hence, the plant is not put in a tension originated from moist lack in the soil and gets water easily without disbursing much energy. This provides much better plant growth and usually much more amount and quality product is obtained.

c. The plant nutrient elements are given through fertilizer injection unit by mixing the irrigation water in the drip irrigation method. This provides the possibility to apply the macro or micro nutrient elements that the plant is in need during the growth season at the requested time and amount. In this way, an extremely effective fertilizing is provided. Consequently, also high yield and quality product is obtained.

d. The irrigation water is applied in well-regulation at requested time and amount with the drip irrigation method. The operation of the system is extremely easy and the irrigation workmanship costs are at the minimum level.

e. The salt existed in the soil is carried to the parietes of the wet soil volume with the effect of the gravity and the capillary force and environment where the plant capillary roots are grown is purified from salt at a certain ratio. Therefore, even the plants which are sensitive to salt can be grown confidently on the salty soil conditions under the drip water irrigation method.

f. On the salty irrigation water condition; although the osmotic pressure caused by dissolved salt in soil water is high, the power of water to be held by soil particles (matrix tension) is at lower level as a continuous high soil moist is point at issue during the growth season. The plant can get water through its roots at the soil moist tension which is the total of these two values. In conclusion, the salty irrigation water which cannot be applied with the other watering methods can be applied with drip irrigation method.

g. As the on-soil organs are not wetted, the plant diseases are avoided to spread; besides, weed struggling is carried out more easily as the weed grown is limited to the wetted area.

h. Utilizing from the dry area between the plant rows, some agricultural instruments and machines can be operated and pesticide, harvesting, etc. agricultural processes can be carried out during the irrigation.

i. As in the sprinkle watering method, the drip irrigation method can also be applied to the soils where the surface watering methods cannot be applied, high sloped, wavy, light textured or superficial safe.

j. The energy cost is low with the drip irrigation method in comparison with the sprinkle irrigation method as the operation pressure is much lower**.**

k. In the drip irrigation method, even extremely low capacity water sources can be benefitted.

2) FACTORS LIMITING THE APPLICATION OF DRIP IRRIGATION METHOD AND THEIR SOLUTIONS

Beside the advantages of the drip irrigation method listed above, some factors which limit its application are point at issue. These factors and the solutions for some of them are listed as in the following.

a. As the cross section of the water flow way of the drips is too narrow, the most important problem with this method is the blockage of the drips. The blockage is caused by accumulation of chemical matters with the substances such as sand, sediment, moss, etc. and formation of the organic materials.For the solution of the problem, the irrigation water is infiltrated in the hydro-cyclone (sand-separator) which is existed in the control unit right before releasing water to the system; the sand-pebbles are filtered in the filter and sieve filter in stages and all the physical matters which may exist in water is bowdlerized. In order to avoid the chemical matter accumulation and formation of organic materials in the drips, it is necessary to operate the system at the pressure to provide the fast flow of water in the flow way of the drips within the bounds of the possibility, and also give lime solvent diluted hydrochloric or orthophosphoric acid a few times to the system utilizing from the fertilizer tank in the control unit during the watering season.
After diluted acid application, water is let go out for some time by removing the pipe stoppers at the end of the pipes and the system is washed.

b. Even though the irrigation water which is applied to the drip irrigation method is good quality water, it contains some amount of salt. Also there is salt in the soil. As the water moves towards the parietes of the wetted soil volume with the effect of the gravity and capillary forces, these salts is moved to the parietes of this wet volume together with water and accumulates here. As this local salt accumulation may cause problem, it may be needed to wash away under the root zone. In the regions where the annual rainfall is more than 300 mm, it generally causes no problems as the winter falls wash the salt in question under root zone. However, it may be necessary to give wash water additionally so as to wash away the salt accumulated in soil in the regions where the annual rainfall is low or on the salty soil and low-quality watering water conditions. This process is mainly realized via a portable sprinkle system which will make available in the organization out of watering season.

c. The first establishment costs are quite high in the drip irrigation. Beside this, a continuous energy cost is also point at issue on the conditions where a pump unit is required to provide the operation pressure during the watering season. That's why, the drip irrigation systems are necessary to be planned and operated to require low cost as much as possible on condition of being suitable to its technique. Especially, it is extremely important that the planning of the system, sizing the system elements and introducing the operational principles procedures should be made by experts who are specialized on the issue.

3) THE CONDITIONS WHERE THE DRIP IRRIGATION METHODS WOULD BE APPLIED

Soil, topography, plant and water source features to which the drip irrigation method can be applied are described below.

Soil and Topography features :
The drip irrigation method can be applied to soils from sandy to clayey, all sort of soil structure classes, with the superficial soils where the ground water or impermeable layer is too close, with salty soil, and beside this with the low or high sloped fields and wavy topography. However, the system arrangement should be made suitable to the topographic conditions of the field to be irrigated.

Plant Features:
The drip irrigation method generally can be used for watering all the field and garden plants except the grain, lawn and pasture plants. However, watering some field plants via drip irrigation method may not be economical due to high system cost. The method is especially suitable to vegetable, vineyard, fruit trees, plants which are grown under cover and ornamental plants which are sensitive to moist lack in the soil and whose market value is high. On the conditions where the water source is limited, the drip irrigation method can be applied to the filed plants such as cotton, maize, potatoes as much wider area can be watered in comparison to other watering methods.

Water Source Features:
In the drip irrigation method, all sort of aboveground and underground water sources can be benefitted even though they are of low capacity. The low quality irrigation water consisting of high percentage of salt can be used in drip irrigation. Only when the aboveground water source is benefitted, it is necessary to use the water not consisting more amount of sediment and floating matters or use after the sediment is precipitated in the pools and the floating matter are infiltrated in the filtering systems.

4) DRIP IRRIGATION SYSTEM

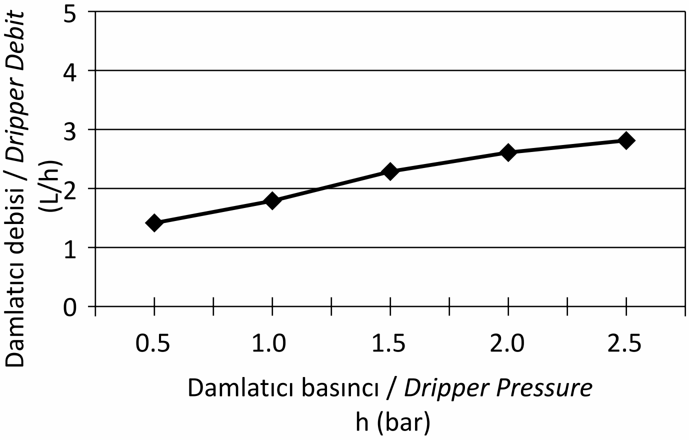
The drip irrigation systems are of pressured and consists of the necessary structure, machine, pipe, instruments and tools for receiving water from the source, filtering, mixing plant nutrient elements with water using fertilizer injection unit, conveying to the field to be watered, distribution in the field and giving to the plant root zone in controlled way. It is generally in fixed system form. The system elements remain in the same position during the watering season. However, some elements are removed from the elements at the end of the watering season.
Some examples of the products to which the drip irrigation is applied; Corn, cotton, orchard, citrus fruit, thyme, etc.

YUVARLAK DAMLA SULAMA BORULARIMIZIN BASINÇ - DEBİ İLİŞKİSİ

İlgili kuruluşlarca yapılan deneylerde Ø 16 mm yuvarlak damla sulama borularımızda yer alan (2,0 L/s Debili) damlatıcılarının farklı çalışma basınçlarındaki ortalama damlatıcı debileri (q), damlatıcı özelliklerini belirten damlatıcı parametreleri (k, x) ve yapım farklılıkları katsayıları (Vm) çizelge 1'de, basınç - debi ilişkisini gösteren grafikleri ise çizelge 2'de gösterilmiştir.

PRESSURE – FLOW RELATIONS OF OUR ROUND DRIP IRRIGATION PIPES

The average drip flow rates (q) under the various working pressures of (2,0 L/h Flow rate) drips which take place inside of Ø 16 mm round drip irrigation pipes that have been tested, the drip parameters (k, x) which describes the drip features and the production disparities coefficient (Vm) is shown in Chart 1 and the graphs showing the pressure - flow rate relations are shown in Chart 2.



Çalışma Basıncı Working Pressure	**Ortalama Damlatıcı Debisi** Average Dripper Flow	**Damlatıcı Parametreleri** Dripper Parameters (q=khx)		**Tahminleme Katsayısı** Estimation Coefficient	**Yapım Farklılığı Katsayısı** Production Difference Coefficient
h (Bar)	q (L/h)	k*	k**	R^2	Vm
0,5					
1,0	1,85				
1,5	2,27	1,888	0,448	0,989	0,0249
2,0	2,58				
2,5	2,87				

(*) Damlatıcı boyutlarını karakterize eden katsayı - Dripper Dimensions characterization coefficient
(**) Damlatıcı akış rejimi katsayısı (akış üssü değeri) - Dripper flow coefficient

Çizelge 1: **Ø 16 mm Yuvarlak Damla Sulama Borularımıza ait (2,0 L/s Debili) Damlatıcıların farklı çalışma basınçlarındaki ortalama damlatıcı debileri, damlatıcı parametreleri ve yapım farklılığı katsayısı**

Chart 1: The average drip flow rates under the various working pressures of (2,0 L/h Flow) drips belong to our Ø 16 mm round drip irrigation pipes, the drip parameters and the production disparities coefficient

Çizelge 2: **Ø 16 mm Yuvarlak Damla Sulama Borularımızın (2,0 L/s Debili) Damlatıcılarına ait Basınç - Debi ilişkisi**

Chart 2: **The pressure - Flow rate relations belong to the (2,0 L/h Flow) drips of our Ø 16 mm round Drip Irrigation pipes**

Çizelge 1'den de görüleceği gibi ilgili kuruluşlarca yapılan deneylerde Ø 16 mm yuvarlak damla sulama borularımızda yer alan, 2,0 L/s debili damlatıcımızın yapım farklılığı katsayısı Vm= 0,0249 olarak bulunmuş olup, bu değerler ASABE (American Society Of Agricultural and Biological Engineers) Standartları tarafından verilen sınıflandırmaya göre ''MÜKEMMEL'' sınırları içerisinde yer almaktadır.

As it is seen in Chart 1, the production disparities coefficient of our 2,0 L/h flow drips of our Ø 16 mm round drip irrigation pipes that have been tested, its production disparities coefficient has been found as Vm= 0,0249; this value takes place within the "EXCELLENT" limits according to the classification ascribed by ASABE (American Society Of Agricultural and Biological Engineers) Standards.

Ø 16 mm dış çaplı, 2,0 L/s debili yuvarlak damla sulama borularımızın farklı işletme koşullarındaki (işletme basıncı ve eğim) eşit su dağılımını sağlayacak optimum lateral uzunlukları çizelge 3'te verilmiştir.

The optimum lateral lengths to provide equal water distribution at various operation conditions (operation pressure and slope) of our Ø 16 mm external diameter, 2,0 L/h flow Round Drip irrigation pipes are given in Chart 3.

Çizelge 3: Ø 16 mm dış çaplı , 2,0 L/s debili yuvarlak damla sulama borularımızın farklı işletme koşullarındaki eşit su dağılımını sağlayacak optimum lateral uzunlukları (lateral sonu basıncı: 1 bar)

Chart 3: The optimum lateral lengths to provide equal water distribution at various operation conditions of our Ø 16 mm external diameter, 2,0 L/h flow Round Drip Irrigation Pipes (lateral end pressure: 1 bar)

Damlatıcı Aralığı Dripper Space (cm)	**Debi Değişimi** Flow Rate Change q (değişim) %	**Lateral Uzunlukları /** Lateral Lenght (m)						
		Eğimsiz/ Without Slope	**Aşağı Eğimli/** Down Slope			**Yukarı Eğimli/** Above Slope		
		% 0	% 1	% 2	% 3	% 1	% 2	% 3
20	10	49	52	55	57	46	42	39
	15	59	61	64	66	56	53	50
	20	67	70	72	74	64	62	59
25	10	58	62	65	69	53	49	45
	15	69	73	76	79	65	61	57
	20	79	82	85	88	75	72	68
33	10	71	77	82	87	64	57	51
	15	84	90	94	99	78	72	67
	20	97	102	106	110	91	86	80
40	10	81	89	96	102	72	64	56
	15	97	104	110	116	89	81	74
	20	777	118	123	129	104	96	90
50	10	96	107	116	124	83	72	62
	15	114	124	132	140	103	93	83
	20	131	140	148	155	121	111	102
60	10	109	123	134	145	93	79	66
	15	130	143	154	163	116	103	91
	20	149	161	170	180	136	124	112
75	10	128	147	163	178	107	87	71
	15	153	170	185	199	134	116	100
	20	176	191	205	218	158	140	125
100	10	158	186	209	222	125	98	77
	15	189	214	236	257	159	133	111
	20	217	240	260	280	189	164	143

Damlatıcı Boyu : 32, 1 mm
Drip Length

Damlatıcı İç Çapı : 11,7 mm
Drip Inside Diameter

Damlatıcı Dış Çapı : 15,9 mm
Drip Outside Diameter

Su Çıkış Deliği Sayısı : 2-4
Number of Water Out Hole

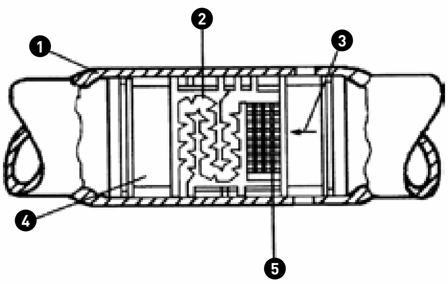
Lateral Duvarı 1
Lateral Wall

Labirent Kanallı Uzun Akış Yolu 2
Labyrinth Channeled Long Flow Path

Su Akış Yönü 3
Water Flow Direction

Su Çıkış Odacığı 4
Water Outlet

Su Girişi (Süzgeçli) 5
Water Inlet (Strainer)



Firmamız tarafından imalatı yapılan, labirent kanallı uzun akış yollu yuvarlak damlatıcılarımız, lateral içine geçik (in-line) tiptedir. Damlatıcılarımız lateral olarak adlandırılan yumuşak polietilen borularımızın içerisine imalat sırasında 20, 25, 33, 35, 40, 50, 60, 75, 100 cm aralıklarında yerleştirilmektedir. (Şekil 1)

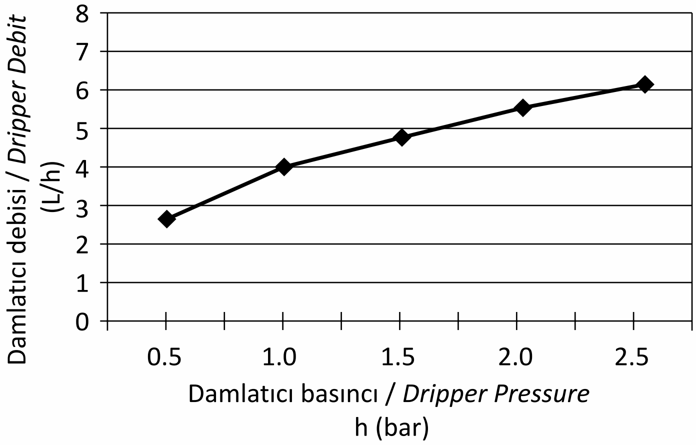
Our round drips with labyrinth grooved long flow lined which are manufactured by our company are lateral in-line type. Our drips are placed into our soft polyethylene pipes which are named lateral at 20, 25, 33, 35, 40, 50, 60, 75, 100 cm spaces during the production. (Drawing 1)

YUVARLAK DAMLA SULAMA BORULARIMIZIN BASINÇ - DEBİ İLİŞKİSİ

İlgili kuruluşlarca yapılan deneylerde Ø 16 mm yuvarlak damla sulama borularımızda yer alan (4,0 L/s Debili) damlatıcıların farklı çalışma basınçlarındaki ortalama damlatıcı debileri (q), damlatıcı özelliklerini belirten damlatıcı parametreleri (k, x) ve yapım farklılıkları katsayıları (Vm) çizelge 1'de , basınç - debi ilişkisini gösteren grafikleri ise çizelge 2'de gösterilmiştir.

PRESSURE – FLOW RELATIONS OF OUR ROUND DRIP IRRIGATION PIPES

The average drip flow rates (q) under the various working pressures of (4,0 L/h Flow rate) drips which take place inside of Ø 16 mm round drip irrigation pipes that have been tested, the drip parameters (k, x) which describes the drip features and the production disparities coefficient (Vm) is shown in Chart 1 and the graphs showing the pressure - flow rate relations are shown in Chart 2.



Çalışma Basıncı Working Pressure	**Ortalama Damlatıcı Debisi** Average Dripper Flow	**Damlatıcı Parametreleri** Dripper Parameters (q=khx)		**Tahminleme Katsayısı** Estimation Coefficient	**Yapım Farklılığı Katsayısı** Production Difference Coefficient
h (Bar)	q (L/h)	k*	k**	R^2	Vm
0,5	2,66	3,855	0,515	0,995	0,0139
1,0	3,95				
1,5	4,79				
2,0	5,48				
2,5	6,12				

(*) Damlatıcı boyutlarını karakterize eden katsayı - Dripper Dimensions characterization coefficient
(**) Damlatıcı akış rejimi katsayısı (akış üssü değeri) - Dripper flow coefficient

Çizelge 1: **Ø 16 mm yuvarlak damla sulama borularımıza ait (4,0 L/s Debili) damlatıcıların farklı çalışma basınçlarındaki ortalama damlatıcı debileri, damlatıcı parametreleri ve yapım farklılığı katsayısı**

Chart 1: The average drip flow rates under the various working pressures of (4,0 L/h Flow) drips belong to our Ø 16 mm round drip irrigation pipes, the drip parameters and the production disparities coefficient

Çizelge 2: **Ø 16 mm yuvarlak damla sulama borularımızın (4,0 L/s Debili) damlatıcılarına ait basınç - debi ilişkisi**

Chart 2: **The pressure - Flow rate relations belong to the (4,0 L/h Flow) drips of our Ø 16 mm round drip irrigation pipes**

Çizelge 1'den de görüleceği gibi ilgili kuruluşlarca yapılan deneylerde Ø 16 mm yuvarlak damla sulama borularımızda yer alan, 4,0 L/s debili damlatıcımızın yapım farklılığı katsayısı Vm= 0,0249 olarak bulunmuş olup, bu değerler ASABE (American Society Of Agricultural and Biological Engineers) Standartları tarafından verilen sınıflandırmaya göre ''MÜKEMMEL'' sınırları içerisinde yer almaktadır.

As it is seen in Chart 1, the production disparities coefficient of our 4,0 L/h flow drips of our Ø 16 mm round drip irrigation pipes that have been tested, its production disparities coefficient has been found as Vm= 0,0249; this value takes place within the "EXCELLENT" limits according to the classification ascribed by ASABE (American Society Of Agricultural and Biological Engineers) Standards.

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The optimum lateral lengths to provide equal water distribution at various operation conditions (operation pressure and slope) of our Ø 16 mm external diameter, 4,0 L/h flow Round Drip irrigation pipes are given in Chart 3.

Çizelge 3: **Ø 16 mm dış çaplı , 4,0 L/s debili yuvarlak damla sulama borularımızın farklı işletme koşullarındaki eşit su dağılımını sağlayacak optimum lateral uzunlukları (lateral sonu basıncı: 1 bar)**

Chart 3: The optimum lateral lengths to provide equal water distribution at various operation conditions of our Ø 16 mm external diameter, 4,0 L/h flow Round Drip Irrigation Pipes (lateral end pressure: 1 bar)

Damlatıcı Aralığı Dripper Space (cm)	Debi Değişimi Flow Rate Change q (değişim) %	Lateral Uzunlukları / Lateral Lenght (m)						
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20	10	30	31	32	33	28	27	25
	15	35	36	37	38	34	33	31
	20	40	41	42	43	39	38	37
25	10	35	37	38	40	33	31	29
	15	42	43	45	46	40	38	36
	20	47	49	50	51	46	44	43
33	10	43	45	48	50	40	37	34
	15	51	53	55	57	48	46	43
	20	58	60	62	64	55	53	51
40	10	49	52	56	58	45	42	38
	15	58	62	64	67	55	52	48
	20	66	70	72	74	63	60	57
50	10	58	63	67	71	53	48	43
	15	69	73	77	80	64	60	55
	20	79	83	86	89	74	70	66
60	10	66	72	77	82	59	53	47
	15	79	84	89	93	72	67	61
	20	89	95	99	103	84	79	73
75	10	77	86	93	100	68	59	52
	15	92	100	107	113	84	76	68
	20	105	113	119	125	98	90	83
100	10	96	108	119	128	81	69	58
	15	114	125	135	144	101	89	79
	20	130	140	149	158	118	107	97

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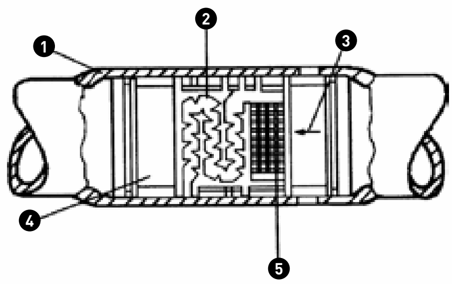

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