IMPACTS OF DIFFERENT WATER LEVELS ON YIELD, WATER USE EFFICIENCY AND FIBER QUALITY PROPERTIES OF COTTON (*GOSSYPIUM HIRSUTUM* L.) IRRIGATED BY DRIP SYSTEMS

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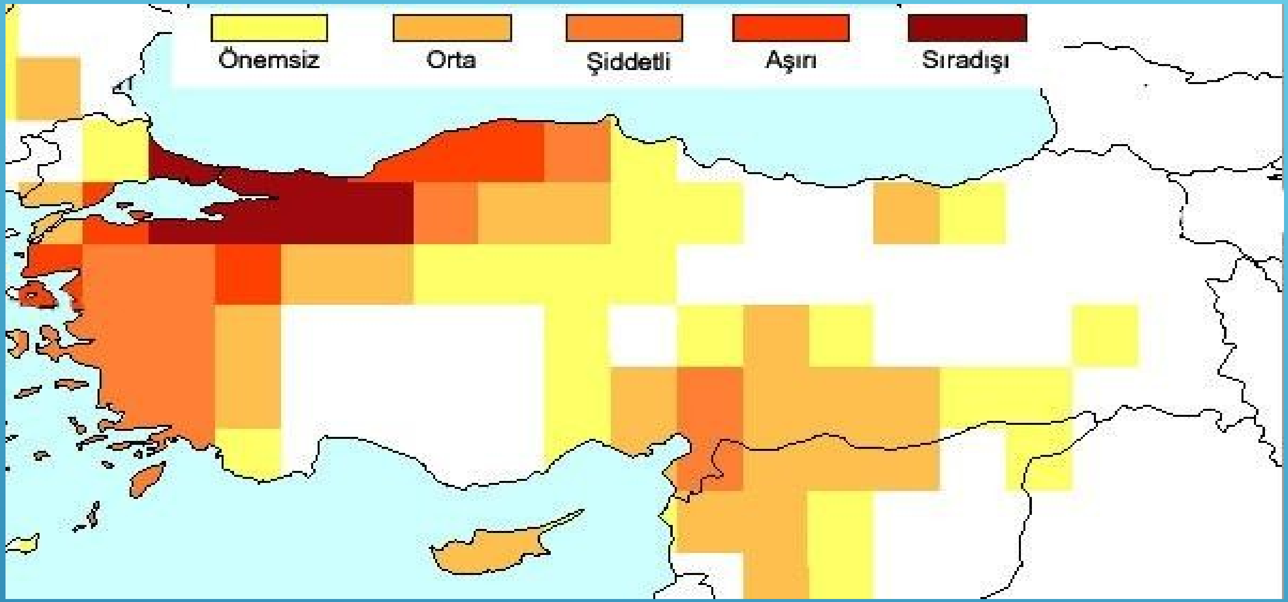
INTRODUCTION

- **The Aegean region is one of the most important agricultural and industrial region in Turkey.**
- **All cotton production areas of western Turkey receive inadequate amounts or inadequate distribution of rainfall.**
- **Present cotton production in Turkey is about 602 000 tons of lint cotton from 450 000 ha.**
- **The Aegean region of western Turkey produces 41.2 % of the national cotton production of the country [1].**

- Irrigation water availability is a major concern in cotton production during the hot and dry summer period like Aegean region.
- Water shortage, increasing production cost and low water use efficiency (WUE) made the economical profit marginal and challenging to the end users.
- Thus new irrigation strategies must be established to use the limited water resource more efficiently. One of the new irrigation strategies is the deficit irrigation scheduling, which is a valuable and sustainable production strategy for dry regions [2].
- However, the use of drip irrigation techniques is inevitable in the near feature because of the salinity problem caused by traditional irrigation methods [3].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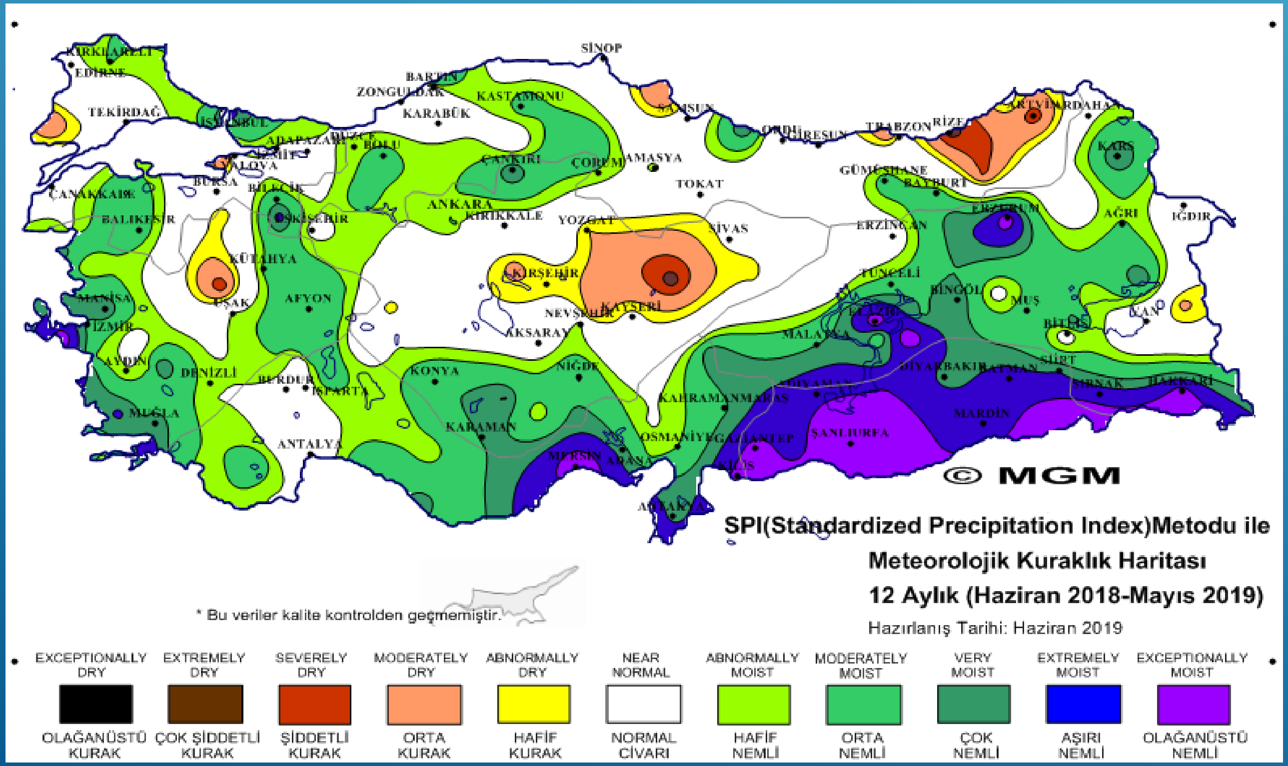
© MGM
SPI(Standardized Precipitation Index)Metodu ile
Meteorolojik Kuraklık Haritası
12 Aylık (Haziran 2018-Mayıs 2019)
Hazırlanış Tarihi: Haziran 2019
* Bu veriler kalite kontrolden geçmemiştir.
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EXTREMELY DRY
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OLAĞANÜSTÜ KURAK
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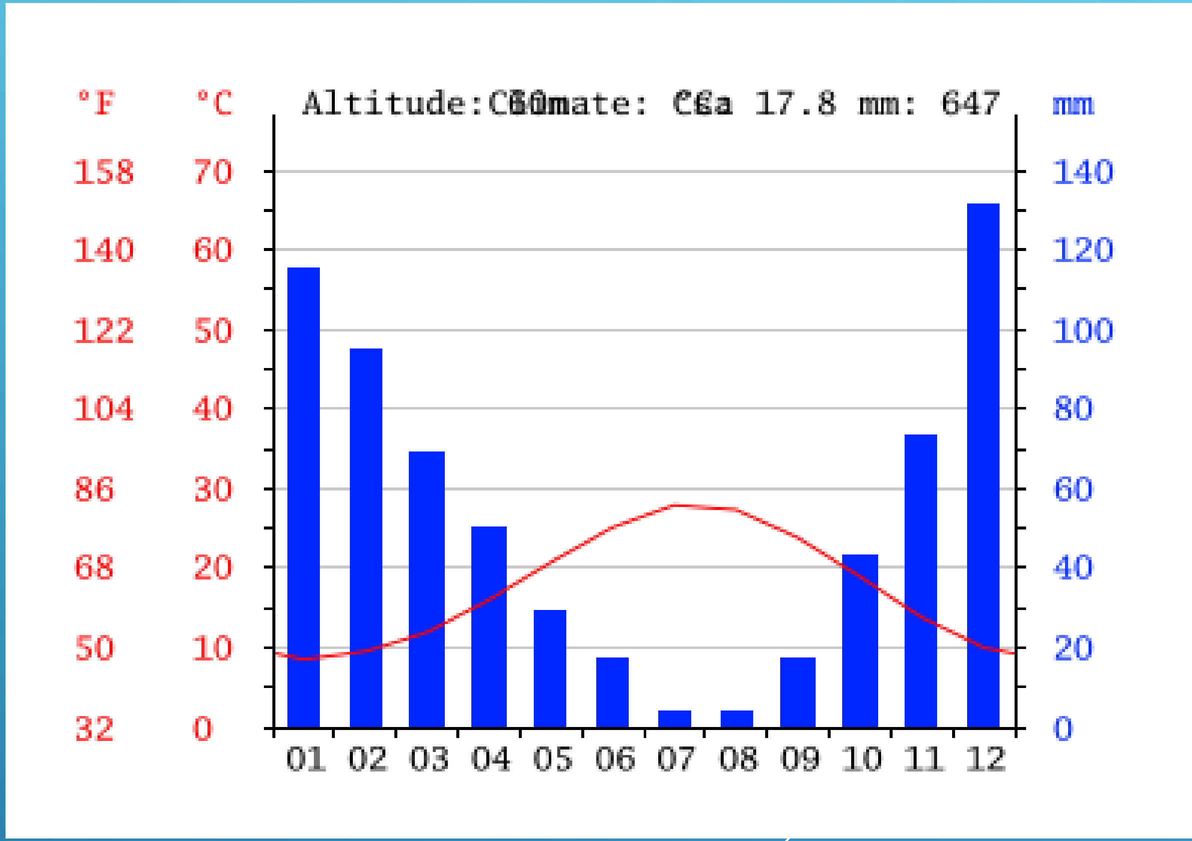
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158 140 122 104 86 68 50 32
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140 120 100 80 60 40 20 0
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- **Also, drip irrigation have been suggested as a means of supplying most types of crops with frequent and uniform applications of water, adaptable over a wide range of topographic and soil conditions [4].**

- **Under good management practices, deficit irrigation can result in substantial water savings with little impact on the quality and quantity of the harvested yield.**

- **The dependence of crop yields on water supply is a critical issue due to the increasingly limited water resources for irrigation in the Aegean region and its semi-arid climate.**
- **However, little attempt has been made to assess deficit irrigation regimes for cotton under drip irrigation in the Aegean region. Therefore, this research was conducted to evaluate the water use efficiency, yield and fiber quality of cotton under different deficit drip irrigation regimes.**

- **This study was conducted during the growing seasons of 2017-2018 at the Agricultural Research Station of Adnan Menderes University, Aydin-Turkey at 37° 51’ N latitude, 27°51’ E longitude. There was no waterlogging problem and the average annual rainfall was 668,4 mm with a mean monthly temperature of 17.96 ^{o}C according to long-term meteorological data (1975-2017) in the experimental area. Total rainfall during the growing periods was 135.3 and 171,2 mm in 2017 and 2018 respectively**.

MATERIALS AND METHODS

- **The soil type of the experiental area was loam and sandy loam in texture. For the cotton experiment area, water content at field capacity varied from 20.3 to 27.6 % and wilting point varied from 7.2 to 9.7 % on dry weight basis. The dry soil bulk densities ranged from 1.42 to 1.50 g cm^{-3} throughout the 1.2 m deep profile. The total available soil water content within the top 1.2 m of the soil profile was 281 mm.**

- **Carmen cotton variety was planted second week of May in 2017 and 2018, respectively. Cotton plants were thinned to a spacing of 0.70 m (row width) x 0.15 m when the plants were about 0.15 m in height. A compound fertilizer (each included 15 % composite) was applied at a rate of 60 kg ha^{-1} pure N, P and K at planting. The required remaining portion of nitrogen was followed by 82 kg ha^{-1} as ammonium nitrate 33 % before first irrigation.**

- **Treatment layout was conducted to a randomised complete block design as three replications. There were 3.0 m apart between each plot in order to minimize water movement among treatments. Each experimental plot was designed as 6.0 x 4.2 m (6 rows per plot) and had a total area of 25.2 m^2 at sowing. In the study, five irrigation treatments, differing in irrigation rate was evaluated.**





- Control treatment T_{100} was designated to receive 100 % soil water depletion and irrigation was applied when ~50% of available soil moisture was consumed in the 1.20 m root zone at T_{100} treatment during the irrigation periods. In treatments, T_{75}; T_{50}; T_{25} and T_{00} irrigations were applied at the rates of 75, 50, 25 and 0 % of control treatments (T_{100}) on the same day, respectively.

- Soil water level was monitored by using the gravimetric method from the plots of the second replication of the various treatments. Cotton yield was determined by hand harvesting the two center rows in each plot on 16 September 2017 and on 17 September 2018. Crop evapotranspirations under varying irrigation regimes were calculated using the soil water balance equation as [12]:
- $$ET = R + I - D \pm \Delta W \qquad (1)$$

- Water use efficiency (WUE) was calculated as yield (kg ha^{-1}) divided by seasonal evapotranspiration (mm). Irrigation water use efficiency (IWUE) was determined as yield (kg ha^{-1}) per unit irrigation water applied[13] (mm).
- Analysis of variance (ANOVA) was conducted to evaluate the effects of the treatments on seed cotton yield (kg ha^{-1}). Duncan’s multiple range test was used to compare and rank the treatment means. Differences were declared significant at $P < 0.05$ or $P < 0.01$.

- **The total number of irrigation, irrigation water amounts applied, seasonal water use and water use efficiency values of cotton for the experimental years were presented in Table 1. The amount of irrigation water applied for different treatment of cotton ranged from 700 to 175 mm in 2017 and from 690 to 173 mm in 2018.**
- **The results were similar for both years The seasonal irrigation water applied in T_{100} treatment was maximum in growing season suggesting that water applied was enough to meet the full crop water requirements in both years. Seasonal water use varied between 315 and 785 mm in 2017 and between 305 and 775 mm in 2018. This small difference in water use between the years can be attributed to the variations in climatic factors.**

RESULTS AND DISCUSSION

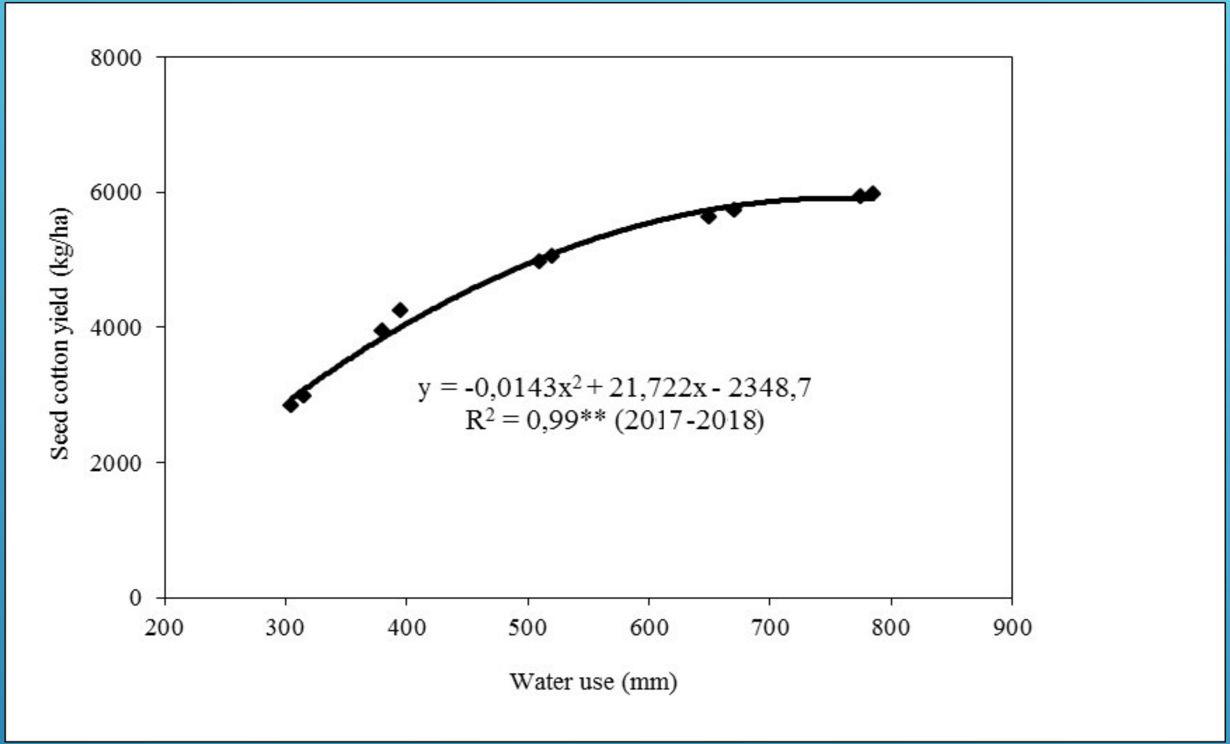
WATER USE- YIELD PARAMETERS

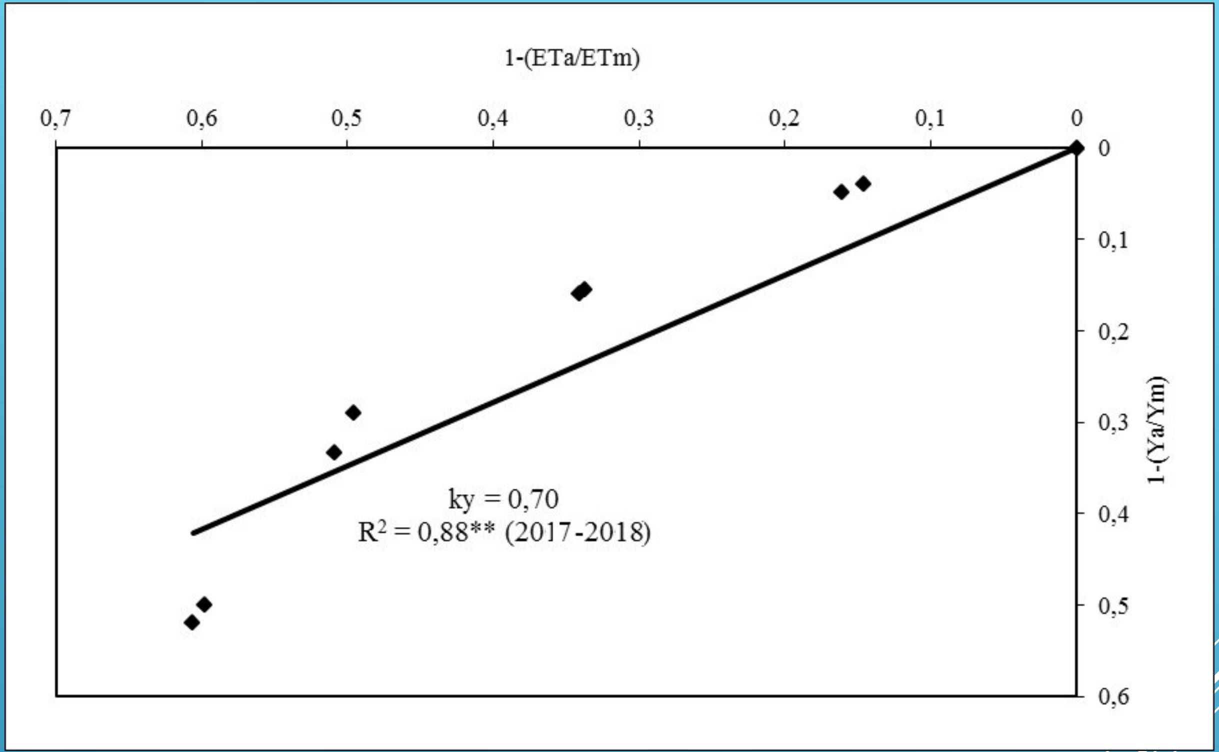
Year	Treatment	Number of irrigation	Irrigation water applied (mm)	Water use (mm)	Seed cotton yield (kg ha^{-1})	IWUE (kg m^{-3})	WUE (kg m^{-3})
2017	T_{100}	5	700	785	5980a**	0.85	0.76
	T_{75}	5	563	670	5740b	1.02	0.85
	T_{50}	5	350	520	5050c	1.44	0.97
	T_{25}	5	175	395	4240d	2.42	1.07
	T_{00}	-	-	315	2985e	-	0.94
2018	T_{100}	5	690	775	5925a**	0.86	0.76
	T_{75}	5	518	650	5640b	1.09	0.87
	T_{50}	5	345	510	4980c	1.44	0.98
	T_{25}	5	173	380	3950d	2.28	1.04
	T_{00}	-	-	305	2840e	-	0.93

Table 1. **Total number of irrigation, amount of irrigation, water use, seed cotton yield and water use efficiencies of cotton for the experiment period in 2017-2018**

**** - different letters indicate significant differences at *P*< 0.01 using Duncan's multiple range test**

- Seasonal water use of cotton under the same region has been reported as 899 mm and between 855-882 mm under furrow irrigation system [14,15]. Once the results of this study are compared with those of furrow irrigation studies at the same region, it is clear that drip irrigation systems are able to save substantial amount of water. Under drip irrigation applications, seasonal water use of cotton was obtained as 435-615 mm in Çukurova conditions, and 456-868 mm in southeast Turkey [16,17].
- In addition, water use of cotton was determined as 265-753 mm for a 2 year study of deficit and full irrigation in Aydın province and with values of approximately 748-760 mm for the Aydın Plain conditions by using drip system [9,10]. On the other hand, the seasonal water use in cotton varied between 432 and 739 mm depending on irrigation regimes in Uzbekistan conditions by using drip and furrow irrigation methods [18]. In southeastern Turkey, a total of 814 mm irrigation water was applied to LEPA and drip irrigated cotton [17].





CROP RESPONSE TO WATER STRESS (K_Y)

Year	Treatments	Fiber length (mm)	Fiber strength (g/tex)	Fiber fineness (micronaire)
2017	T_{100} T_{75} T_{50} T_{25} T_{00}	30.8a* 30.0ab 29.5ab 28.6b 28.0c	32.1a* 31.9ab 29.5b 28.0c 27.8c	4.94a* 4.88ab 4.80ab 4.60bc 4.51c
2018	T_{100} T_{75} T_{50} T_{25} T_{00}	29.7a* 28.5ab 26.7bc 25.8c 25.3c	31.8a* 30.5a 28.9b 28.0c 27.8c	5.01a* 4.94ab 4.83bc 4.71bc 4.63c

* - different letters indicate significant differences at *P*< 0.05 using Duncan's multiple range test

FIBER QUALITY PARAMETERS

- **It is concluded that seed cotton yield and fiber qualities were significantly affected by drip irrigation application rate in 2017 and 2018.**
- **Seasonal water use was 315-785 mm and 305-775 mm in 2017 and 2018, respectively.**
- **Seed cotton yields were positively influenced by increased irrigation levels in both growing seasons. The highest seed cotton yield was obtained from the T_{100} treatment for both years. Maximum seed cotton yield was obtained from the T_{100} treatment, with 700 and 690 mm irrigation water resulting in 5980 and 5925 kg ha^{-1}.**
- **WUE and IWUE values decreased with increase in irrigation water applied in both years.**
- **The average yield response factor (k_y) was determined to be 0.70. The WUE and k_y values obtained here could be used for the purposes of irrigation management and water allocation scheduling for irrigation schemes under limited irrigation water supply. A positive linear relationship between seasonal water use rate and yield existed during the experimental years.**

CONCLUTIONS

- **Thank you very much for your Attention**