RESULTS AND DISCUSSIONS

4. RESULTS AND DISCUSSION

4.1. EVAPOTRANSPIRATION

Evapotranspiration is the loss of water from plants and soil to the atmosphere . This process includes evaporation from the soil and plant surfaces plus transpiration of water from within the plant. Meteorological factors such as radiation, temperature, relative humidity and wind velocity, control evaporation from free water surfaces . Factors related to the crop and the soil, in addition to these meteorological factors, affect evapotranspiration from a cropped soil (Rijetma , 1965).

4.1.1. Actual Evapotranspiration

4.1.1.1. Seasonal Rates

A detailed summary of evapotranspiration rates of wheat as a function of growth regulators and antitranspirants under three soil moisture stresses during the two seasons is presented in Tables (8 , 9 , 10 , 11 , 12 and 13) and illustrated in Figures (3 , 4 and 5). The results clearly show that seasonal evapotranspiration vary widely between 394.9 and 555.2 mm. under the various treatments . It seems that water consumptive use values by wheat were higher in the first season than those obtained in the second irrespective to the effect of the different treatments . This is mainly due to the differences in climatic conditions . In this respect , Pruitt (1960) concluded that studies had

Table (8): Effect of growth regulators and antitranspirants on evapotranspiration rates of wheat under low soil moisture stress in mm. /week during season 1980 / 1981 .

Periods / Substances		2/12 8/12	9/12 15/12	16/12 22/12	23/12 29/12	30/12 5/1	6/ 1 12/ 1	13/1 19/1	20/1 26/1	27/1 2/2	3/2 9/2	10/2 16/2	17/2 23/2	24/2 2/3	3/3 9/3	10/3 16/3	17/3 23/3	24/3 30/3	31/3 6/4	7/4 13/4	14/4 20/4	21/4 27/4	28/4 30/4	Seasonal Et mm.
Control																								
0		8.1	8.1	8.1	11.9	15.5	19.0	24.0	27.0	29.0	32.4	33.9	35.8	35.1	39.8	44.8	40.9	36.8	32.8	28.8	23.3	15.5	4.6	555.2
Growth Promoters																								
NAA	50 ppm.	8.1	8.1	8.1	11.9	15.5	19.0	24.0	27.0	30.9	34.5	33.4	37.1	37.4	40.5	43.8	46.8	43.1	36.7	32.5	25.9	16.2	4.6	585.1
NAA	100 ppm.	8.1	8.1	8.1	11.9	15.5	18.3	23.0	28.3	30.7	36.3	35.3	37.8	36.1	40.3	45.4	49.4	42.0	36.0	30.4	25.5	16.9	4.6	588.5
GA_3	50 ppm.	8.1	8.1	8.1	11.9	15.5	19.1	23.6	28.4	30.1	35.2	36.7	37.7	38.0	41.6	43.6	47.2	38.3	35.1	30.5	24.5	16.1	4.6	582.0
GA_3	100 ppm.	8.1	8.1	8.1	11.9	15.5	18.6	23.8	27.8	30.7	37.9	36.1	38.8	36.8	37.6	44.2	47.6	41.3	36.1	32.5	26.5	16.5	4.6	589.1
Growth Retardants																								
Alar	500 ppm.	8.1	8.1	8.1	11.9	15.5	19.3	23.8	27.7	27.9	29.5	30.4	31.2	33.1	36.3	39.3	37.8	33.6	31.6	28.0	25.2	16.3	4.5	527.2
Alar	1000 ppm.	8.1	8.1	8.1	11.9	15.5	19.1	24.1	27.9	27.1	29.3	28.7	30.4	34.9	37.1	38.1	36.6	32.3	31.0	29.4	26.2	16.6	4.6	521.5
Ethrel	500 ppm.	8.1	8.1	8.1	11.9	15.5	19.0	23.9	27.1	26.5	27.8	30.7	32.9	34.8	36.0	38.1	35.2	31.0	31.0	27.9	25.2	16.8	4.6	520.2
Ethrel	1000 ppm.	8.1	8.1	8.1	11.9	15.5	19.3	23.7	25.3	27.1	29.0	31.0	31.0	33.2	35.4	39.6	36.3	33.1	31.3	28.4	26.5	16.6	4.6	523.1
Antitranspirants																								
PMA	5 x10^{-5}<u>M</u>	8.1	8.1	8.1	11.9	15.5	14.9	20.1	24.0	26.3	27.4	30.8	32.1	33.9	37.3	41.5	36.9	32.3	31.7	27.3	23.4	15.9	4.7	512.2
PMA	1 x10^{-4}<u>M</u>	8.1	8.1	8.1	11.9	15.5	14.0	17.7	22.1	24.9	25.3	27.2	29.9	33.8	34.6	38.6	35.8	34.2	32.0	28.4	23.9	15.7	4.6	494.4
Sulphonates	1 x10^{-2}<u>M</u>	8.1	8.1	8.1	11.9	15.5	17.0	23.5	25.0	27.2	27.4	31.9	34.9	35.7	38.9	43.9	37.8	35.7	32.4	29.2	23.1	14.7	4.6	534.6
Sulphonates	5 x10^{-2}<u>M</u>	8.1	8.1	8.1	11.9	15.5	16.7	23.2	24.0	27.9	25.9	30.7	35.2	34.5	38.1	43.7	38.3	35.9	32.5	29.1	23.3	15.1	4.6	530.4
Mean		8.1	8.1	8.1	11.9	15.5	18.0	23.0	26.3	28.2	30.6	32.1	34.2	35.2	38.0	41.9	40.5	36.1	33.1	29.4	24.8	16.1	4.6	543.7

(Low soil moisture stress = 30 % depletion in available water)

Table (9): Effect of growth regulators and antitranspirants on evapotranspiration rates of wheat under medium soil moisture stress in mm. / week during season 1980 / 1981

Substances	Periods	2/12 8/12	9/12 15/12	16/12 22/12	23/12 29/12	30/12 5/ 1	6/ 1 12/1	13/1 19/1	20/1 26/1	27/1 2/2	3/ 2 9/ 2	10/2 16/2	17/ 2 23/2	24/ 2 2/ 3	3/ 3 9/ 3	10/3 16/3	17/ 3 23/ 3	24/3 30/3	31/3 6/4	7/ 4 13/4	14/ 4 20/ 4	21/4 27/4	28/ 4 30/ 4	Seasonal Et. mm.
Control																								
0		8.1	8.1	8.1	10.8	13.9	16.6	18.4	21.2	25.1	28.8	31.4	33.8	34.7	37.1	39.5	36.2	31.1	27.7	24.1	21.3	15.3	4.3	495.6
Growth Promoters																								
NAA	50 ppm.	8.1	8.1	8.1	10.8	13.9	16.6	18.3	20.8	26.7	28.0	33.3	32.8	36.2	36.7	42.3	42.9	34.2	33.6	27.4	21.8	15.2	4.3	520.1
NAA	100 ppm.	8.1	8.1	8.1	10.8	13.9	16.6	18.2	20.9	26.3	27.8	33.7	32.2	35.0	36.7	43.4	40.6	36.2	33.4	26.9	20.9	15.6	4.4	517.8
GA_3	50 ppm.	8.1	8.1	8.1	Lo.8	13.9	L6.7	18.1	20.8	26.6	29.1	33.0	34.4	36.3	36.2	43.2	38.6	35.9	32.1	27.0	20.2	15.5	4.3	517.0
GA_3	100 ppm.	8.1	8.1	8.1	10.8	13.9	16.4	18.9	21.4	25.8	27.9	31.4	34.0	36.9	37.1	44.3	39.9	36.1	33.4	26.4	22.7	15.7	4.3	521.6
Growth Retardants																								
Alar	500 ppm.	8.1	8.1	8.1	10.8	13.9	16.6	19.1	21.6	23.5	24.7	26.2	30.6	31.6	33.8	37.0	34.9	31.4	28.1	25.2	20.7	15.5	4.4	473.9
Alar	1000 ppm.	8.1	8.1	8.1	10.8	13.9	16.7	18.6	21.5	24.1	25.2	25.9	28.3	30.1	32.9	38.9	34.2	31.1	28.6	24.7	20.7	15.8	4.4	470.7
Ethrel	500 ppm.	8.1	8.1	8.1	10.8	13.9	16.8	18.9	21.3	26.9	26.9	26.3	30.5	32.9	32.9	37.4	35.0	32.6	27.7	23.3	20.4	15.7	4.4	478.9
Ethrel	1000 ppm.	8.1	8.1	8.1	10.8	13.9	16.7	19.2	21.5	25.3	26.0	27.2	31.1	31.3	32.4	37.9	35.1	29.7	26.1	21.9	21.1	15.2	4.4	471.1
Antitranspirants																								
PMA	5 $x10^{-5}$M	8.1	8.1	8.1	10.8	13.9	14.6	15.6	19.1	21.6	23.5	28.5	31.1	31.2	34.3	38.5	35.6	32.0	26.3	23.2	20.1	15.4	4.4	464.0
PMA	1 $x10^{-4}$M	8.1	8.1	8.1	10.8	13.9	14.2	14.8	17.3	19.4	22.3	23.4	29.2	32.6	34.6	37.1	34.3	32.3	27.6	25.5	19.5	15.6	4.4	453.1
Sulph-onates	1 $x10^{-2}$M	8.1	8.1	8.1	10.8	13.9	14.9	17.3	20.1	24.7	27.2	28.4	32.7	33.1	35.1	38.8	35.2	32.9	28.9	25.6	18.9	15.6	4.5	482.8
Sulph-onates	5 $x10^{-2}$M	8.1	8.1	8.1	10.8	13.9	14.5	17.1	19.0	23.8	25.4	26.9	32.4	33.2	37.1	39.8	34.4	33.3	28.3	25.2	18.3	15.6	4.4	477.6
Mean		8.1	8.1	8.1	10.8	13.9	16.0	17.9	20.5	24.6	26.4	28.9	31.8	33.5	35.2	39.9	36.7	33.0	29.4	25.1	20.5	15.5	4.4	488.3

(Medium soil moisture stress = 60 % depletion in available water)

Table (10): Effect of growth regulators and antitranspirants on evapotranspiration rates of wheat under high soil moisture stress in mm. / week during season 1980 / 1981

Substances	Periods	2/12 8/12	9/12 15/12	16/12 22/12	23/12 29/12	30/12 5/ 1	6/ 1 12/1	13/1 19/1	20/1 26/1	27/ 1 2/ 1	3/2 9/2	10/ 2 16/ 2	17/ 2 23/ 2	24/2 2/3	3/3 9/3	10/ 3 16/3	17/ 3 23/ 3	24/3 30/3	31/ 3 6/ 4	7/4 13/4	14/4 20/4	21/4 27/4	28/4 30/4	Seasonal ET. mm.
Control																								
0		8.1	8.1	8.1	10.6	13.8	15.4	15.7	17.5	22.4	26.7	24.9	27.8	30.0	33.4	31.9	28.5	23.5	21.1	20.1	16.4	15.5	4.4	423.9
Growth Promoters																								
NAA	50 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	15.3	17.5	22.5	26.1	25.2	29.3	30.1	33.2	33.1	30.4	25.2	21.0	20.3	16.3	15.5	4.4	429.5
NAA	100 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	15.3	17.9	22.2	25.9	26.0	28.2	30.7	32.7	32.0	30.3	25.1	21.4	21.2	17.1	15.5	4.4	430.0
GA_3	50 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	15.7	17.4	23.9	26.1	25.3	29.4	30.9	32.1	33.0	29.2	25.2	21.0	20.0	16.9	15.5	4.4	430.1
GA_3	100 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	15.7	18.3	21.6	25.3	25.4	29.6	30.4	33.5	32.5	30.3	25.2	22.0	20.1	16.3	15.5	4.4	430.2
Growth Retardants																								
Alar	500 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	16.1	18.3	21.6	23.8	23.5	26.3	29.0	32.3	30.5	27.2	23.1	20.6	20.1	16.3	15.5	4.4	412.7
Alar	1000 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	16.6	17.4	20.9	23.2	24.6	25.9	29.2	32.9	30.3	27.2	23.1	20.6	20.0	16.3	15.5	4.4	412.2
Ethrel	500 ppm.	8.1	8.1	8.1	10.6	13.8	15.4	15.3	17.4	20.4	23.3	25.4	25.3	29.1	32.0	30.3	27.2	22.9	20.8	20.0	16.3	15.5	4.4	409.7
Ethrel	1000 ppm.	8.1	8.1	8.1	10.6	13.8	15.5	15.7	17.3	21.0	22.7	25.4	25.7	29.2	32.1	30.1	27.2	23.0	20.8	20.0	16.3	15.6	4.5	410.8
Antitranspirants																								
PMA	5 $\times 10^{-5}$ M	8.1	8.1	8.1	10.6	13.8	14.5	14.7	16.1	20.4	21.7	22.2	24.3	28.5	32.7	30.5	26.9	23.1	21.0	19.9	16.7	15.5	4.5	401.9
PMA	1 $\times 10^{-4}$ M	8.1	8.1	8.1	10.6	13.8	13.8	14.1	15.3	19.6	20.3	22.8	24.3	27.4	31.4	30.3	27.7	22.2	20.7	19.9	16.3	15.6	4.5	394.9
Sulphonates	1 $\times 10^{-2}$ M	8.1	8.1	8.1	10.6	13.8	14.2	14.7	16.3	21.1	23.6	25.0	26.3	30.3	33.9	31.9	28.3	23.2	21.7	19.9	16.5	15.6	4.5	415.7
Sulphonates	5 $\times 10^{-2}$ M	8.1	8.1	8.1	10.6	13.8	14.8	14.6	15.6	20.6	24.1	24.3	26.3	30.5	33.0	31.0	27.7	23.2	21.9	19.9	16.4	15.6	4.5	413.6
Mean		8.1	8.1	8.1	10.6	13.8	15.1	15.4	17.1	21.4	24.1	24.7	26.8	29.6	32.7	31.3	28.3	23.7	21.1	20.1	16.5	15.5	4.4	416.5

(High soil moisture stress = 90 % depletion in available water)

Table (11): Effect of growth regulators and antitranspirants on evapotranspiration rates of wheat under low soil moisture stress in mm. /week during season 1981 / 1982

Substances / Periods	23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	21/12 27/12	28/12 3/ 1	4/ 1 10/ 1	11/1 17/1	18/ 1 24/1	25/1 31/1	1/ 2 7/2	8/ 2 14/2	15/2 21/2	22/ 2 28/ 2	1/3 7/3	8/3 14/3	15/3 21/3	22/3 28/3	29/3 4/4	5/4 11/4	12/4 18/4	19/ 4 25/4	Seasonal Et mm.
Control																							
0	7.7	7.7	7.7	10.4	13/7	16.6	22.3	25.4	27.1	33.8	33.0	35.6	36.7	37.0	41.9	38.3	33.6	31.9	26.6	24.3	17.4	11.5	540.2
Growth promoters																							
NAA 50 ppm.	7.7	7.7	7.7	10.4	13.7	16.7	21.7	25.2	29.8	36.0	37.2	39.3	40.6	42.2	44.9	45.3	35.2	33.7	30.2	26.2	17.1	11.6	580.1
NAA 100 ppm.	7.7	7.7	7.7	10.4	13.7	16.7	22.7	24.9	29.9	35.5	36.8	38.4	37.8	40.1	45.1	46.2	36.0	34.4	27.7	24.9	17.2	11.6	573.1
GA_3 50 ppm.	7.7	7.7	7.7	10.4	13.7	17.1	22.9	24.8	30.7	35.3	36.9	38.2	39.3	42.8	44.7	46.2	36.6	32.8	27.1	26.5	17.7	11.6	578.4
GA_3 100 ppm.	7.7	7.7	7.7	10.4	13.7	17.2	22.2	24.4	30.7	33.4	37.5	34.9	37.5	42.9	44.2	47.3	37.3	33.0	27.7	25.7	17.5	11.6	572.2
Growth Retardants																							
Alar 500 ppm.	7.7	7.7	7.7	10.4	13.7	17.9	21.2	23.5	22.6	28.5	33.1	31.4	35.2	36.3	34.5	42.6	34.3	28.5	25.4	26.2	16.9	11.6	516.9
Alar 1000 ppm.	7.7	7.7	7.7	10.4	13.7	17.9	21.8	22.0	26.2	30.4	34.1	29.6	35.7	37.3	34.5	36.6	32.4	27.9	25.5	23.7	16.7	11.6	511.1
Ethrel 500 ppm.	7.7	7.7	7.7	10.4	13.7	17.3	21.3	23.0	25.8	29.5	29.4	29.6	33.7	36.7	38.3	37.0	33.7	29.8	25.4	22.3	17.1	11.6	508.4
Ethrel 1000 ppm.	7.7	7.7	7.7	10.4	13.7	16.6	21.6	23.0	25.2	30.4	31.1	30.6	33.7	36.9	38.1	36.3	31.6	28.2	24.7	23.2	16.9	11.6	506.9
Antitranspirants																							
PMA 5 $x10^{-5}$M	7.7	7.7	7.7	10.4	13.7	14.9	18.2	20.1	22.5	25.3	29.0	31.7	34.9	36.0	40.1	38.9	34.4	30.3	29.1	24.5	16.9	11.6	505.6
PMA 1 $x10^{-4}$M	7.7	7.7	7.7	10.4	13.7	14.0	16.0	19.6	22.8	23.9	27.8	30.1	32.1	36.5	38.8	36.6	33.3	31.1	25.7	24.7	16.9	11.6	488.7
Sulph- onates 1 $x10^{-2}$M	7.7	7.7	7.7	10.4	13.7	15.4	18.6	22.4	24.9	32.0	32.2	35.4	35.1	39.8	40.7	37.6	32.4	30.9	26.3	24.5	17.6	11.6	524.6
Sulph- onates 5 $x10^{-2}$M	7.7	7.7	7.7	10.4	13.7	15.0	18.6	21.3	26.3	30.7	31.9	34.1	34.8	37.2	40.9	37.6	33.7	29.4	27.1	23.0	17.6	11.6	518.0
Mean	7.7	7.7	7.7	10.4	13.7	16.4	20.7	23.0	26.5	31.1	33.2	33.9	35.8	38.6	40.7	40.5	34.3	30.9	26.8	24.6	17.2	11.6	533.1

(Low soil moisture stress = 30 % depletion in available water)

Table (12): Effect of growth regulators and antitranspirants on evapotranspiration rates of wheat under medium soil moisture stress in mm. / week during season 1981 / 1982 .

Periods / Substances		23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	2L/12 27/12	28/12 3/ 1	4/1 10/1	11/1 17/1	18/1 24/1	25/ 1 31/1	1/ 2 7/2	8/2 14/2	15/ 2 21/2	22/2 28/2	1/ 3 7/ 3	8/3 14/3	15/ 3 21/ 3	22/3 28/3	29/3 4/4	5/4 11/4	12/4 18/4	19/4 25/4	Seasonal ET mm.
												Control												
0		7.7	7.7	7.7	9.9	13.5	15.8	19.5	21.9	23.7	27.9	30.6	32.0	33.5	35.2	38.6	36.3	30.2	26.9	22.7	19.8	17.8	11.5	490.4
												Growth Promoters												
NAA	50 ppm.	7.7	7.7	7.7	9.9	13.5	15.8	19.7	21.8	25.9	30.6	32.5	34.9	35.4	37.3	41.1	43.1	34.4	28.1	22.8	18.9	17.8	11.5	518.1
NAA	100 ppm.	7.7	7.7	7.7	9.9	13.5	15.8	19.5	21.4	25.9	31.7	32.4	35.0	37.3	37.2	41.1	41.2	35.1	29.1	22.8	18.5	17.8	11.5	519.8
GA_3	50 ppm	7.7	7.7	7.7	9.9	13.5	15.8	19.1	22.7	24.9	28.7	34.2	36.1	35.5	36.9	42.1	38.7	35.2	29.1	22.3	19.7	17.8	11.5	516.8
GA_3	100 ppm.	7.7	7.7	7.7	9.9	13.5	15.6	19.3	21.3	26.5	30.2	35.5	34.3	36.2	36.3	40.5	41.2	37.2	29.1	22.3	19.1	17.6	11.5	520.2
												Growth Retardants												
Alar	500 ppm.	7.7	7.7	7.7	9.9	13.5	15.7	19.3	21.3	24.1	25.7	28.6	30.0	32.3	40.0	36.9	33.5	29.3	25.5	21.1	18.5	17.3	11.5	471.1
Alar	1000 ppm.	7.7	7.7	7.7	9.9	13.5	15.8	19.3	21.8	23.2	25.3	29.5	30.1	30.9	33.5	36.6	33.2	28.1	25.9	21.2	18.7	17.3	11.5	468.4
Ethrel	500 ppm.	7.7	7.7	7.7	9.9	13.5	15.8	19.3	21.8	23.2	26.2	28.5	30.3	32.1	33.9	35.8	32.9	29.2	25.7	21.2	18.5	17.3	11.5	469.7
Ethrel	1000 ppm.	7.7	7.7	7.7	9.9	13.5	15.8	19.3	21.8	24.2	25.6	28.9	29.2	32.0	34.0	36.7	32.7	28.5	24.3	21.3	18.1	17.3	11.5	467.7
												Antitranspirants												
PMA	5 $\times 10^{-5}$ M	7.7	7.7	7.7	9.9	13.5	13.7	17.1	18.0	20.3	23.9	28.8	31.2	33.8	35.9	37.0	33.4	28.5	24.7	21.8	18.1	16.8	11.5	461.0
PMA	1 $\times 10^{-4}$ M	7.7	7.7	7.7	9.9	13.5	13.0	16.6	17.7	19.5	23.0	26.5	29.3	34.7	35.8	37.7	32.9	28.6	25.0	22.1	18.5	16.5	11.5	455.4
Sulphonates	1 $\times 10^{-2}$ M	7.7	7.7	7.7	9.9	13.5	14.0	17.2	19.4	21.3	25.7	28.4	30.5	32.1	35.7	38.9	37.1	31.0	26.3	23.8	19.1	17.7	11.5	476.2
Sulphonates	5 $\times 10^{-2}$ M	7.7	7.7	7.7	9.9	13.5	13.9	16.8	18.1	21.5	23.7	27.6	31.0	33.2	35.2	39.0	35.7	32.2	26.5	23.9	19.0	17.9	11.5	473.2
Mean		7.7	7.7	7.7	9.9	13.5	15.1	18.6	20.7	23.4	26.8	30.2	31.8	33.8	35.5	38.6	36.3	31.3	26.6	22.3	18.8	17.5	11.5	485.3

(Medium soil moisture stress = 60 % depletion in available water)

Table (13): Effect of growth regulators and antitranspirants on evapotranspiration rates of wheat under high soil moisture stress in mm. / week during season 1981 / 1982

Substances	Periods	23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	21/12 27/12	28/12 3/ 1	4/1 10/1	11/1 17/1	18/1 24/1	25/ 1 31/ 1	1/ 2 7/2	8/2 14/2	15/ 2 21/ 2	22/ 2 28/ 2	1/ 3 7/ 3	8/3 14/3	15/ 3 21/3	22/ 3 28/ 3	29/3 4/4	5/4 11/4	12/4 18/4	19/4 25/4	Seasonal ET. mm.
Control																								
0		7.7	7.7	7.7	9.6	13.1	15.2	15.9	18.0	20.6	23.8	25.0	28.2	31.4	32.6	30.8	26.7	24.3	21.6	19.5	18.5	16.9	11.4	426.2
Growth Promoters																								
NAA	50 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.9	18.1	21.3	24.7	26.5	28.4	32.0	33.2	30.9	28.1	25.9	20.9	19.3	18.7	17.1	11.4	433.4
NAA	100 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.8	18.3	22.0	23.9	26.0	28.6	31.9	33.2	30.5	28.3	25.4	21.3	19.5	18.7	17.1	11.4	432.9
GA_3	50 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.8	18.2	22.0	25.0	25.6	28.1	32.1	33.2	31.4	27.4	25.0	21.1	19.2	18.9	17.1	11.4	432.5
GA_3	100 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.9	18.0	22.0	24.1	26.4	28.1	32.1	34.0	31.0	28.0	24.4	20.5	19.3	18.9	17.2	11.3	432.2
Growth Retardants																								
Alar	500 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.9	18.1	20.9	23.1	24.2	27.0	29.3	31.6	29.5	26.1	23.9	20.4	19.5	18.5	17.2	11.3	417.5
Alar	1000 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.7	18.0	20.9	22.3	24.6	26.9	30.1	32.0	30.0	25.8	22.4	20.6	19.1	18.6	17.1	11.4	416.5
Ethrel	500 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.9	18.0	21.1	22.2	23.7	27.3	28.9	32.1	30.1	26.2	22.6	20.7	19.2	18.6	16.8	11.3	415.7
Ethrel	1000 ppm.	7.7	7.7	7.7	9.6	13.1	15.2	15.7	18.0	21.3	22.2	23.5	27.1	28.7	31.2	29.3	26.2	22.9	20.5	19.1	18.6	16.8	11.3	413.4
Antitranspirants																								
PMA	5×10^{-5} M	7.7	7.7	7.7	9.6	13.1	14.7	15.0	16.5	18.9	21.2	22.9	26.3	28.8	32.0	30.1	26.9	23.7	20.8	19.1	18.7	16.9	11.3	411.6
PMA	1×10^{-4} M	7.7	7.7	7.7	9.6	13.1	14.0	14.4	15.9	18.1	20.5	22.0	24.6	27.3	31.6	30.8	26.1	24.4	21.7	19.7	18.7	16.8	11.3	403.7
Sulphonates	1×10^{-2} M	7.7	7.7	7.7	9.6	13.1	14.7	15.1	16.6	19.0	21.6	24.0	26.8	29.7	32.3	30.1	27.1	24.6	21.6	19.2	19.8	16.9	11.3	416.2
Sulphonates	5×10^{-2} M	7.7	7.7	7.7	9.6	13.1	14.6	14.9	16.4	18.5	21.3	24.6	26.4	29.2	32.4	30.2	26.3	24.3	21.2	19.6	19.9	16.9	11.3	413.8
Mean		7.7	7.7	7.7	9.6	13.1	15.0	15.5	17.5	20.5	22.8	24.5	27.2	30.1	32.4	30.4	26.9	24.1	20.9	19.3	18.9	17.0	11.4	420.4

(High soil moisture stress = 90 % depletion in available water)

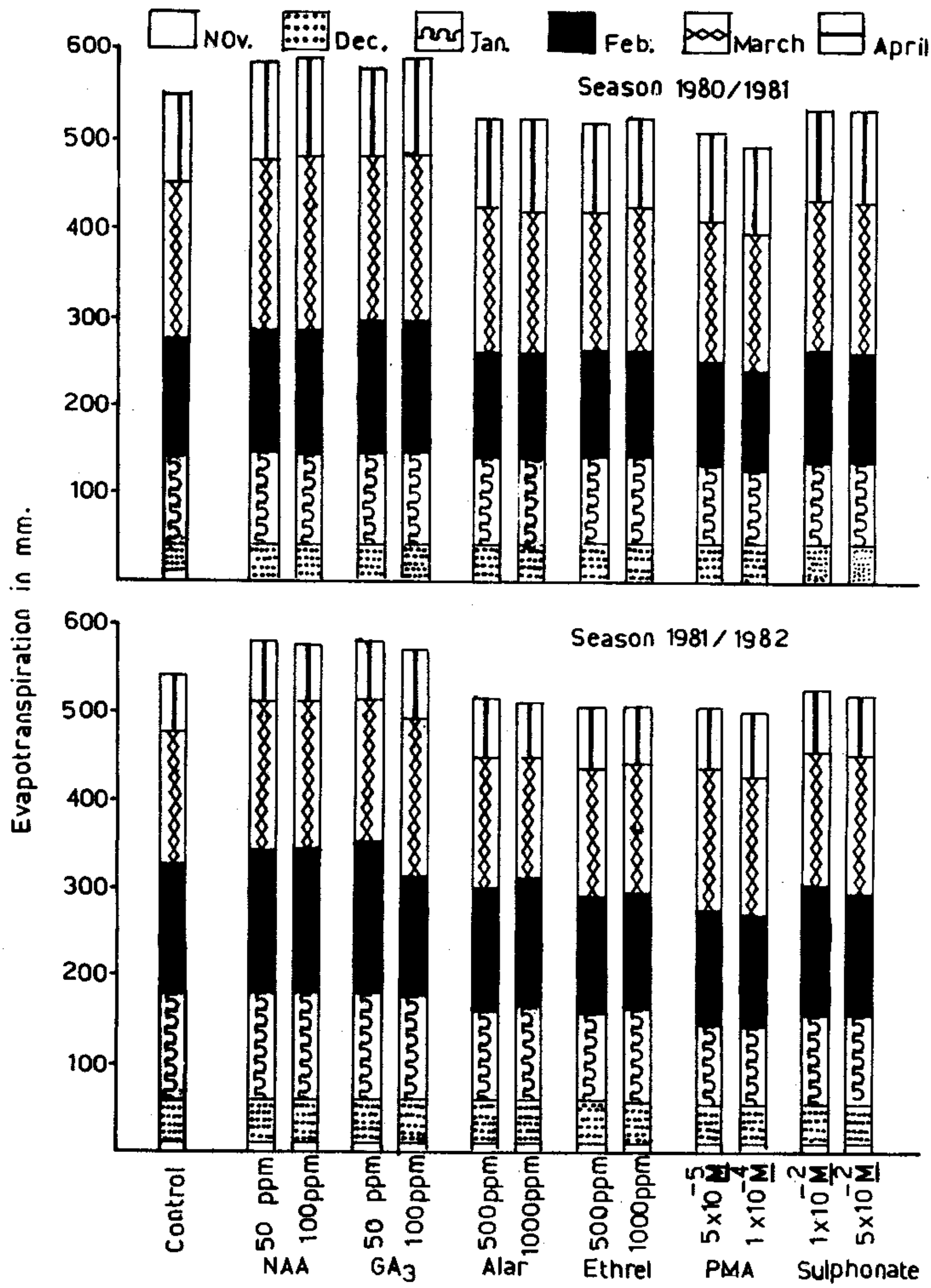

FIG. (3) CUMULATIVE EVAPOTRANSPIRATION FOR WHEAT UNDER LOW SOIL MOISTURE STRESS AS AEFECTED BY GROWTH REGULATORS AND ANTITRANSPIRANT.

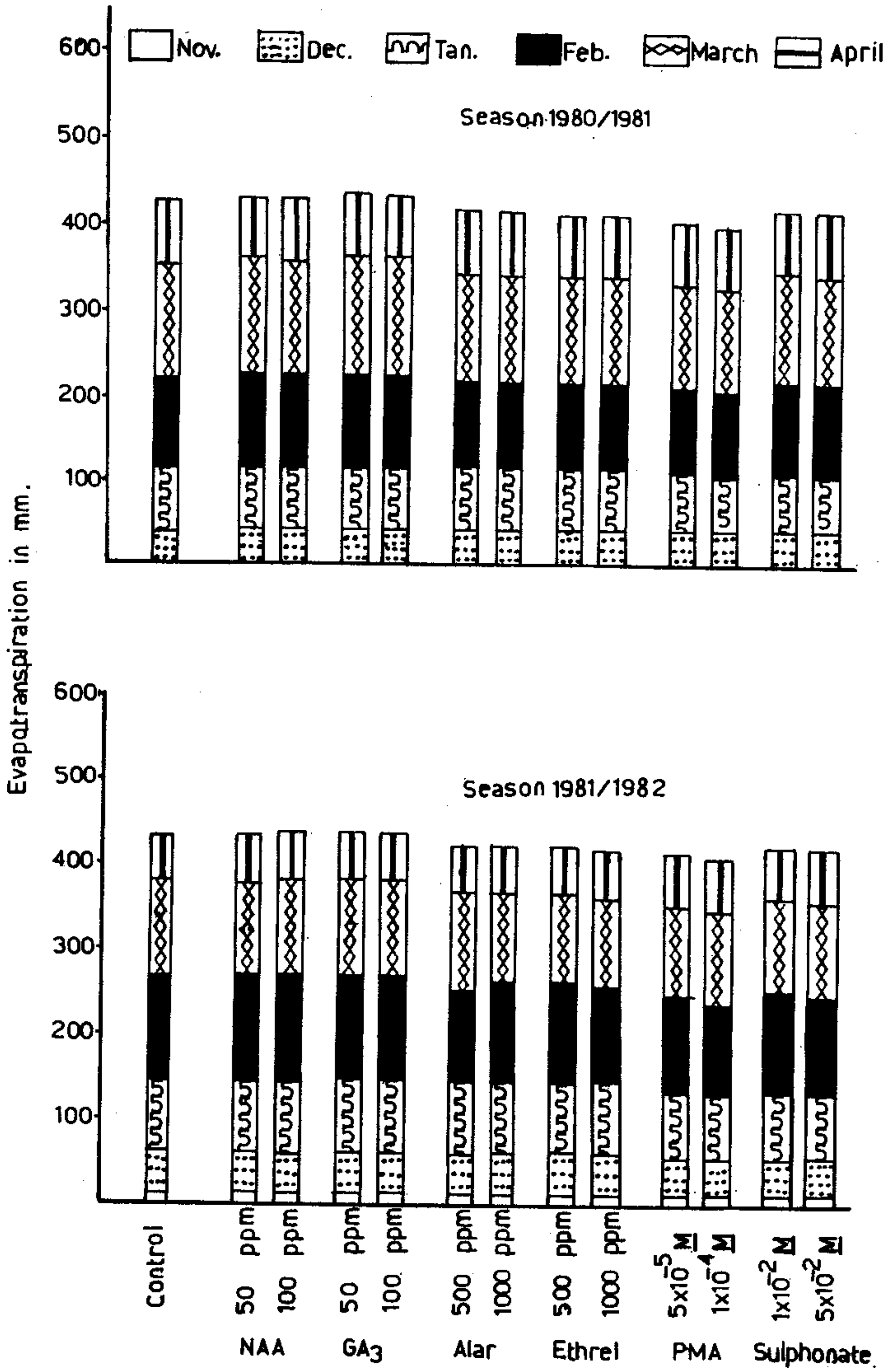

FIG. (5) CUMULATIVE EVAPOTRANSPIRATION FOR WHEAT UNDER HIGH SOIL MOISTURE STRESS AS AFFECTED BY GROWTH REGULATORS AND ANTITRANSPIRANTS.

shown a very close correlation of water consumptive use and climate . Also, Jensen (1968) indicated that crops such as small grains would not necessarly require the same amount of water when grown in different regions under widely different climatic conditions or when grown at different times during the year at a given location. Thus, water requirements of a crop can not be discussed without considering the crop season and potential evapotranspiration at various stages of growth . The above mentioned results are in full agreement with those reported by Doorenbos et al.(1979) who pointed out that for high yields of wheat, evapotranspiratión ranged from 450 - 650 mm. , and that depending on climate and length of the growing season .

Table (14) represent the mean seasonal evapotranspiration rates of wheat under the various treatments (average of the two seasons) as well as the relative increase or decrease percentage . Results indicate that water consumption was increased as soil moisture stress decreased . The least evapotranspiration rate was brought about under dry conditions (severe soil moisture stress) whereas the highest water use was attained under very wet conditions,while under medium water supply,the values falls in between.This phenomena reveal that the increase in water consumptive use depends on the

Table (14): Effect of growth regulators and antitranspirants on seasonal evapotranspiration of wheat under different soil moisture stresses in mm(average of two seasons)

Group	Substances		Seasonal ET. mm. Wet	Medium	Dry	Mean	Relative increase or decrease % Wet	Medium	Dry	Mean
	Control		547.7	493.0	425.1	488.6	100.0	100.0	100.0	100.0
Growth Promoters	NAA	50 ppm.	582.6	519.1	431.5	511.1	106.4	105.3	101.5	104.6
	NAA	100 ppm.	580.8	518.8	431.5	510.4	106.0	105.2	101.5	104.5
	GA_3	50 ppm.	580.2	516.9	431.3	509.5	105.9	104.8	101.5	104.3
	GA_3	100 ppm.	580.7	520.9	431.2	510.9	106.0	105.7	101.4	104.6
Growth Retardants	Alar	500 ppm.	522.1	472.5	415.1	469.9	95.3	95.8	97.6	96.2
	Alar	1000 ppm.	518.1	469.6	414.4	467.4	94.6	95.2	97.5	95.7
	Eth.	500 ppm.	514.3	473.3	412.7	466.8	93.9	96.0	97.1	95.5
	Eth.	1000 ppm.	515.0	469.4	412.1	465.5	94.0	95.2	96.9	95.3
Antrispirants	PMA	$5x10^{-5}$M	508.9	462.5	406.8	459.4	92.9	93.8	95.7	94.0
	PMA	$1x10^{-4}$M	491.6	454.3	399.3	448.4	89.8	92.1	93.9	91.8
	Sulphonates	$1x10^{-2}$M	529.6	479.5	416.0	475.0	96.7	97.3	97.8	97.2
	Sulphonates	$5x10^{-2}$M	524.2	475.4	413.3	471.0	95.7	96.4	97.2	96.4
Mean			538.4	486.8	418.5	481.2	128.7	116.3	100.0	-

available soil moisture in the root zone . When soil moisture was kept wet by frequent irrigations, higher seasonal evapotranspiration was attained . These results may be due to the availability of soil moisture to plants in addition to the high evaporation opportunity from a wet rather than a dry soil surface . The increase in water consumption by wheat plants was found to be 28.7% and 16.3 % respectively for wet and medium soil moisture stresses over the dry treatment .

Tanner et al. (1960) gave an excellent summary of the effect of soil moisture on evapotranspiration . They stated that " on a given type of soil, the total evapotranspiration depends on the water available to the plants as well as that available at the soil surface,and upon the total net radiation above plants and at the soil surface . When water is readily available both to the plants and at the soil surface, maximum evapotranspiration obtains " .

The previous results are in full agreement with those reported by Imam and Miseha (1978) who found that wheat plant did consume more water under wet conditions rather than dry ones .

Regarding the effect of growth promoting substances i.e. NAA or GA_3 on seasonal evapotranspiration, results recorded in Table (14) show a quite increase in water consumption by such substances . Both substances had the same effect on increasing seasonal water consumptive use by wheat irrespective to the effect of soil moisture stress . The mean relative increase in seasonal evapotranspiration was found to be 4.5 % . It is interesting to mention that no more increase in seasonal water use by wheat was observed as a result of increasing either NAA or GA_3 concentration above 50 ppm. The increase in seaonal evapotranspiration followed GA_3 or NAA application may be due to the stimulating effect of such substances on transpiration by wheat . Both substances promote the growth of plants , increasing the transpiring surface and that reflected on seasonal water consumption .

In this connection , Livne and Vaadia (1965) concluded that cytokinins and apparently also gibberellic acid are unique among the compounds which affect stomatal opening in that they simultaneously promote stomatal opening and other physiological processes . Kinetin enhances transpiration rates and the opening of stomata of excised mature barley leaves . The previous results are in harmony with those found by Eweida et al.(1978) and Seif El-Yazal (1983) who recorded an increase in seasonal consumptive use rates by the application of 2,4-D and GA_3 .

A considerable enhancing effect in evapotranspiration by GA_3 or NAA application was detected under wet or medium soil moisture stresses rather than under dry conditions. This phenomena comes from the fact that with decreasing availability of water , the plant reduces the stomatal aperature considerably , cutting down transpiration and although photosynthesis is also reduced the proportional drop is probably less than that for transpiration. In this connection, Shaw and Laing (1965) pointed out that under stress conditions, transpiration is reduced when water deficit reached a critical value characteristic for the species , turgor induced changes in stomatal aperature which causes an increase in the resistance to transpiration in the gaseous phase . The resultant, is reduction in transpiration to prevent or limit dessication rather than to maintain flow at the level of evaporation demand .

The use of growth retardants i.e. Alar or Ethrel exhibit a reverse phenomena on seasonal evapotranspiration by wheat to that observed with growth promoters (NAA or GA_3) . The use of such substances did result in a decrease in seasonal water use by wheat with about 5 % . Higher concentrations of either Alar or ethrel did not cause any applicable decrease in seasonal evapotranspiration . However, ethrel application induce a slight decrease more than that caused by alar . This trend may be due to retardation in plant growth . In this respect Livne and Vaadia (1972) proposed that the increase in drought tolerance of plants treated with growth retardants might be related to the interference of these compounds with the biosynthesis of gibberelic acid . The reduced level of GA_3 in the treated plants could result in reduced stomatal opening and hence lower transpiration. Also, Wright (1977) found that water stress increased ethylene production in excised wheat leaves with the greatest production at a leaf water potential of 12 bar .

In case of antitranspirants, results presented in Tables (8 ,9 , 10 , 11, 12 , 13 and 14) and Figures (3 , 4 and 5) indicate that seasonal evapotranspiration by wheat was decreased by the application of either PMA or -hydroxy sulphonate at both concentrations . Increasing the rate of antitranspirants did result in decreasing seasonal values of ET. In other words, the decrease in water consumption by wheat was more pronounced by higher rates of PMA and sulphonate. These results can be attributed to the partial closure of stomata caused by the used antitranspirants which in turn reduced transpiration (the large component in evapotranspiration). Stomatal closure was more induced by higher rates of such substances .

The mode of action of PMA on stomatal closure was explained by Meidner and Mansfield (1968). They pointed out that PMA sprayed on leaves reduced transpiration and that accompanied by decreasing the rate of carbon dioxide intake . Stomatal closure following PMA treatment was the result of changes in the concentration of carbon dioxide in the guard cells, since closure of stomata by PMA can be prevented or reversed by treatment of epidermal strips with carbon dioxide free air. However, the action of α-hydroxy sulphonate in causing stomatal closure is almost due to their adverse effect on photosynthesis, which result in an increased concentration of carbon dioxide in the leaf . Such compound inhibit the oxidation of glycollate , an early product of photosynthesis and a product of degradiation of more complex photosynthates in the absence of carbon dioxide.

From data recorded in Table (14), it can be noticed that seasonal water use by wheat was relatively lower under PMA treatment than α -hydroxy sulphonate. This result indicate that PMA spray was more effective in causing stomatal closure than sulphonate . This result is in full agreement with those reported by Kramer (1968) who concluded that the most promosing compound for causing closure of stomata is PMA.Similar results were found by Imam and Miseha (1978) who showed that spraying wheat plants with PMA antitranspirant decreased seasonal evapotranspiration. They added that as PMA concentration increased seasonal water use decreased and ascribed this reduction to stomatal closure induced by PMA.

It is desirable to mention that the relative decrease in seasonal consumptive use of water by wheat was more pronounced by increasing the concentration of antitranspirants . The relative reduction - in seasonal ET. was found to be much more under wet rather than under dry conditions . This means that plants sprayed with antitranspirant can indure drought . These results are in line with those obtained by Shimshi (1963) who found that PMA spray decreased transpiration by 26 % where the soil was moist and by 10 % where it was dry . Also, Imam and Miseha (1978) came to the same conclusion . They stated that the relative decrease in evapotranspiration by wheat treated with PMA was more effective under wet soil rather than under dry one .

In the view of the previous results it can be concluded that evapotranspiration exhibits a great response to changes in soil moisture levels . It is high at low stress and decreased rapidaly at severe moisture stress . Also, application of growth promoters increased the rate of evapotranspiration while either growth retardants or antitranspirants reduced such values . Such increase or decrease in seasonal ET. was greater under wet soil compared with dry ones .

4.1.1.2 Monthly Rates

Monthly consumptive use by wheat under the various treatments after two seasons of study is illustrated in Figures (3 , 4 and 5). Results clearly indicate that soil moisture stress had a determintal effect upon such values . An increase in soil moisture stress prior to irrigation did result in a significant decrease in monthly rates and the reverse was found to be true . These results are in agreement with Eagleman and Decker (1965)who stated that water consumption increase depends on the increasing of soil moisture availability for plants . Less monthly evapotranspiration was recorded at the beginning of the growing season or at later stages of growth . The highest monthly value occured during March which represent the period of heading and grain development . At this month, consumptive use recorded the highest value .

As for the effect of growth regulators on monthly water consumption, data in Figures (3 , 4 and 5) indicate that the enhancing influence caused by NAA or GA_3 spray was restricted mainly during February and March. However, the reduction caused by growth retardants (Alar or Ethrel) started its effect some what earlier during January and extended till March .

In case of antitranspirant application and its effect on monthly water use , the observed data(Fig. 3, Table (15): Effect of growth regulators and antitranspirants on daily evapotranspiration of wheat under low soil moisture stress in mm. /day during season 1980 / 1981

Substances	Periods	2/12 8/12	9/12 15/12	16/12 22/12	23/12 29/12	30/12 5/1	6/1 12/1	13/1 19/1	20/1 26/1	27/1 2/2	3/2 9/2	10/2 16/2	17/2 23/2	24/2 2/3	3/3 9/3	10/3 16/3	17/3 23/3	24/3 30/3	31/3 6/4	7/4 13/4	14/4 20/4	21/4 27/4	28/4 30/4	Mean daily ET.
Control																								
0		1.16	1.16	1.16	1.70	2.21	2.71	3.43	3.86	4.14	4.63	4.84	5.11	5.01	5.69	6.40	5.84	5.26	4.69	4.11	3.33	2.21	1.53	3.70
Growth Promoters																								
NAA	50 ppm.	1.16	1.16	1.16	1.70	2.21	2.71	3.43	3.86	4.41	4.93	4.77	5.30	5.34	5.79	6.26	6.69	6.16	5.24	4.64	3.70	2.31	1.53	3.90
NAA	100 ppm.	1.16	1.16	1.16	1.70	2.21	2.61	3.29	4.04	4.39	5.19	5.04	5.40	5.16	5.76	6.56	7.06	6.00	5.14	4.34	3.64	2.41	1.53	3.92
GA_3	50 ppm.	1.16	1.16	1.16	1.70	2.21	2.73	3.37	4.06	4.30	5.03	5.24	5.39	5.43	5.94	6.23	6.74	5.47	5.01	4.36	3.50	2.30	1.53	3.88
GA_3	100 ppm.	1.16	1.16	1.16	1.70	2.21	2.66	3.40	3.97	4.39	5.41	5.16	5.54	5.26	5.37	6.31	6.80	5.90	5.16	4.64	3.79	2.36	1.53	3.93
Growth Retardants																								
Alar	500 ppm.	1.16	1.16	1.16	1.70	2.21	2.76	3.40	3.96	3.99	4.21	4.34	4.46	4.73	5.19	5.61	5.40	4.80	4.51	4.00	3.60	2.33	1.50	3.51
Alar	1000 ppm.	1.16	1.16	1.16	1.70	2.21	2.73	3.44	3.99	3.87	4.19	4.10	4.34	4.99	5.30	5.44	5.23	4.61	4.43	4.20	3.74	2.37	1.53	3.50
Ethrel	500 ppm.	1.16	1.16	1.16	1.70	2.21	2.71	3.41	3.87	3.79	3.97	4.39	4.70	4.97	5.14	5.44	5.03	4.43	4.43	3.99	3.60	2.40	1.53	3.47
Ethrel	1000 ppm.	1.16	1.16	1.16	1.70	2.21	2.76	3.39	3.61	3.87	4.14	4.43	4.43	4.44	5.06	5.66	5.19	4.73	4.47	4.06	3.79	2.37	1.53	3.49
Antitranspirants																								
PMA	5 $x10^{-5}$M	1.16	1.16	1.16	1.70	2.21	2.13	2.87	3.43	3.76	3.91	4.40	4.59	4.84	5.33	5.93	5.27	4.61	4.53	3.90	3.34	2.27	1.57	3.41
PMA	1 $x10^{-4}$M	1.16	1.16	1.16	1.70	2.21	2.00	2.53	3.16	3.56	3.61	3.89	4.27	4.83	4.94	5.51	5.11	4.89	4.57	4.06	3.41	2.24	1.53	3.30
Sulphonates	1 $x10^{-2}$M	1.16	1.16	1.16	1.70	2.21	2.43	3.36	3.57	3.89	3.91	4.56	4.99	5.10	5.56	6.27	5.40	5.10	4.63	4.17	3.30	2.10	1.53	3.56
Sulph-	5 $x10^{-2}$M	1.16	1.16	1.16	1.70	2.21	2.39	3.31	3.43	3.99	3.70	4.39	5.03	4.93	5.44	6.24	5.47	5.13	4.64	4.16	3.33	2.16	1.53	3.54
Mean		1.16	1.16	1.16	1.70	2.21	2.57	3.29	3.76	4.03	4.37	4.58	4.89	5.03	5.43	5.99	5.79	5.16	4.73	4.20	3.54	2.30	1.53	3.62

(Low soil moisture stress = 30 % depletion in available water)

Table (16): Effect of growth regulators and antitranspirants on daily evapotranspiration of wheat under medium soil moisture stress in mm. / day during season 1980 / 1981

Periods		2/12	9/12	16/12	23/12	30/12	6/1	13/1	20/1	27/ 1	3/ 2	10/ 2	17/ 2	24/ 2	3/ 3	10/3	17/3	24/ 3	3L/3	7/ 4	14/ 4	21/ 4	28/4	Mean
Substances		8/12	15/12	22/12	29/12	5/ 1	12/1	19/1	26/1	2/ 2	9/ 2	16/ 2	23/ 2	2/ 3	9/ 3	16/3	23/3	30/ 3	6/4	13/ 4	20/ 4	27/ 4	30/4	daily ET
												Control												
0		1.16	1.16	1.16	1.54	1.99	2.37	2.63	3.03	3.59	4.11	4.49	4.83	4.96	5.30	5.64	5.17	4.44	3.96	3.44	3.04	2.19	1.43	3.30
												Growth Promoters												
NAA	50 ppm.	1.16	1.16	1.16	1.54	1.99	2.37	2.61	2.97	3.81	4.00	4.76	4.69	5.17	5.24	6.04	6.13	4.89	4.80	3.91	3.11	2.17	1.43	3.47
NAA	100 ppm.	1.16	1.16	1.16	1.54	1.99	2.37	2.60	2.99	3.76	3.97	4.81	4.60	5.00	5.24	6.20	5.80	5.17	4.77	3.84	2.99	2.23	1.47	3.45
GA_3	50 ppm.	1.16	1.16	1.16	1.54	1.99	2.39	2.59	2.97	3.80	4.16	4.71	4.91	5.19	5.17	6.17	5.51	5.13	4.59	3.86	2.89	2.21	1.43	3.45
GA_3	100 ppm.	1.16	1.16	1.16	1.54	1.99	2.34	2.70	3.06	3.69	3.99	4.49	4.86	5.27	5.30	6.33	5.70	5.16	4.77	3.77	3.24	2.24	1.43	3.48
												Growth Retardants												
Alar	500 ppm.	1.16	1.16	1.16	1.54	1.99	2.37	2.73	3.09	3.36	3.53	3.74	4.37	4.51	4.83	5.29	4.99	4.49	4.01	3.60	2.96	2.21	1.47	3.16
Alar	1000 ppm.	1.16	1.16	1.16	1.54	1.99	2.39	2.66	3.07	3.44	3.60	3.70	4.04	4.30	4.70	5.56	4.89	4.44	4.09	3.53	2.96	2.26	1.47	3.14
Ethrel	500 ppm.	1.16	1.16	1.16	1.54	1.99	2.40	2.70	3.04	3.84	3.84	3.76	4.36	4.70	4.70	5.34	5.00	4.66	3.96	3.33	2.91	2.24	1.47	3.19
Ethrel	1000 ppm.	1.16	1.16	1.16	1.54	1.99	2.39	2.74	3.07	3.61	3.71	3.89	4.44	4.47	4.63	5.41	5.01	4.24	3.73	3.13	3.01	2.17	1.47	3.14
												Antitranspirants												
PMA	5×10^{-5} M	1.16	1.16	1.16	1.54	1.99	2.09	2.23	2.73	3.09	3.36	4.07	4.44	4.46	4.90	5.50	5.09	4.57	3.76	3.31	2.87	2.20	1.47	3.09
PMA	1×10^{-4} M	1.16	1.16	1.16	1.54	1.99	2.03	2.11	2.47	2.77	3.19	3.34	4.17	4.66	4.94	5.30	4.90	4.61	3.94	3.64	2.79	2.23	1.47	3.02
Sulphonate	1×10^{-2} M	1.16	1.16	1.16	1.54	1.99	2.13	2.47	2.87	3.53	3.89	4.06	4.67	4.73	5.01	5.54	5.03	4.70	4.13	3.66	2.70	2.23	1.47	3.22
Sulphonate	5×10^{-2} M	1.16	1.16	1.16	1.54	1.99	2.07	2.44	2.71	3.40	3.63	3.84	4.63	4.74	5.30	5.69	4.91	4.76	4.04	3.60	2.61	2.23	1.47	3.18
Mean		1.16	1.16	1.16	1.54	1.99	2.29	2.56	2.93	3.51	3.77	4.13	4.54	4.79	5.03	5.70	5.24	4.71	4.20	3.59	2.93	2.21	1.47	3.26

(Medium soil moisture stress = 60 % depletion in available water)

Table (17): Effect of growth regulators and antitranspirants on daily evapotranspiration of wheat under high soil moisture stress in mm. /day during season 1980 / 1981

Substances	Periods	2/12 8/12	9/12 15/12	16/12 22/12	23/12 29/12	30/12 5/ 1	6/ 1 12/ 1	13/1 19/1	20/1 26/1	27/ 1 2/ 2	3/2 9/2	10/ 2 16/ 2	17/ 2 23/ 2	24/2 2/3	3/3 9/3	10/ 3 16/ 3	17/ 3 23/ 3	24/3 30/3	31/ 3 6/ 4	7/4 13/4	14/4 20/4	21/4 27/4	28/4 30/4	Mean daily ET.
Control																								
0		1.16	1.16	1.16	1.51	1.97	2.20	2.24	2.50	3.20	3.81	3.56	3.97	4.29	4.77	4.56	4.07	3.36	3.01	2.87	2.34	2.21	1.47	2.83
Growth Promoters																								
NAA	50 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.19	2.50	3.21	3.73	3.60	4.19	4.30	4.74	4.73	4.34	3.60	3.01	2.90	2.33	2.21	1.47	2.86
NAA	100 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.19	2.56	3.27	3.70	3.71	4.03	4.39	4.67	4.57	4.33	3.59	3.06	3.03	2.44	2.21	1.47	2.87
GA_3	50 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.24	2.49	3.41	3.73	3.61	4.20	4.41	4.59	4.71	4.17	3.60	3.01	2.87	2.41	2.21	1.47	2.87
GA_3	100 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.24	2.61	3.09	3.61	3.63	4.23	4.34	4.79	4.64	4.33	3.60	3.14	2.87	2.33	2.21	1.47	2.87
Growth Retardants																								
Alar	500 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.30	2.61	3.09	3.40	3.36	3.76	4.14	4.61	4.36	3.89	3.30	2.94	2.87	2.33	2.21	1.47	2.75
Alar	1000 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.37	2.49	2.99	3.31	3.51	3.70	4.17	4.70	4.33	3.89	3.30	2.94	2.87	2.33	2.21	1.47	2.75
Ethrel	500 ppm.	1.16	1.16	1.16	1.51	1.97	2.20	2.19	2.49	2.91	3.33	3.63	3.61	4.16	4.57	4.33	3.89	3.27	2.97	2.87	2.33	2.21	1.47	2.73
Ethrel	1000 ppm.	1.16	1.16	1.16	1.51	1.97	2.21	2.24	2.47	3.00	3.24	3.63	3.67	4.17	4.59	4.30	3.89	3.29	2.97	2.87	2.33	2.23	1.50	2.74
Antitranspirants																								
PMA	5×10^{-5} M	1.16	1.16	1.16	1.51	1.97	2.07	2.10	2.30	2.91	3.10	3.17	3.47	4.07	4.67	4.36	3.84	3.30	3.01	2.84	2.39	2.23	1.50	2.68
PMA	1×10^{-4} M	1.16	1.16	1.16	1.51	1.97	1.97	2.01	2.19	2.80	2.90	3.26	3.47	3.91	4.49	4.33	3.96	3.17	2.96	2.84	2.33	2.23	1.50	2.63
Sulphonates	1×10^{-2} M	1.16	1.16	1.16	1.51	1.97	2.03	2.10	2.33	3.01	3.37	3.57	3.76	4.33	4.84	4.56	4.04	3.31	3.10	2.84	2.36	2.23	1.50	2.77
Sulphonates	5×10^{-2} M	1.16	1.16	1.16	1.51	1.97	2.11	2.09	2.23	2.94	3.44	3.47	3.76	4.36	4.71	4.43	3.96	3.31	3.01	2.84	2.34	2.23	1.50	2.75
Mean		1.16	1.16	1.16	1.51	1.97	2.15	2.20	2.44	3.06	3.44	3.53	3.83	4.23	4.67	4.47	4.04	3.39	3.01	2.87	2.36	2.21	1.48	2.78

(High soil moisture stress = 90 % depletion in available water)

Table (18): Effect of growth regulators and antitranspirants on daily evapotranspiration of wheat under low soil moisture stress in mm. / day during season 1981 / 1982

Substances	Periods	23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	21/12 27/12	28/12 3/ 1	4/1 10/1	11/1 17/1	18/1 24/1	25/1 31/1	1/ 2 7/ 2	8/ 2 14/2	15/ 2 21/ 2	22/ 2 28/ 2	1/ 3 7/ 3	8/3 14/3	15/3 21/3	22/ 3 28/ 3	29/ 3 4/ 4	5/ 4 11/ 4	12/4 18/4	19/4 25/4	Mean daily ET.
Control																								
0		1.10	1.10	1.10	1.49	1.96	2.37	3.19	3.63	3.87	4.83	4.71	5.09	5.24	5.29	5.99	5.47	4.80	4.56	3.80	3.47	2.49	1.64	3.51
Growth Promoters																								
NAA	50 ppm.	1.10	1.10	1.10	1.49	1.96	2.39	3.10	3.60	4.26	5.14	5.31	5.61	5.80	6.03	6.41	6.47	5.03	4.81	4.31	3.74	2.44	1.64	3.77
NAA	100 ppm.	1.10	1.10	1.10	1.49	1.96	2.39	3.24	3.56	4.27	5.07	5.26	5.49	5.40	5.73	6.44	6.60	5.14	4.91	3.96	3.56	2.46	1.64	3.72
GA_3	50 ppm.	1.10	1.10	1.10	1.49	1.96	2.44	3.27	3.54	4.39	5.04	5.27	5.46	5.61	6.11	6.39	6.60	5.23	4.69	3.87	3.79	2.53	1.64	3.76
GA_3	100 ppm.	1.10	1.10	1.10	1.49	1.96	2.46	3.17	3.49	4.39	4.77	5.36	4.99	5.36	6.13	6.31	6.76	5.33	4.71	3.96	3.67	2.50	1.64	3.72
Growth Retardants																								
Alar	500 ppm.	1.10	1.10	1.10	1.49	1.96	2.56	3.03	3.36	3.23	4.07	4.73	4.49	5.03	5.19	4.93	6.09	4.90	4.07	3.63	3.74	2.41	1.64	3.36
Alar	1000 ppm.	1.10	1.10	1.10	1.49	1.96	2.56	3.11	3.14	3.74	4.34	4.87	4.23	5.10	5.33	4.93	5.23	4.63	3.99	3.64	3.39	2.39	1.64	3.32
Ethrel	500 ppm.	1.10	1.10	1.10	1.49	1.96	2.47	3.04	3.29	3.69	4.17	4.20	4.23	4.81	5.24	5.47	5.29	4.81	4.26	3.63	3.19	2.44	1.64	3.30
Ethrel	1000 ppm.	1.10	1.10	1.10	1.49	1.96	2.37	3.09	3.29	3.60	4.34	4.44	4.37	4.81	5.27	5.44	5.19	4.51	4.03	3.53	3.31	2.41	1.64	3.29
Antitranspirants																								
PMA	5 $\times 10^{-5}$ M	1.10	1.10	1.10	1.49	1.96	2.13	2.60	2.87	3.21	3.61	4.14	4.53	4.99	5.14	5.73	5.56	4.91	4.33	4.16	3.50	2.41	1.64	3.28
PMA	1 $\times 10^{-4}$ M	1.10	1.10	1.10	1.49	1.96	2.00	2.29	2.80	3.26	3.41	3.97	4.30	4.59	5.21	5.54	5.23	4.76	4.44	3.67	3.53	2.41	1.64	3.17
Sulphonates	1 $\times 10^{-2}$ M	1.10	1.10	1.10	1.49	1.96	2.20	2.66	3.20	3.56	4.57	4.60	5.06	5.01	5.69	5.81	5.37	4.63	4.41	3.76	3.50	2.51	1.64	3.40
Sulphonate	5 $\times 10^{-2}$ M	1.10	1.10	1.10	1.49	1.96	2.20	2.66	3.04	3.76	4.39	4.56	4.87	4.97	5.31	5.84	5.37	4.81	4.20	3.87	3.29	2.51	1.64	3.36
Mean		1.10	1.10	1.10	1.49	1.96	2.34	2.96	3.29	3.79	4.44	4.74	4.84	5.11	5.21	5.81	5.79	4.90	4.41	3.83	3.51	2.46	1.64	3.46

(Low soil moisture stress = 30 % depletion inavailable)

Table (19): Effect of growth regulators and antitranspirants on daily evapotranspiration of wheat under medium soil moisture stress in mm. / day during season 1981 / 1982

Periods / Substances		23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	21/12 27/12	28/12 3/ 1	4/1 10/1	11/1 17/1	18/ 1 24/ 1	25/ 1 31/ 1	1/ 2 7/ 2	8/2 14/2	15/2 21/2	22/ 2 28/ 2	1/3 7/3	8/ 3 14/ 3	15/ 3 21/ 3	22/3 28/3	29/ 3 4/ 4	5/4 11/4	12/ 4 18/ 4	19/4 25/4	Mean daily ET.
Control																								
0		1.10	1.10	1.10	1.41	1.93	2.26	2.79	3.13	3.39	3.99	4.37	4.57	4.79	5.03	5.51	5.19	4.31	3.84	3.24	2.83	2.54	1.64	3.18
Growth Promoters																								
NAA	50 ppm.	1.10	1.10	1.10	1.41	1.93	2.26	2.81	3.11	3.70	4.37	4.64	4.99	5.06	5.33	5.87	6.16	4.91	4.01	3.26	2.70	2.54	1.64	3.36
NAA	100 ppm.	1.10	1.10	1.10	1.41	1.93	2.26	2.79	3.06	3.70	4.53	4.63	5.00	5.33	5.31	5.87	5.89	5.01	4.16	3.26	2.64	2.54	1.64	3.38
GA_3	50 ppm.	1.10	1.10	1.10	1.41	1.93	2.26	2.73	3.24	3.56	4.10	4.89	5.16	5.07	5.27	6.01	5.53	5.03	4.16	3.19	2.81	2.54	1.64	3.36
GA_3	100 ppm.	1.10	1.10	1.10	1.41	1.93	2.23	2.76	3.04	3.79	4.31	5.07	4.90	5.17	5.19	5.79	5.89	5.31	4.16	3.19	2.73	2.54	1.64	3.38
Growth Retardants																								
Alar	500 ppm.	1.10	1.10	1.10	1.41	1.93	2.24	2.76	3.04	3.44	3.67	4.09	4.29	4.61	4.86	5.27	4.79	4.19	3.64	3.01	2.64	2.47	1.64	3.06
Alar	1000 ppm.	1.10	1.10	1.10	1.41	1.93	2.26	2.76	3.11	3.31	3.61	4.21	4.30	4.41	4.79	5.23	4.74	4.01	3.70	3.03	2.67	2.37	1.64	3.04
Ethrel	500 ppm.	1.10	1.10	1.10	1.41	1.93	2.26	2.76	3.11	3.31	3.74	4.07	4.33	4.59	4.84	5.11	4.70	4.17	3.67	3.03	2.64	2.74	1.64	3.05
Ethrel	1000 ppm.	1.10	1.10	1.10	1.41	1.93	2.26	2.76	3.11	3.46	3.66	4.13	4.17	4.57	4.86	5.24	4.67	4.07	3.47	3.04	2.59	2.47	1.64	3.04
Antitranspirants																								
PMA	$5 \times 10^{-5} \underline{M}$	1.10	1.10	1.10	1.41	1.93	1.96	2.44	2.57	2.90	3.41	4.11	4.46	4.83	5.13	5.29	4.77	4.07	3.53	3.11	2.59	2.40	1.64	2.99
PMA	$1 \times 10^{-4} \underline{M}$	1.10	1.10	1.10	1.41	1.93	1.86	2.37	2.53	2.79	3.29	3.79	4.19	4.96	5.11	5.39	4.70	4.09	3.57	3.16	2.64	2.36	1.64	2.96
Sulph-onates	$1 \times 10^{-2} \underline{M}$	1.10	1.10	1.10	1.41	1.93	2.00	2.46	2.77	3.04	3.67	4.06	4.36	4.59	5.10	5.56	5.30	4.43	3.76	3.40	2.73	2.53	1.64	3.09
Sulph-	$5 \times 10^{-2} \underline{M}$	1.10	1.10	1.10	1.41	1.93	1.99	2.40	2.59	3.07	3.39	3.94	4.43	4.74	5.03	5.57	5.10	4.60	3.79	3.41	2.71	2.56	1.64	3.07
Mean		1.10	1.10	1.10	1.41	1.93	2.16	2.66	2.96	3.34	3.83	4.31	4.54	4.83	5.07	5.51	5.19	4.47	3.80	3.19	2.69	2.50	1.64	3.15

(Medium soil moisture stress = 60 % depletion in available water)

Table (20): Effect of growth regulators and antitranspirants on daily evapotranspiration of wheat under high soil moisture stress in mm./ day during season 1981 / 1982

Periods / Substances	23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	21/12 27/12	28/12 3/ 1	4/1 10/1	11/1 17/1	18/1 24/1	25/ 1 31/ 1	1/ 2 7/ 2	8/2 14/2	15/ 2 21/ 2	22/ 2 28/ 2	1/ 3 7/ 3	8/3 14/3	15/ 3 21/ 3	22/ 3 28/ 3	29/3 4/4	5/4 11/4	12/4 18/4	19/4 25/4	Mean daily ET.
Control																							
0	1.10	1.10	1.10	1.37	1.87	2.17	2.27	2.57	2.94	3.40	3.57	4.03	4.49	4.66	4.40	3.81	3.47	3.09	2.79	2.64	2.41	1.63	2.77
Growth Promoters																							
NAA 50 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.27	2.59	3.04	3.53	3.79	4.06	4.67	4.74	4.41	4.01	3.70	2.99	2.76	2.67	2.44	1.63	2.81
NAA 100 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.26	2.61	3.14	3.41	3.71	4.09	4.56	4.74	4.36	4.04	3.63	3.04	2.79	2.67	2.44	1.63	2.81
GA_3 50 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.26	2.60	3.14	3.57	3.66	4.01	4.59	4.74	4.49	3.91	3.57	3.01	2.74	2.70	2.44	1.63	2.81
GA_3 100 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.27	2.57	3.14	3.44	3.77	4.01	4.59	4.86	4.43	4.00	3.49	2.93	2.76	2.70	2.46	1.61	2.81
Growth Retardants																							
Alar 500 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.27	2.59	2.99	3.30	3.46	3.86	4.19	4.51	4.21	3.73	3.41	2.91	2.79	2.64	2.46	1.61	2.71
Alar 1000 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.24	2.57	2.99	3.19	3.51	3.84	4.30	4.57	4.29	3.69	3.20	2.94	2.73	2.66	2.44	1.63	2.70
Ethrel 500 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.27	2.57	3.01	3.19	3.39	3.90	4.13	4.59	4.30	3.74	3.23	2.96	2.74	2.66	2.40	1.61	2.70
Ethrel 1000 ppm.	1.10	1.10	1.10	1.37	1.87	2.17	2.27	2.57	3.04	3.17	3.36	3.87	4.10	4.46	4.19	3.74	3.27	2.93	2.73	2.66	2.40	1.61	2.68
Antitranspirants																							
PMA 5×10^{-5} M	1.10	1.10	1.10	1.37	1.87	2.10	2.14	2.36	2.70	3.03	3.27	3.76	4.11	4.57	4.30	3.84	3.39	2.97	2.73	2.67	2.41	1.61	2.67
PMA 1×10^{-4} M	1.10	1.10	1.10	1.37	1.87	2.00	2.06	2.27	2.59	2.93	3.14	3.51	3.90	4.51	4.40	3.73	3.49	3.10	2.81	2.67	2.40	1.61	2.62
Sulphonates 1×10^{-2} M	1.10	1.10	1.10	1.37	1.87	2.10	2.16	2.37	2.71	3.09	3.43	3.83	4.24	4.61	4.30	3.87	3.51	3.09	2.74	2.83	2.41	1.61	2.70
Sulphonates 5×10^{-2} M	1.10	1.10	1.10	1.37	1.87	2.09	2.13	2.34	2.64	3.04	3.51	3.77	4.17	4.63	4.30	3.76	3.47	3.03	2.80	2.84	2.41	1.61	2.69
Mean	1.10	1.10	1.10	1.37	1.87	2.14	2.22	2.51	2.93	3.25	3.51	3.89	4.30	4.63	4.34	3.84	3.45	3.00	2.76	2.69	2.43	1.62	2.73

(High soil moisture stress = 90 % depletion in available water)

(1959) who measured the relative amounts of evaporation and transpiration by weighing lysimeters .They concluded that evaporation was found to be greater than transpiration early in the season when the plants were small and intercept little of the net radiation . Later, as the extent of plant cover increased, transpiration was greater than evaporation. Lemon et al. (1959) reported that the gradual increase in evapotranspiration from planting to maturity can be explained on the basis of percent cover . The decrease in evapotranspiration after maturation is probably a plant-dependant factor . However, in many studies soil water is not maintained at a high level after maturation. Fritshen and Van Bavel (1964) indicated that when plants reached maturity , evapotranspiration was much less than at earlier stages of growth . Imam and Miseha (1978) concluded that the daily evapotranspiration from wheat was low at the beginning of the season, reached a peak by Mid March and declined after that. They mentioned that this trend follow the vegetative growth curve of wheat .

Soil moisture stress had a negative response on daily water use by wheat . In other words, as soil moisture stress increased a relative decrease in daily evapotranspiration was observed . This trend is a function of water availability to plants . The explaination of such results was reported by Black (1965) who concluded that the independence of evapotranspiration and density of vegetation canopy exists for different reasons where soil is dry than where availability of water for evaporation and transpiration is unlimited. Under moist soil, the control is in the atmosphere. Under dry conditions the control is in the soil. Under intermediate conditions, the control may be partly in the soil and partly in the plants . Also, Russell (1975) stated that " the drier the soil, the lower is the maximum rate that the roots can supply water to the leaves , so the less strong the evaporative conditions need to be for the canopy resistance to begin to control transpiration".

As for the effect of growth promoting substances (NAA or GA_3) on daily water use, results indicate that both of them increased daily evapotranspiration. Such increase was developed at later periods (during February and March) . However, when plants going to maturity , their effect was ceased . This trend may be due to the enhancing effect of both substances on growth as well as on transpiration. In this respect , Tal and Imber (1971) observed that prolonged treatment of tomato plants by 2-4- dichlorophenoxy acetic acid at relatively low concentration resulted in an increased transpiration rate .

Concerning the role of growth retardants (Alar or

Ethrel) on daily evapotranspiration by wheat , results presented in Tables (15 , 16 , 17 , 18 , 19 and 20) showed that a reduction in daily rates was gained by both substances . Such reduction in daily water use started some what earlier than NAA or GA_3 and extended to later periods of growth . This pattern may be due to the reduced growth of wheat plants either by Alar or Ethrel as well as the interference of these compounds on the biosynthesis of gibberellic acid in the treated plants . When the level of GA_3 within the plant is reduced a substantial reduction in transpiration occured and hence decrease daily evapotranspiration rates .

Daily evapotranspiration of wheat plants sprayed with antitranspirant was lower than those of unsprayed - specially through the period of spray - indicating a reduction in transpiration induced either by PMA or α -sulphonate. The greatest reduction was found by higher concentration of both substances . These results may show that increasing the concentration of antitranspirants did result in more stomatal closure. However , such decrease was found to be more with PMA than that followed the application of sulphonate . This pattern reveal that stomatal closure was induced more by PMA than sulphonate indicating a practical use of PMA in reducing transpiration losses . These results are confirmed by Shimshi (1963) and Slatyer (1967) who pointed out that PMA spray has a direct effect on stomatal closure and thereby reducing transpiration . More reduction in transpiration was observed by higher concentration of PMA .

The lower values of daily water use in plants treated with antitranspirants (PAM or sulphonates) than the control was observed during the period of spray only . Later on, the values reincreased again. Such reduction was extended for short periods (2 - 3 weeks) then wear off. This trend was very clear in PMA however, in case of sulphonate , the period was less shorter . These results are in full agreement with those reported by Meidner and Mansfield (1968) who concluded that the effects of sprays of PMA and of α - hydroxy sulphonates wear off after about two weeks.

The discussion of evapotranspiration rates by wheat under the various treatments covered their influence on resistance to evapotranspiration . These effects can be grouped into three categories :

1- The influence of degree of crop cover or canopy that influences diffusive resistance.
2- The maturation of the crop, including the development of seed heads above a crop can influence evapotranspiration by decreasing the portion of net radiation converted to latent heat of vaporization .

3- Net soil moisture stress prior to irrigation can influence the effective diffusive resistance.Low stress prior irrigation decrease the effective diffusive resistance .

A summary of the effect of different treatments i.e. growth regulators , antitranspirants and soil moisture levels on daily evapotranspiration by wheat as related to its growth cycle are given in Tables (21 , 22 and 23) and Figure (6). The data reveal that the values started very low at the beginning of the season, increased gradually as the plants developed to reach a maximum when plants complete 70 % of their growth cycle then declined after that to a minimum at harvest . Soil moisture stress decreased such values in the corresponding growth periods but follow the same pattern . However, growth regulators or antitranspirants may cause some modifications in the daily values either by increase or decrease depending on the mode of action of the used substances . Such modifications occured in some specific periods of wheat growth cycle. In other words, growth promoters restricted their effect from 50 - 80 % , growth retardants 40 - 90 %. However, antitranspirants mainly affect the period from 30 to 60 % of the growth cycle of wheat .

When considering this pattern, it seems better to represent the data of daily water use by wheat as a

Table (21): Effect of growth regulators and antitranspirants on mean daily evapotranspiration of wheat under low soil moisture stress in mm. / day .

Substances		Relative growth period %										Mean
		10	20	30	40	50	60	70	80	90	100	
	Control	1.13	1.48	2.54	3.70	4.60	5.07	5.80	5.14	4.15	2.55	3.62
Growth Promoters	NAA	1.13	1.48	2.53	3.79	4.94	5.40	6.08	6.07	4.51	2.66	3.86
	GA_3	1.13	1.48	2.56	3.81	4.99	5.37	6.06	6.02	4.41	2.68	3.85
	Mean	1.13	1.48	2.55	3.80	4.97	5.39	6.07	6.05	4.46	2.67	3.86
Growth Retardants	Alar	1.13	1.48	2.58	3.54	4.21	4.63	5.22	5.06	3.99	2.64	3.45
	Ethrel	1.13	1.48	2.61	3.50	4.15	4.58	5.31	4.86	3.96	2.60	3.42
	Mean	1.13	1.48	2.60	3.52	4.18	4.61	5.27	4.96	3.98	2.62	3.44
Antitran-spirants	PMA	1.13	1.48	2.18	3.04	3.76	4.53	5.38	5.00	4.09	2.56	3.32
	Sulphonates	1.13	1.48	2.37	3.36	4.20	4.47	5.60	5.11	4.10	2.52	3.43
	Mean	1.13	1.48	2.28	3.20	3.98	4.50	5.49	5.06	4.10	2.54	3.38
Mean		1.13	1.48	2.48	3.53	4.41	4.86	5.64	5.32	4.17	2.60	3.56

Table (22): Effect of growth regulators and antitranspirants on mean daily evapotranspiration of wheat under medium soil moisture stress in mm. / day .

	Substances	Relative growth period %										Mean
		10	20	30	40	50	60	70	80	90	100	
	Control	1.13	1.40	2.28	3.09	4.07	4.74	5.34	4.72	3.51	2.39	3.27
Growth Promoters	NAA	1.13	1.40	2.28	3.13	4.29	4.93	5.61	5.43	3.82	2.37	3.44
	GA_3	1.13	1.40	2.27	3.15	4.27	5.03	5.62	5.34	3.79	2.39	3.44
	Mean	1.13	1.40	2.28	3.14	4.28	4.98	5.62	5.39	3.81	2.38	3.44
Growth Retardants	Alar	1.13	1.40	2.28	3.07	3.67	4.29	5.03	4.52	3.45	2.34	3.12
	Ethrel	1.13	1.40	2.29	3.12	3.78	4.38	4.99	5.21	3.32	2.33	3.20
	Mean	1.13	1.40	2.29	3.10	3.73	4.34	5.01	4.87	3.39	2.34	3.16
Antitran-spirants	PMA	1.13	1.40	2.04	2.59	3.40	4.41	5.16	4.55	3.39	2.29	3.04
	Sulphonates	1.13	1.40	2.10	2.80	3.68	4.51	5.31	4.79	3.57	2.32	3.16
	Mean	1.13	1.40	2.07	2.70	3.54	4.46	5.24	4.67	3.48	2.31	3.10
Mean		1.13	1.40	2.23	3.01	3.91	4.63	5.30	4.91	3.55	2.36	3.24

Table (23): Effect of growth regulators and antitranspirants on mean daily evapotranspiration of wheat under high soil moisture stress in mm. / day .

Substances		Relative growth period %										Mean
		10	20	30	40	50	60	70	80	90	100	
	Control	1.13	1.38	2.12	2.61	3.49	4.10	4.35	3.64	2.87	2.22	2.79
Growth Promoters	NAA	1.13	1.38	2.11	2.63	3.54	4.19	4.61	3.85	2.89	2.24	2.86
	GA_3	1.13	1.38	2.11	2.65	3.56	4.18	4.65	3.78	2.86	2.24	2.85
	Mean	1.13	1.38	2.11	2.64	3.55	4.19	4.63	3.82	2.88	2.24	2.86
Growth Retardants	Alar	1.13	1.38	2.12	2.62	3.37	3.92	4.43	3.51	2.82	2.23	2.75
	Ethrel	1.13	1.38	2.11	2.58	3.27	3.88	4.40	3.50	2.82	2.22	2.73
	Mean	1.13	1.38	2.12	2.60	3.32	3.90	4.42	3.51	2.82	2.23	2.74
Antitran-spirants	PMA	1.13	1.38	2.01	2.35	3.02	3.69	4.43	3.55	2.85	2.24	2.67
	Sulphonates	1.13	1.38	2.04	2.40	3.25	3.94	4.53	3.62	2.88	2.26	2.74
	Mean	1.13	1.38	2.03	2.38	3.14	3.82	4.48	3.59	2.87	2.25	2.71
Mean		1.13	1.38	2.10	2.56	3.38	4.00	4.47	3.64	2.86	2.24	2.78

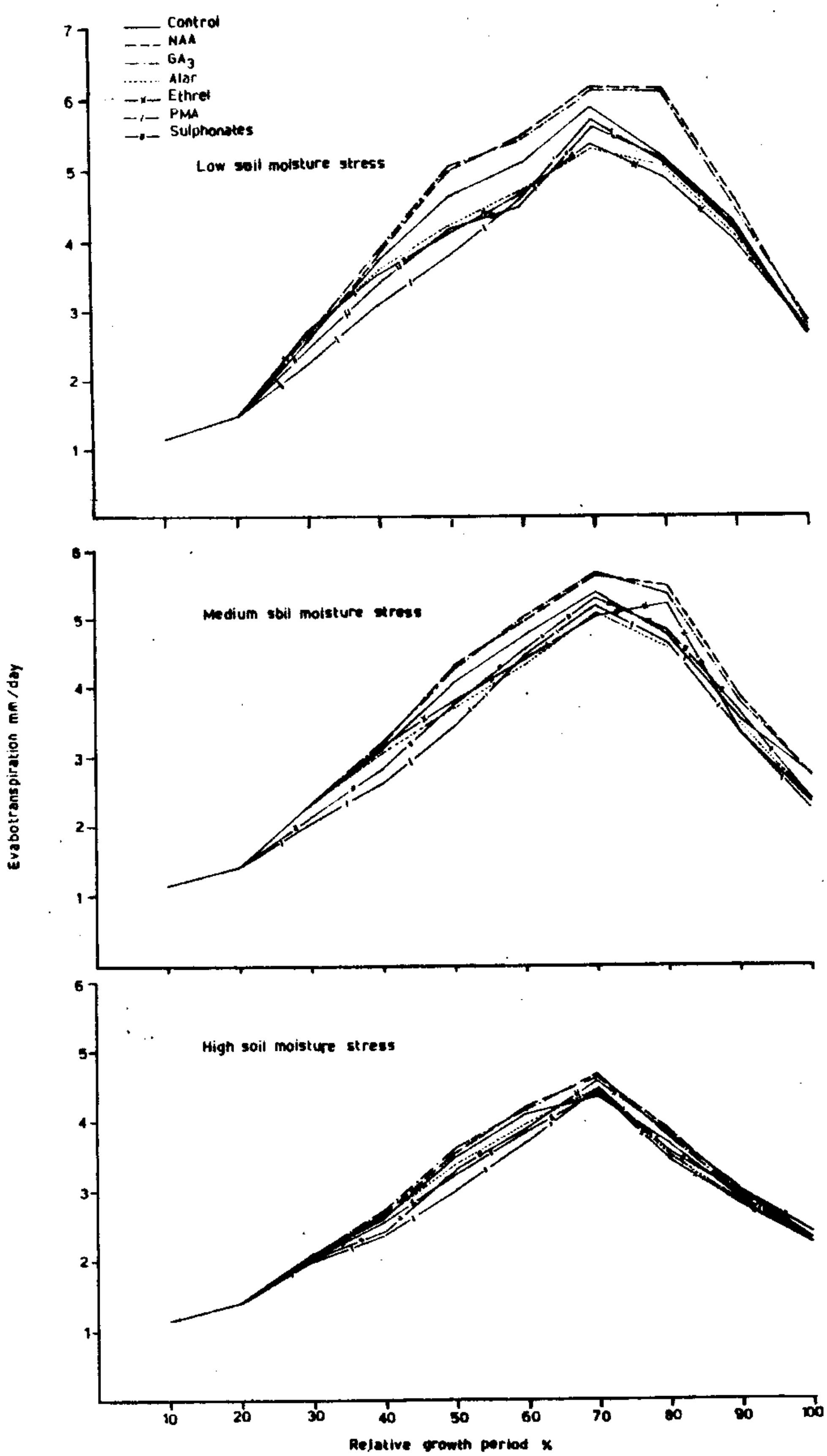

FIG.(8) DAILY EVAPOTRANSPIRATION OF WHEAT AS RELATED TO RELATIVE GROWTH PERIOD(%) UNDER THE VARIOUS TREATMENTS.

continous function relating the daily rate to the relative growth period in percentage . One of the easiest function to work with and generally has given the best description of a daily water use of a crop with respect to its growth cycle is the quadratic function in the form :

$$Y = a + b X + c X^2$$

where :

Y = daily evapotranspiration of wheat mm./day

X = relative growth period as percentage

a , b , c are the parameters of the function.

Such type of functions may demonstrate how far the growth cycle of the plant affect its daily water use rate . These equations predict the daily evapotranspiration of wheat at any specific period of wheat development as well as the period of maximum demand for water by the plant . The latter can de determined by differentiation and equating the derivative with zero .

Tables (24 , 25 and 26) illustrate the different functions obtained under the three moisture levels when wheat growth was affected either by growth regulators or antitranspirants . The varations between the parameters of these functions may show to what extent growth substances , antitranspirants and soil moisture stress affect the daily water use by wheat, as well as the period of maximum demand to water . This period ranged

Table (24): Daily evapotranspiration of wheat in mm. as a function of growth cycle for various growth regulators and antitranspirants treatments at Low Soil Moisture Stress

Substances		Quadratic Function $Y = a + bX + cX^2$ Y = daily evapotranspiration of wheat in mm. X = growth period in percentage	Maximum daily ET. % of growth cycle	Maximum daily ET. Days after sowing
	Control	$Y = -1.540 + 0.203X - 0.00156X^2$	65.1	98
Growth Promoters	NAA	$Y = -1.883 + 0.223X - 0.00170X^2$	65.6	98
	GA_3	$Y = -1.850 + 0.223X - 0.00170X^2$	65.6	98
Growth Retardants	Alar	$Y = -1.270 + 0.184X - 0.00140X^2$	65.7	99
	Ethrel	$Y = -1.030 + 0.172X - 0.00130X^2$	66.2	99
Antitranspirant	PMA	$Y = -1.090 + 0.160X - 0.00120X^2$	66.7	100
	Sulphonates	$Y = -1.350 + 0.185X - 0.00140X^2$	66.1	99

Table (25): Daily evapotranspiration of wheat in mm. as a function of growth cycle for various growth regulators and antitranspirant treatments at Medium Soil Moisture Stress

Substances		Quadratic Function $Y = a + BX + cX^2$ Y = daily evapotranspiration of wheat in mm. X = growth period in percentage	Maximum daily ET.	
			% of growth cycle	Days after sowing
	Control	$Y = -1.243 + 0.180X - 0.00140X^2$	64.3	97
Growth Promoters	NAA	$Y = -1.790 + 0.200X - 0.00150X^2$	66.7	100
	GA_3	$Y = -1.790 + 0.200X - 0.00150X^2$	66.7	100
Growth Retardants	Alar	$Y = -0.952 + 0.158X - 0.00120X^2$	65.8	99
	Ethrel	$Y = -1.150 + 0.170X - 0.00130X^2$	65.4	98
Antitran-spirants	PMA	$Y = -1.144 + 0.160X - 0.00120X^2$	66.7	100
	Sulphonates	$Y = -1.290 + 0.172X - 0.00130X^2$	66.2	99

Table (26): Daily evapotranspiration of wheat in mm. as a function of growth cycle for various growth regulators and antitranspirants treatments at High Soil Moisture Stress

Substances		Quadratic Function $Y = a + bX + cX^2$ Y = daily evapotranspiration of wheat in mm. X = growth period in percentage	Maximum daily ET. % of growth cycle	Maximum daily ET. Days after sowing
	Control	$Y = -0.750 + 0.140X - 0.00110X^2$	63.6	95
Growth Promoters	NAA	$Y = -0.710 + 0.140X - 0.00110X^2$	63.6	95
	GA_3	$Y = -0.720 + 0.140X - 0.00110X^2$	63.6	95
Growth Retardants	Alar	$Y = -0.550 + 0.130X - 0.00100X^2$	65.0	98
	Ethrel	$Y = -0.570 + 0.130X - 0.00100X^2$	65.0	98
Antitranspirants	PMA	$Y = -0.550 + 0.120X - 0.00090X^2$	66.7	100
	Sulphonates	$Y = -0.630 + 0.130X - 0.00100X^2$	65.0	98

from 95 to 100 days after sowing and depending on the factors affecting the growth as well as the level of soil moisture when irrigation was practiced .

4.1.2. Potential Evapotranspiration

Predictions of evapotranspiration are basic parameters for the engineer , or agronomist invilved in planning and developing water resources . Estimates of evapotranspiration are also used extensively in assessing the irrigation water - management efficiency of existing projects, future project drainage requirements and the magnitude of deep percolation losses under existing management practices . Water delivered to fields must provide for evapotranspiration and unavoidable losses beyond root zone . The first is dependant on meteorological conditions and the vegetative characteristics of the crop when water is not limiting . The second is dependant on management practices and it is not directly dependant on meteorological conditions .

Full utilization of water resources will require more reliable estimates of evapotranspiration in future. Emperical methods are used for estimating or predicting evapotranspiration when :

a) inadequate meteorological and soil -crop data are available to apply complete rational equations based on the physical processes involved .

b) the absoulte accuracy of the data needed may be adequate using simple emperical equations that require less time and effort to solve, and

c) complete rational equations often require greater technical ability and experience in meteorology , physics and agronomy than many users of evapotranspiration data .

A large number of methods for calculation of evapotranspiration from climatic data have been suggested, described ; tested and used with varying degrees of success. The methods range from complex calculation based on the physics of evaporation process, and requiring very accurate microclimate measurements ,to purely emprical approaches based on correlation between measured ET. and air temperature . An attempt was made to compare estimates of potential evapotranspiration obtained by seven different meteorological methods i.e. Modified Penman , Radiation , Jensen & Haise , Turc , Blaney & Criddle , Buchet and Class A pan evaporation with measured ET. values from wheat .

Daily , monthly and seasonal potential evapotranspiration rates on the basis of weekly agrometeorological data during the two growing seasons 1980/1981 and 1981/1982 are listed in Tables (27 , 28 and 29) and Figures (7 and 8). Also , monthly and seasonal values of potential evapotranspiration (ETp)calculated

Table (27): Daily potential evapotranspiration (ETp) calculated by different methods during season 1980 / 1981 in mm./day

Periods / Methods	2/12 8/12	9/12 15/12	16/12 22/12	23/12 29/12	30/12 5/ 1	6/1 12/1	13/1 19/1	20/1 26/1	27/1 2/2	3/2 9/2	10/2 16/2	17/2 23/2	24/2 2/3	3/3 9/3	10/3 16/3	17/3 23/3	24/3 30/3	31/3 6/4	7/4 13/4	14/4 20/4	21/4 27/4	28/4 30/4	Mean
Modified Penman	2.94	2.23	2.50	2.31	2.92	2.95	3.06	3.35	3.17	3.49	3.37	3.54	3.40	4.99	5.28	5.52	4.84	5.97	5.81	6.58	7.80	6.78	4.17
Radiation	2.22	1.58	1.96	1.80	2.17	2.03	2.06	2.43	2.34	2.53	2.43	2.40	2.99	4.61	4.80	4.72	4.28	5.37	5.31	6.37	6.63	5.82	3.49
Jensen & Haise	2.54	1.69	2.08	1.92	2.20	1.98	2.06	2.16	2.25	2.50	2.55	2.54	2.62	4.43	4.89	4.82	4.09	5.45	5.02	6.06	7.22	6.30	3.52
Turc	2.46	1.83	2.17	2.02	2.30	2.12	2.17	2.29	2.38	2.57	2.56	2.54	2.66	3.98	4.17	4.15	3.93	4.64	4.48	4.91	5.21	4.96	3.21
Blaney & Criddle	2.16	1.43	1.77	1.78	1.83	1.66	1.80	1.80	1.98	1.98	2.18	1.89	2.24	5.39	5.88	5.83	3.83	4.68	4.27	5.08	4.75	5.30	3.16
Bouchet	3.62	3.28	3.34	3.13	3.89	3.50	3.95	4.70	3.75	3.65	3.36	4.94	3.07	4.31	6.31	6.28	4.49	6.63	4.81	7.40	11.10	9.30	4.95
Pan Evaporation	2.60	2.30	2.50	2.20	2.20	2.80	2.50	2.50	3.20	2.90	3.00	3.10	3.40	3.20	3.70	4.20	4.30	4.20	4.00	4.10	4.20	4.50	3.25
Mean	2.65	2.05	2.33	2.17	2.50	2.43	2.51	2.75	2.72	2.80	2.77	2.99	2.91	4.42	5.00	5.07	4.25	5.28	4.81	5.79	6.70	6.14	3.68

(Calculated on short period basis , 7 days intervals)

Table (28): Daily potential evapotranspiration (ETp) calculated by different methods during season 1981 / 1982 in mm./day

Periods / Methods	23/11 29/11	30/11 6/12	7/12 13/12	14/12 20/12	21/12 27/12	28/12 3/1	4/1 10/1	11/1 17/1	18/1 24/1	25/1 31/1	L/2 7/2	8/2 14/2	15/2 21/2	22/2 28/2	1/3 7/3	8/3 14/3	15/3 21/3	22/3 28/3	29/3 4/4	5/4 11/4	12/4 18/4	19/4 25/4	Mean
Modified Penman	3.04	2.82	2.59	2.97	3.35	2.54	2.58	2.78	2.84	3.03	3.33	3.13	3.52	3.47	4.67	4.33	4.04	4.67	6.12	5.61	6.39	6.60	3.84
Radiation	2.42	2.32	2.26	2.31	2.15	2.22	2.01	2.43	2.12	2.00	2.40	2.22	2.85	2.57	4.24	3.96	4.16	4.01	5.09	4.91	5.89	5.79	3.20
Jensen & Haise	2.68	2.51	2.41	2.51	2.54	2.34	2.12	2.47	2.27	2.12	2.58	2.18	2.85	2.77	3.73	3.42	3.77	3.74	5.10	4.96	5.70	5.75	3.21
Turc	2.62	2.50	2.43	2.48	2.44	2.39	2.20	2.52	2.31	2.21	2.57	2.30	2.86	2.71	3.57	3.32	3.57	3.46	4.37	4.25	4.58	4.51	3.01
Blaney & Criddle	2.20	2.33	2.26	2.01	2.24	2.40	1.96	2.29	2.05	2.12	1.94	1.57	2.07	2.72	3.40	3.33	3.54	3.94	4.66	4.67	5.21	5.47	2.93
Bouchet	3.37	3.28	2.60	3.83	4.14	3.44	3.42	3.38	3.67	4.53	3.12	3.67	4.26	5.02	4.63	5.24	5.16	5.87	5.82	6.20	6.93	8.05	4.53
Pan Evaporation	2.70	2.50	2.20	2.40	2.30	2.80	2.10	3.30	3.40	2.90	2.80	2.50	3.20	3.30	3.20	3.40	3.70	4.10	4.20	4.10	4.40	4.80	3.20
Mean	2.72	2.61	2.39	2.64	2.74	2.59	2.34	2.74	2.67	2.70	2.68	2.51	3.09	3.22	3.92	3.86	3.99	4.26	5.05	4.96	5.59	5.85	3.42

(Calculated on short period basis , 7 days intervals)

Table (29): Potential evapotranspiration (ETp) calculated by different methods on short period basis during season 1980/1981 and 1981/1982

Method	Season 1980/1981						Season 1981/1982							Mean
	Monthly ETp mm					Seasonal	Monthly ETp mm						Seasonal	
	Dec.	Jan.	Feb.	March	April		Nov.§	Dec.	Jan.	Feb.	March	April@		
Modified Penman	75.7	96.0	96.1	157.2	197.5	622.5	24.1	89.5	86.2	94.2	142.3	154.7	591.0	606.8
Radiation	57.3	68.2	71.2	140.2	177.9	514.8	19.3	69.8	66.6	70.3	129.9	136.5	492.4	503.6
Jensen & Haise	59.8	65.7	76.7	138.3	179.7	520.2	21.3	76.6	69.9	72.7	117.9	135.3	493.7	507.0
Turc	64.0	69.5	71.8	123.6	144.9	473.8	20.8	76.0	71.9	73.1	110.6	110.9	463.3	468.6
Blaney & Criddle	53.6	55.9	57.5	155.7	142.7	465.4	17.7	69.2	66.1	58.1	113.5	126.1	450.7	458.1
Bouchet	101.4	123.3	106.5	162.5	230.9	724.6	26.9	107.4	115.3	112.5	163.8	171.5	697.4	711.0
Pan Evaporation	71.6	81.6	86.4	118.8	124.8	483.2	21.4	74.5	90.3	82.6	113.4	109.9	492.1	487.5
Mean	69.1	80.0	80.9	142.3	171.2	543.5	21.6	80.4	80.9	80.5	127.3	135.0	525.8	534.7

§ Nov. 8 days
@ April 25 days
(Calculated on short period basis , 7 days interval)

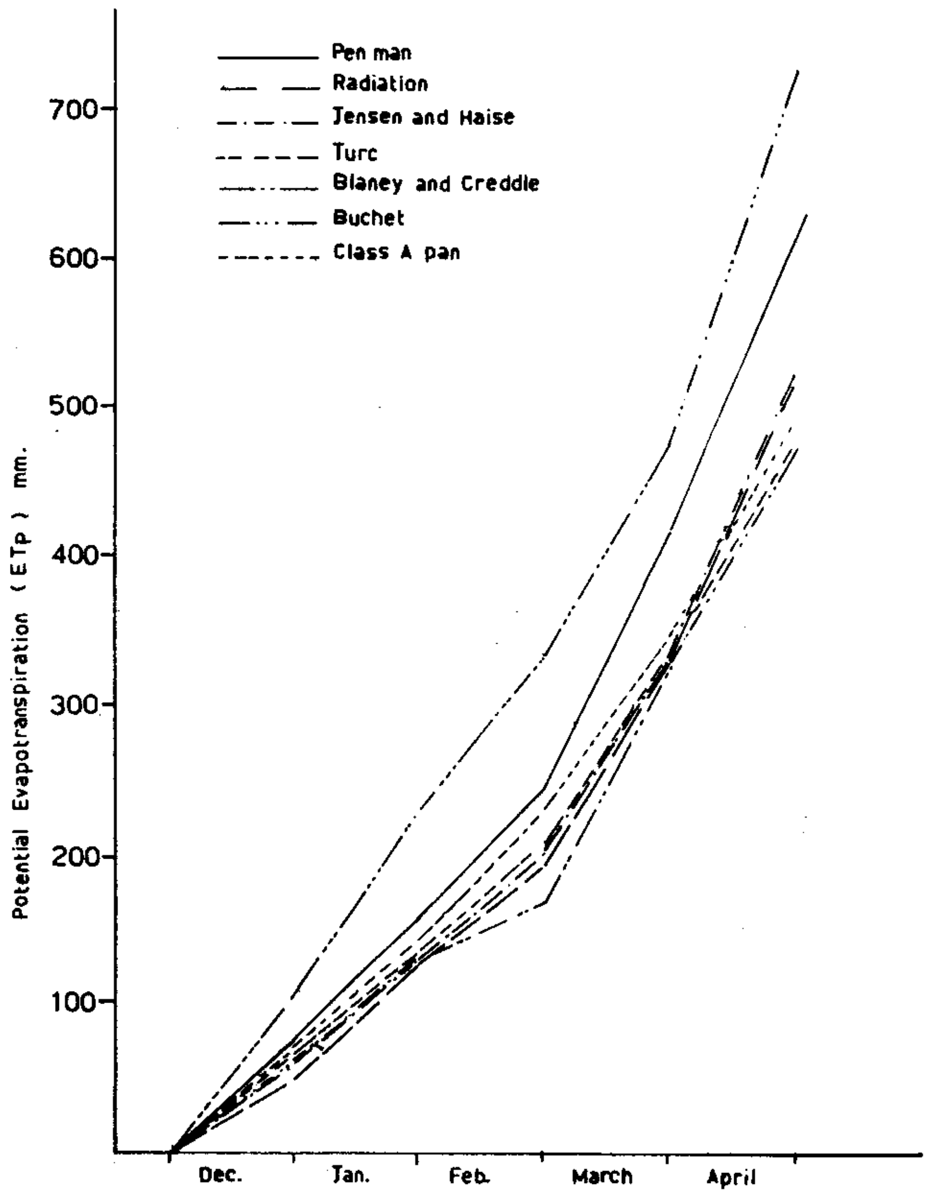

FIG. (7) CUMULATIVE POTENTIAL EVAPOTRANSPIRATION (ETp) AS CALCULATED BY DIFFERENT METHODS FOR THE GROWING SEASON 1980 / 1981.

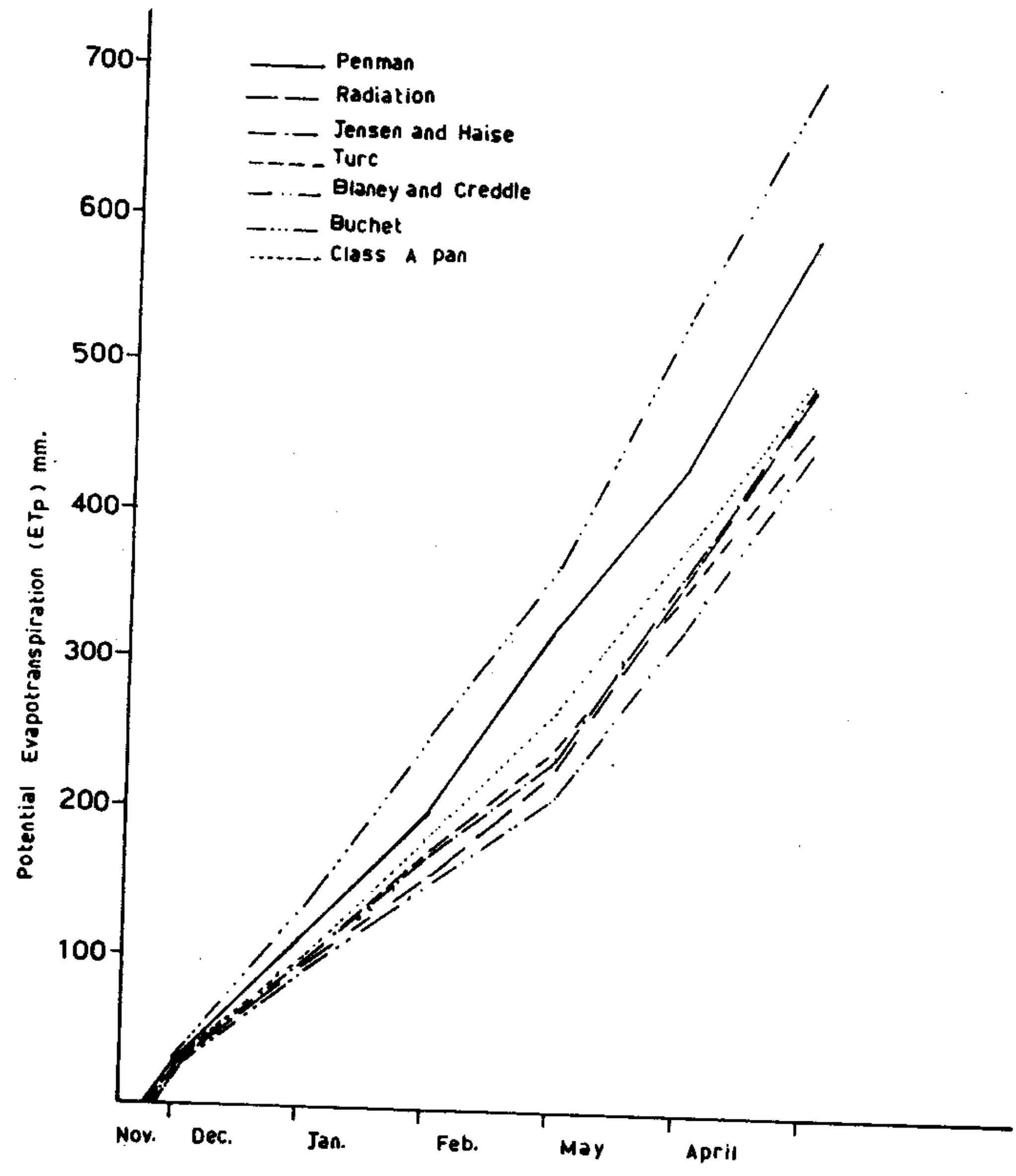

FIG. (8) CUMULATIVE POTENTIAL EVAPOTRANSPIRATION (ET_p) AS CALCULATED BY DIFFERENT METHODS FOR THE GROWING SEASON 1981/1982.

on monthly records in the same seasons are presented in Table (30) .

The results indicate that estimates of potential evapotranspiration by radiation , Jensen and Haise , Blaney and Criddle , and class A pan evaporation were underestimating the mean values of ETp. However , Buchet and Penman methods were overestimating the mean evapotranspiration . These results may be due to the fact that radiation may not be enought to get reasonable estimates of evapotranspiration. Also, the constants in both Jensen and Haise and Turc formulae are not suitable for Delta region . In this respect, Jensen (1966) pointed out that the major limitation of any emperical equation for estimating evapotranspiration is that its constant may not be applicable in other climatic regions without calibration .

The less values obtained from pan evaporation may be due to its screening . All the evaporation pans are protected against losses from animals and birds by standard screen . These results are in agreement with those reported by Stanhill (1962). He found a 10.4 % reduction of evaporation caused by the screen in a comparison of the evaporation from screened pans with that from unprotected instruments . This reduction factor was similar throughout the year at three different stations . The same author concluded that the

Table (30) : Potential evapotranspiration (ETp) calculated by different methods on monthly records during season 1980 / 1981 and 1981 / 1982 in mm.

Methods	Season 1980 / 1981						Sesaon 1981 / 1982							Mean
	Monthly ETp mm.					Seasonal	Monthly ETp mm.						Seasonal	
	Dec.	Jan.	Feb.	March	April		Nov.§	Dec.	Jan.	Feb.	March	April@		
Modified Penman	74.1	95.5	96.6	160.3	200.2	626.7	24.6	87.7	83.1	92.5	149.3	150.7	587.9	607.3
Radiation	56.8	64.6	84.L	140.4	171.2	517.1	20.3	69.5	64.7	81.0	127.0	126.7	489.2	503.2
Jensen & Haise	61.9	64.6	72.9	140.6	189.3	529.3	22.2	75.9	68.3	69.6	114.0	134.2	484.2	506.8
Turc	63.9	66.5	78.9	118.9	147.4	475.6	22.1	73.1	67.9	76.0	104.6	109.5	453.2	464.4
Blaney & Criddle	56.4	54.6	78.9	125.9	163.2	479.0	17.9	62.0	62.0	78.9	108.7	129.1	458.6	468.8
Bouchet	109.9	122.9	107.5	163.6	233.6	737.5	27.1	118.0	115.7	110.7	162.7	182.3	716.5	727.0
Pan Evaporation	72.0	80.6	86.8	117.8	126.0	483.2	21.6	74.4	93.0	84.0	114.7	112.5	500.2	491.7
Mean	70.7	78.5	86.5	138.2	175.8	549.8	22.3	80.1	79.2	84.7	125.9	135.0	527.1	538.5

§ Nov. 8 days

@ April 25 days

(Calculated on monthly records)

water level within the pan must not allowed to fall more than 5 cm. below its upper level before refilling. Also , Doorenbos and Pruitt (1975) proposed a 10 % increasing factor for water loss reading from screened pan evaporation .

In case of Blaney and Criddle formula, the values of daily , monthly and seasonal evapotranspiration were lower than the mean . This is mainly due to that it involves only two parameters, temperature (T) and percentage of day time hours (P) as climatic variables to predict the effect of climate on evapotranspiration. The effect of climate on evapotranspiration is not fully defined by temperature and day lengthrelated factor(F) alone . Also, the modification made by Doorenbos and Pruitt (1977) was found to be insufficient for estimating potential evapotranspiration . These results are in line with those reported by Rijtema and Abou Khaled (1975) who concluded that the Blaney and Criddle consumptive use factor (F) insufficiently reflects the differences in agrometeorological conditions for crop water requirements . It will be necessary to determine the crop coefficients experimentally for different regions .

The data collected for daily, monthly or seasonal evapotranspiration by Piche (Buchet method) was very high than the mean. This trend may be due to that the constant (0.37) of this formula was drived for humid areas . Also, Piche evaporimeter reading is not so enough to measure the vaporizing power of the air . In this connection, Stanhill (1961) concluded that the least accurate of all methods for estimating evapotranspiration was the Piche evaporimeter . Puech and Combert (1969) stated that the coefficient 0.37 can not be used in all cases .

The short and long period accuracy for the emprical equations was estimated . Such estimations are given in Tables (29 and 30). Results clearly show that methods using radiation (Penman, Radiation , Jensen & Haise and Turc) as the primary variable , provide adequate and reliable estimates of evapotranspiration either on short or long period determination. However, those depend on temperature as the main parameter (Blaney & Criddle and Buchet) was found to be inconsistence when calculated on short or long period basis . These results are in full agreement with those reported by Jensen (1966) . He pointed out that an emprical equation with air temperature as the main parameter would not be as reliable for short period estimates in humid areas as in arid areas . In contrast, since radiant energy is the main source of heat energy in both areas, emprical equations with a radiation term can be applied with more confidence in either areas, when calibrated .

From the above comparison between the estimates of potential evapotranspiration , it can be seen that , of the formulae, the most successful method was that of Penman (Modified Penman by Doorenbos and Pruitt, 1977). It gives the most accurate results as its values are very close to that measured by wheat. Radiation , and Jensen and Haise gave estimates which were incorrect but their values were similar , whereas Turc method require considerable correction before use . Blaney and Criddle formula , a part from the fact that it requires crop factor not normally available and of unknown applicability, was also less accurate . The least accurate of all the methods tested was the Piche evaporimeter . These results are in harmony with those found by Stanhill (1961) who concluded that the methods with a sound theoretical basis i.e. open water surface evaporation calculated by Penman's method or measured with a standard surface are the most satisfactory , whilst the emprical methods are either inaccurate or require considerable correction . On the other hand, Tawadros et al. (1979) reported that correlation studies between the actual and the estimated values of evapotranspiration showed a significant relationships. Blaney and Criddle formula gave a good reliable estimates for crops grown in Upper and Middle Egypt. At Northern Delta , Modified

Penman and Radiation method gave lower values than those obtained by Blaney and Criddle formula .

Measurement of potential evapotranspiration(ETp) by a class A pan evaporation is the simplest method as it is inexpensive , easily operated and needs no more aditional climatic data . However, its readings need a correction factor to be drived . The relationship between the daily potential evapotranspiration determined from Penman's method and the records of class A pan was compared by ploting the two values against each other . The least square method was applied to obtain the following regression equation (Figure 9) that fits the data :

$$Y = 1.31 X - 0.127$$

where :

Y = potential evapotranspiration in mm./day

X = pan evaporation value in mm./day

Statistical analysis of the data showed that the relationship was highly significant with a correlation coefficient of + 0.79 .The slope of the regression line (1.31) can be considered as the correction factor for the screened class A pan evaporation. The constant in the linear function could be negleted as it is very small (0.12) to affect the estimation of potential evapotranspiration . Thus, it can be concluded that the daily records of a class A pan must be

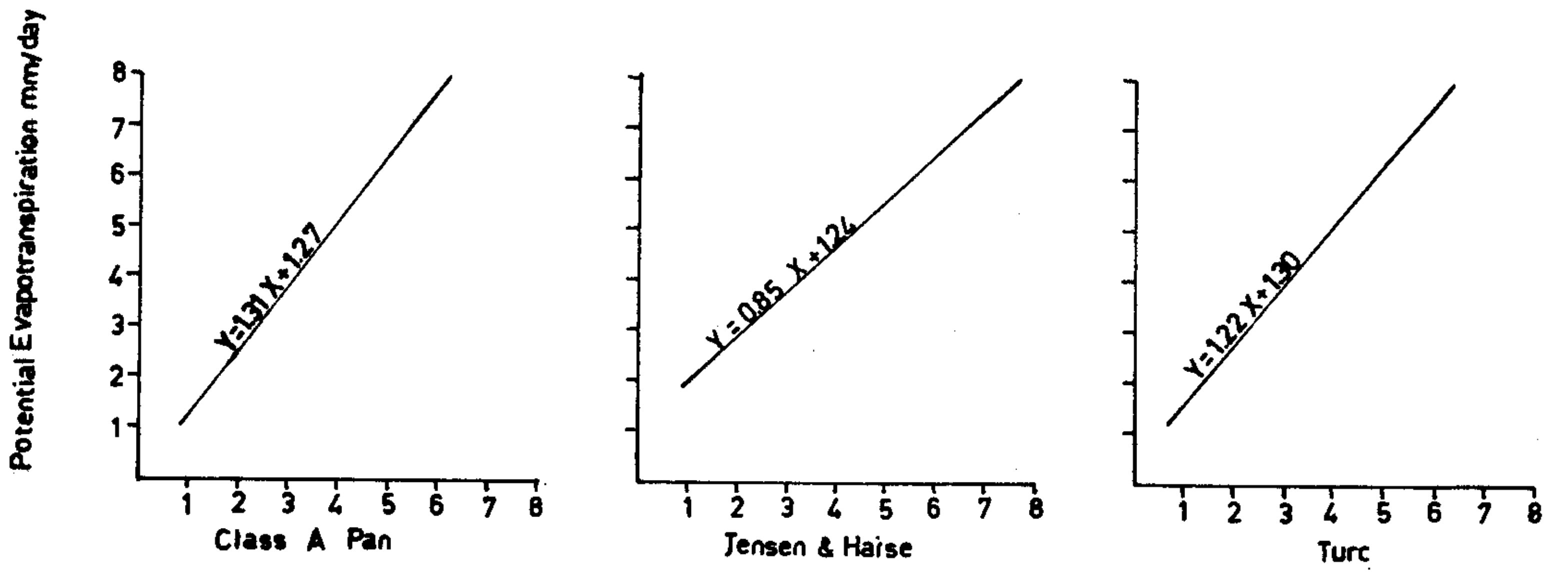

FIG. (9) ADJUSTING PAN EVAPORATION, JENSEN & HAISE AND TURC FORMULAE TO POTENTIAL EVAPOTRANSPIRATION multiplied by 1.30 to obtain the corresponding evapotranspiration values .

The accuracy of estimating potential evapotranspiration appears to be sufficient using Penman method . However, the utility of Penman method is somewhat restricted by the availability of meteorological data. Input data are not always available . On the other hand, methods depending on solar radiation i.e. Jensen and Haise or Turc need less climatic data. Both methods use solar radiation as the main parameter in estimating evapotranspiration. These results had the same trend obtained by Jensen (1966) . He pointed out that the major advantages of emperical equations using solar radiation are simplicity " calibration " for an area is not difficult , and estimates have sufficient reliability for most engineering or water management applications . Solar radiation is measured at a large number of locations throughout the world . Mean values can be estimated for most areas using clear -day or extraterrestrial values and percent of sunshine or cloud cover. Also, Doorenbos and Pruitt (1975) concluded that radiation method is more reliable than the Blaney & Criddle approach .

From practical point of view, the calculation of potential evapotranspiration by Jensen and Haise or Turc methods that give a reasonable accuracy need calibration.

Therefore, calibration was done by plotting the values obtained from Penman method against the estimated ones determined by both formulae to assure accuracy. Statistical analysis of the data using least square method give the following regression equations (Fig. 9):

1 - Jensen and Haise

$$Y = 0.85 X + 1.24$$

2 - Turc

$$Y = 1.22 X + 0.31$$

where

Y = Potential evapotranspiration in mm./day

X = values of evapotranspiration estimated by either Jensen & Haise or Turc formulae in mm./day .

Therefore, when limited meteorological data are available , Jensen and Haise or Turc emperical formulae provide adequate and reliable estimates of potential evapotranspiration after correction. Those methods does not require much skill and the time and effort required are minimal. In case of Jensen and Haise equation , each value can be adjusted using the linear function:

$$Y = 0.85 X + 1.24$$

where :

Y = potential evapotranspiration in mm./day

X = evapotranspiration values obtained from the formula of Jensen and Haise in mm./day .

However in case of using Turc, for better use a new constant was drived and the modified equations are as follows :

$$ETp = 0.017 \frac{T}{T + 15} (Rs + 50) \text{ mm./day}$$

when mean relative humidity is greater than 50 % .

$$ETp = 0.017 \frac{T}{T + 15} (Rs + 50)(1+ \frac{50 - RH}{70}) \text{ mm./day}$$

when mean relative humidity is less than 50 % .

where :

ETp = potential evapotranspiration

T = mean air temperature in ^{o}C

Rs = solar radiation in cal./cm^2/day

RH = relative humidity

4.1.3. Crop Coefficient (K_c)

Since most crops do not require as much water during the season as would be needed to meet potential evapotranspiration, even though adequate soil moisture is provided, an additional term is desired to differenitate water requirements of agricultural crops when water is not limiting from water use when soil moisture may be limiting during a portion of the season. This term can be refered to as " crop potential evapotranspiration " . The magnitude of this term generally will be less than potential evapotranspiration during some periods in the season . This primarly because of limited plant canopy during a portion of the season and the over all increase in resistance to evaporation as the crop matures . Crop potential evapotranspiration as defined can be represented by the following equation :

$$ET_c = K_c \, ET_o$$

where

ET_c = Crop potential evapotranspiration

K_c = Crop coefficient when soil water is not limiting

ET_o = Potential evapotranspiration

Experimentally developed crop coefficient reflects the physiology of the crop , the degree of crop cover and the reference evapotranspiration.Determination of crop coefficient , both crop evapotranspiration and potential evapotranspiration are measured concurrently. The crop coefficient is calculated as the dimensionless ratio of the two measurements .

Doorenbos et al. (1977) defined the stages in wheat development as follows :

1- Initialstage : germination and early growth when the soil surface is not hardly covered by the crop .

2- Crop develop-ment stage : from end of initial stage to attainment of effective full cover .

3- Mid seasin stage : from attainment of effective full cover to time of start of maturity.

4- Late season stage : from end of mid season stage until maturity

5- Harvesting : from late season stage till harvest.

The crop coefficient of wheat throughout its stages of growth under the various treatments are presented in Table (31) and illustrated in Figure (10). The values were calculated according to the daily potential evapotranspiration estimated by Penman's method and actual ET_c drevied from the wet treatment (considered as the treatment when water is not limiting).

Crop coefficient was very low at the initial period (0.42) due to the relatively large diffusive resistance of bare soil after planting . Then K_c increased as the crop cover increased which represent the decrease in

Table (31): Crop coefficient (K_c) of wheat during the different growth stages as affected by growth regulators and antitranspirants

Treatments			Initiation Stage 21 days	Crop development Stage 28 days	Mid season Stage 63 days	Late season Stage 28 days	Harvest 10 - 15 days	Seasonal 150 - 155 days
Potential ET. mm./day			2.69	2.84	3.74	5.46	6.90	4.01
	Control	ET.	1.13	2.39	5.03	4.26	1.97	3.58
		K_c	0.42	0.84	1.34	0.74	0.29	0.89
Growth Promoters	NAA	ET.	1.13	2.40	5.49	4.65	2.00	3.83
		K_c	0.42	0.85	1.47	0.85	0.29	0.96
	GA_3	ET.	1.13	2.39	5.35	4.57	2.01	3.82
		K_c	0.42	0.84	1.43	0.84	0.29	0.95
Growth Retardants	Alar	ET.	1.13	2.40	4.63	4.12	2.29	3.43
		K_c	0.42	0.85	1.24	0.75	0.33	0.86
	Ethrel	ET.	1.13	2.38	4.55	4.05	2.00	3.39
		K_c	0.42	0.84	1.22	0.74	0.29	0.85
Antitranspirants	PMA	ET.	1.13	2.09	4.40	4.24	1.97	3.29
		K_c	0.42	0.74	1.18	0.78	0.29	0.82
	Sulphonates	ET.	1.13	2.25	4.75	4.19	1.96	3.47
		K_c	0.42	0.79	1.27	0.77	0.29	0.87

ET. = actual evapotranspiration in mm./day

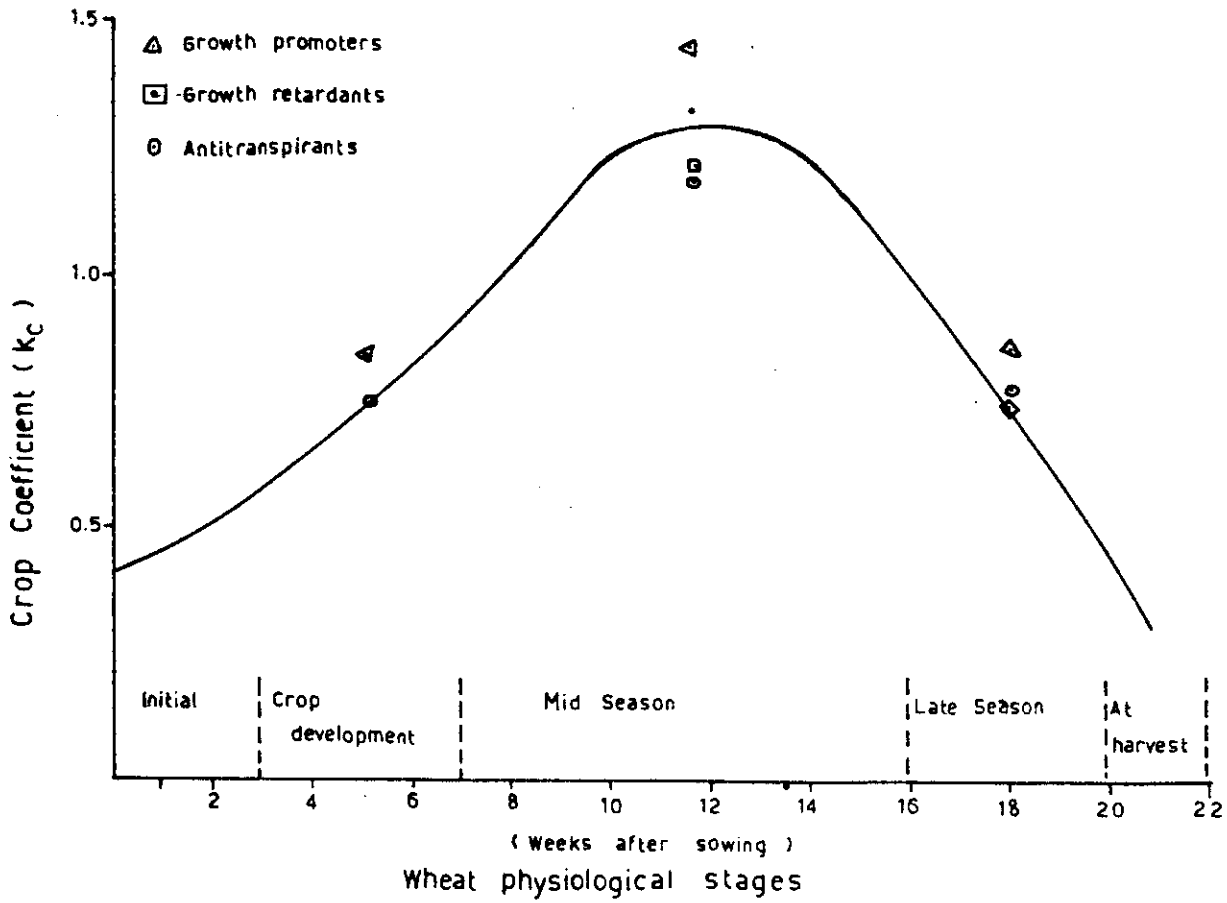

FIG. (10) VALUES OF CROP COEFFICIENT (K_C) AT DIFFERENT PHYSIOLOGICAI STAGES OF WHEAT GROWTH diffusive resistance during the period of rapid leaf-area development. Such values ranged from 0.74 to 0.85 . At mid season stage, K_c value exceeds the unit (1.47 - 1.18) which may demonstrate that this period is considered as the peak water demand by wheat . Thereafter, crop coefficient redecreased again when the crop reached maturity. The above mentioned pattern, was explained by Jensen (1968) who pointed out that seasonal evapotranspiration for most comman farm crops will be less than the potential because the soil may be completely bare for some time prior to planting, leaf area is limited as the seedling emerge and develop , and the effective resistance to transpiration increase as the crop begins to mature . Burch *et al.*(1978) concluded that the ratio of actual to potential evapotranspiration increased from 0.2 early in the season to about 1.2 at later stages for well watered plants .

The effect of growth regulators on crop coefficient (Table,31), indicate that growth promoting substances increased the K_c value during the mid and late season stages due to the decrease in resistance to transpiration caused by such substances (NAA or GA_3) . At other stages , there are no effect on K_c value . However, either Alar or Ethrel (growth retardants) increased the resistance to transpiration and hence decreased the K_c value at the same stages . When antitranspirants were sprayed, leaf resistance to water vapour loss increased, thereby decreased the crop coefficient (K_c) . This trend was found to be clear during the crop development and mid season stages (period of spraying antitranspirants).

It is worthy to mention that seasonal crop coefficient (Table 31) was found to be 0.89 in the control treatment . However, when plant growth was enhanced by growth promoting substances (NAA or AG_3) the value increased to 0.95 . On the other hand, the application of either growth retardants or antitranspirants decreased such value to about 0.85 due to the increase in resistance to water vapour losses . These results are in line with those reported by Doorenbos et al. (1979) who pointed out that seasonal crop coefficient (K_c) of wheat ranged from 0.80 to 0.90 .

In the view of the previous results, it can be concluded that any environmental factor that affect the resistance to water vapour diffusion may result in changes in crop coefficient either by increasing or decreasing such value . Any change in crop coefficient (K_c) may affect directly the evapotranspiration of a crop in concern .

4.2. PLANT GROWTH

Plant growth is often considered as the net gain of internal plant metabolism which is governed by many environmental factors .

4.2.1. Plant Height

Plant height of wheat at harvest time as affected by soil moisture stress, growth regulators and antitranspirants is presented in Table (32). Both growth substances and antitranspirants as well as water regime exhibit a significant response on plant height of wheat .

As for the effect of soil moisture stress on the height of wheat plant , statistical analysis showed that increasing soil moisture stress caused a highly significant reduction on plant height . There was a great depression in the value of plant height when irrigation was given after the removal of 90 % of available soil moisture . On the other hand, high moisture level (30 % depletion in available water) gave the maximum value of plant height, while moderate levels gave an intermediate values . This means that high moisture level enhanced the growth of plants and increased the stem length . In this connection, Beckett and Robertson (1917) , Marr (1927) and Oppeheimer and Elze (1941) concluded that the increase in water supply may result in longer internodes axis and hence the plant height

Table (32): Effect of growth regulators, antitranspirants and soil moisture levels on plant height of wheat at harvest time in cm.

Seasons / Soil moisture levels / Substances			Season 1980 / 1981				Season 1981 / 1982			
			Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean
	Control		104.4	101.5	85.0	97.0	105.1	99.9	87.3	97.4
Growth Promoters	NAA	50 ppm.	107.7	105.3	87.3	100.1	108.3	104.5	85.7	99.5
	NAA	100 ppm.	110.8	104.8	88.0	101.5	108.9	103.6	89.5	100.7
	GA_3	50 ppm.	109.0	104.5	87.3	100.3	109.8	105.3	90.1	101.7
	GA_3	100 ppm.	111.5	104.9	82.5	99.6	110.6	103.8	86.9	100.4
Growth Retardants	Alar	500 ppm.	97.5	96.0	81.6	91.7	99.6	95.3	79.3	91.4
	Alar	1000 ppm.	96.3	95.0	75.9	89.1	98.4	97.7	81.9	92.7
	Ethrel	500 ppm.	93.6	89.8	76.8	86.7	95.6	91.8	79.3	88.9
	Ethrel	1000 ppm.	94.8	91.0	78.3	88.0	95.9	89.2	76.9	87.3
Antitransp-irants	PMA	$5 \times 10^{-5}\underline{M}$	101.9	99.8	86.8	96.2	102.4	98.5	84.3	95.1
	PMA	$1 \times 10^{-4}\underline{M}$	102.2	99.3	85.5	95.7	103.2	97.3	85.8	95.4
	Sulphonate	$1 \times 10^{-2}\underline{M}$	101.6	98.5	81.6	93.9	103.1	98.1	81.2	94.1
	Sulphonate	$5 \times 10^{-2}\underline{M}$	100.3	98.6	83.3	94.1	102.2	96.8	82.9	94.0
	Mean		102.4	99.2	83.1		103.3	98.6	83.9	
L.S.D. 0.05										
Irrigation				1.19				1.10		
Substances				2.47				2.30		

will increased. It is worthy to mention that, the growth and development of plant depend upon continuous cell division, the differentiation and enlargement of cells until the characteristic form of the plant is realized (Slatyer , 1973). Cell division appears less sensitive to water deficit than cell enlargement (Vaadia et. al., 1961 ; Gates , 1964 ; Salter and Goode, 1967). Evidence for this view has shown that cell number is frequently of the same order in plants imposed to water deficit when compared to those grown under wet conditions , however, cell size is greater in the later (Petimov , 1965 ; Brouwer , 1963).

With regard to the effect of growth promoting substances i.e. NAA or GA_3 irrespective of soil moisture stress, mean plant height values indicate that the application of either NAA or GA_3 at the two used rates increased significantly the height of wheat plant.These results can be ascribed to the stimulative effect of such chemicals on the growth of plant which was reflected on the plant height .The explanation of the stimulative effect of GA_3 was reported by Jackson and Edda (1962), who attributed the increase in stem length of GA_3 treated plants to enhancing cell elongation or cell division and consequently internode length. The above mentioned findings are in full agreement with those reported by El-Masry (1970) who found that spraying wheat plant with

NAA increased shoot length .

Concerning the role of growth retardants (Alar and Ethrel) on plant height , results presented in Table (32). revealed a reverse trend to that observed with growth promoters . In other words, both compounds reduced the height of wheat plant whereas , Ethrel was found to be more in this respect . This pattern can be attributed to the retarding effect of such materials on the growth of wheat . The obtained data are in line with those found by Vandan (1974) who concluded that foliar spray with Ethrel markedly reduced the height of wheat plant .

Regarding the influence of antitranspirants (PMA or sulphonate), data shown in Table (32)had a trend towards that observed with growth retardants but to a lesser extent . This pattern may be due to the decrease in the rate of carbon dioxide intake which accompained by a decrease in photosynthesis. These results are in agreement with Davenport et. al. (1971) who found that film forming antitranspirat reduced leaf expansion and plant height under condition of adequate soil moisture and moderate evaporative demand .

It is intersting to mention that, under severe soil moisture stress the enhancing effect of either NAA or GA_3 on the plant height was inhibited . These results may indicate the importance of soil moisture for such chemical , to express the enhancing effect of plant growth as well as plant height . These results are in harmony with those reported by Nowakowski and Lubanska (1975) who pointed out that IAA and GA_3 increased the photosynthetic intensity of wheat under high soil moisture level while had no effect under dry conditions.

4.2.2. Dry Matter Accumulation

Dry matter content of plant organs during different stages of growth may be considered as an indirect indication for accumulation of minerals and physiological activities of the various tested plant parts . In addition, it is one of the main excellent expression for plant growth behaviour .

Dry matter accumulation in different wheat plant parts as well as percentage distribution of such values in relation to the total amount of whole plant at various sampling dates as affected by growth regulators and antitranspirants under three moisture levels are given in Tables (33, 34 , 35 , 36 , 37 , 38 , 39, 40 , 41, 42 , 43 , 44 , 45 and 46).

Dry matter accumulation in the various wheat plant organs started with low amounts at earlier stages of growth (35 days after sowing) , then increased rapidly during the period of shooting through heading (70 -105 days after planting). Such increase is associated with the development of stem and reproductive organs . After

Table (33): Effect of growth regulators and antitranspirants on dry matter accumulation in different organs of wheat plant at various stages of growth grown under low soil moisture stress during season 1980 /1981 (g./plant).

Different organs		Roots				Leaf blades				Sheath				Stem			Heads	
Weeks after sowing / Treatments		5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
Growth Promoters	Control	0.22	1.01	1.02	0.90	0.64	1.78	2.15	1.76	0.21	0.83	1.23	1.14	0.96	4.16	3.93	2.11	4.49
	NAA 50 ppm.	0.22	0.91	0.89	0.90	0.64	1.87	2.29	1.85	0.21	0.87	1.35	1.28	1.05	4.54	4.27	2.06	4.99
	NAA 100 ppm.	0.22	0.93	0.91	0.88	0.64	1.85	2.28	1.87	0.21	0.84	1.39	1.25	1.06	4.56	4.41	2.16	5.12
	GA_3 50 ppm.	0.22	0.91	0.93	0.84	0.64	1.84	2.26	1.89	0.21	0.85	1.39	1.22	1.06	4.59	4.32	2.17	5.19
	GA_3 100 ppm.	0.22	0.92	0.88	0.85	0.64	1.86	2.28	1.89	0.21	0.83	1.38	1.25	1.04	4.58	4.39	2.23	5.14
Growth Retardants	Alar 500 ppm.	0.22	1.06	1.13	1.09	0.64	1.81	2.23	1.81	0.21	0.77	1.15	1.03	0.90	3.76	3.49	2;L8	4.23
	Alar 1000 ppm.	0.22	1.08	1.12	1.09	0.64	1.83	2.24	1.85	0.21	0.76	1.19	1.07	0.92	3.71	3.51	1.98	4.19
	Ethrel 500 ppm.	0.22	1.11	1.12	1.11	0.64	1.78	2.22	1.89	0.21	0.70	1.10	1.01	0.79	3.55	3.41	1.89	3.09
	,, 1000 ppm.	0.22	1.12	1.21	1.12	0.64	1.82	2.26	1.94	0.21	0.71	1.10	1.03	0.78	3.56	3.39	1.72	2.91
Antitranspi-rants	PMA 5×10^{-5} M	0.22	1.05	1.06	0.93	0.64	1.69	2.12	1.61	0.21	0.76	1.13	1.09	0.92	4.06	3.69	2.10	4.21
	PMA 1×10^{-4} M	0.22	1.05	1.01	0.95	0.64	1.67	2.12	1.62	0.21	0.77	1.12	1.05	0.93	4.01	3.65	2.11	4.21
	Sul-phonate 1×10^{-2} M	0.22	1.07	1.03	0.92	0.64	1.67	2.10	1.62	0.21	0.79	1.13	1.06	0.90	4.06	3.61	1.96	4.25
	Sul-phonate 5×10^{-2} M	0.22	1.02	1.05	0.93	0.64	1.68	2.11	1.65	0.21	0.81	1.11	1.09	0.88	4.08	3.62	2.06	4.21
Mean		0.22	1.02	1.03	0.96	0.64	1.78	2.20	1.79	0.21	0.79	1.21	1.12	0.94	4.09	3.82	2.06	4.33
L.S.D. 0.05 Irrigation		N.S.	N.S.	N.S.	N.S.	N.S.	0.26	0.05	0.06	N.S.	0.24	0.07	0.07	N.S.	0.11	0.13	0.10	0.12
Substances		-	N.S.	N.S.	N.S.	-	N.S.	0.08	0.10	-	N.S.	0.12	0.13	N.S.	0.20	0.24	0.22	0.26

Table (34): Effect of growth regulators and antitranspirants on dry matter accumulation in different organs of wheat plant at various stages of growth grown under medium soil moisture stress during season 1980 / 1981 (g./plant).

Different organs		Roots				Leaf blades				Sheath				Stem			Heads	
Weeks after sowing Treatments		5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	0.19	1.01	1.04	1.00	0.62	1.57	2.02	1.65	0.21	0.67	1.12	1.06	0.77	3.79	3.50	1.72	3.79
Growth Promoters	NAA 50 ppm.	0.19	0.89	0.89	0.87	0.62	1.66	2.07	1.72	0.21	0.77	1.17	1.09	0.84	4.06	3.90	1.83	3.91
	NAA 100 ppm.	0.19	0.88	0.88	0.86	0.62	1.65	2.12	1.71	0.21	0.76	1.18	1.06	0.87	4.04	3.96	1.82	3.95
	GA_3 50 ppm.	0.19	0.83	0.91	0.88	0.62	1.64	2.06	1.76	0.21	0.77	1.20	1.11	0.86	4.05	3.91	2.02	3.93
	GA_3 100 ppm.	0.19	0.88	0.88	0.79	0.62	1.67	2.11	1.75	0.21	0.75	1.24	1.13	0.84	4.07	3.88	1.84	3.95
Growth Retardants	Alar 500 ppm.	0.19	1.05	1.12	1.05	0.62	1.59	2.15	1.71	0.21	0.63	1.04	1.00	0.70	3.43	3.22	1.82	3.72
	Alar 1000 ppm.	0.19	1.07	1.14	1.02	0.62	1.57	2.14	1.70	0.21	0.64	1.01	1.01	0.71	3.37	3.18	1.67	3.65
	Ethrel 500 ppm.	0.19	1.06	1.08	1.08	0.62	1.56	2.09	1.69	0.21	0.58	0.96	0.89	0.62	3.23	3.17	1.49	3.18
	Ethrel 1000 ppm.	0.19	1.05	1.06	0.92	0.62	1.58	2.06	1.62	0.21	0.61	0.99	0.83	0.62	3.20	3.19	1.32	3.19
Antitranspirants	PMA 5×10^{-5} M	0.19	1.04	1.01	1.02	0.62	1.58	1.94	1.56	0.21	0.61	1.06	1.01	0.74	3.71	3.40	1.57	3.71
	PMA 1×10^{-4} M	0.19	0.99	0.98	0.96	0.62	1.50	1.95	1.55	0.21	0.64	1.07	1.02	0.74	3.65	3.31	1.62	3.69
	Sulphonate 1×10^{-2} M	0.19	0.98	0.94	1.01	0.62	1.52	1.96	1.55	0.21	0.65	1.04	1.01	0.72	3.64	3.35	1.69	3.62
	Sulphonate 5×10^{-2} M	0.19	1.02	1.01	1.05	0.62	1.49	1.97	1.52	0.21	0.61	1.05	0.99	0.71	3.54	3.30	1.61	3.68
	Mean	0.19	0.98	1.00	0.96	0.62	1.46	2.05	1.65	0.21	0.67	1.09	1.02	0.75	3.36	3.48	1.69	3.69
L.S.D. 0.05																		
Irrigation		N.S.	N.S.	N.S.	N.S.	N.S.	0.26	0.05	0.06	N.S.	0.24	0.07	0.07	N.S.	0.11	0.13	0.10	0.12
Substances		-	N.S.	N.S.	N.S.	-	N.S.	0.08	0.10	-	N.S.	0.12	0.13	N.S.	0.20	0.24	0.22	0.26

Table (35): Effect of growth regulators and antitranspirants on dry matter accumulation in different organs of wheat plant at various stages of growth grown under high soil moisture stress during season 1980 / 1981 (g. /plant).

	Different organs	Roots				Leaf blades				Sheath				Stem			Heads	
	Weeks after sowing / Treatments	5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	0.22	0.81	0.88	0.81	0.62	1.23	1.46	1.21	0.19	0.43	0.93	0.75	0.59	2.25	2.11	1.20	2.79
Growth Promoters	NAA 50 ppm.	0.22	0.73	0.70	0.69	0.62	1.21	1.38	1.22	0.19	0.44	0.86	0.81	0.56	2.23	2.08	1.18	2.86
	NAA 100 ppm.	0.22	0.74	0.68	0.68	0.62	1.16	1.49	1.22	0.19	0.45	0.73	0.75	0.58	2.29	2.15	1.17	2.65
	GA_3 50 ppm.	0.22	0.75	0.76	0.75	0.62	1.14	1.51	1.25	0.19	0.43	0.65	0.70	0.58	2.38	2.20	1.20	2.76
	GA_3 100 ppm.	0.22	0.74	0.96	0.74	0.62	1.17	1.42	1.26	0.19	0.44	0.78	0.72	0.56	2.19	2.14	1.20	2.81
Growth Retardants	Alar 500 ppm.	0.22	0.85	0.92	0.92	0.62	1.12	1.50	1.26	0.19	0.43	0.68	0.73	0.55	2.19	2.13	1.21	2.61
	Alar 1000 ppm.	0.22	0.81	0.93	0.88	0.62	1.21	1.24	1.18	0.19	0.42	0.89	0.76	0.53	2.13	2.06	1.26	2.66
	Ethrel 500 ppm.	0.22	0.84	0.89	0.89	0.62	1.15	1.29	1.19	0.19	0.46	0.86	0.73	0.56	2.11	2.03	1.19	2.38
	Ethrel 1000 ppm.	0.22	0.81	0.91	0.90	0.62	1.16	1.58	1.18	0.19	0.47	0.86	0.80	0.58	2.15	2.04	1.15	2.32
Antitranspirants	PMA 5×10^{-5} M	0.22	0.86	0.93	0.78	0.62	1.18	1.26	1.15	0.19	0.42	0.69	0.68	0.56	2.16	2.09	1.23	2.71
	PMA 1×10^{-4} m	0.22	0.83	0.88	0.82	0.62	1.16	1.47	1.18	0.19	0.45	0.74	0.66	0.57	2.00	2.01	1.27	2.59
	Sulphonate-1 $\times 10^{-2}$ M	0.22	0.87	0.79	0.78	0.62	1.18	1.41	1.16	0.19	0.41	0.74	0.76	0.54	2.09	2.02	1.13	2.54
	Sulphonate-5 $\times 10^{-2}$ M	0.22	0.88	0.81	0.75	0.62	1.18	1.41	1.18	0.19	0.43	0.77	0.74	0.58	2.11	2.03	1.14	2.60
	Mean	0.22	0.81	0.85	0.80	0.62	1.17	1.42	1.20	0.19	0.44	0.78	0.74	0.56	2.18	2.08	1.19	2.64
	L.S.D. 0.05																	
	Irrigation	N.S.	N.S.	N.S.	N.S.	N.S.	0.26	0.05	0.06	N.S.	0.24	0.07	0.07	N.S.	0.11	0.13	0.10	0.12
	Substances	-	N.S.	N.S.	N.S.	-	N.S.	0.08	0.10	-	N.S.	0.12	0.13	N.S.	0.20	0.24	0.22	0.26

Table (36): Effect of growth regulators, antitranspirants and soil moisture stress on dry matter of whole wheat plant at various stages of growth during season 1980 / 1981 (g. / plant).

Soil moisture stress		Wet (30% depletion)				Medium (60% depletion)				Dry (90% depletion)			
Weeks after sowing / Substances		5	10	15	18	5	10	15	18	5	10	15	18
	Control	1.07	4.58	10.67	12.27	1.02	4.02	9.69	11.00	1.03	3.06	6.72	7.67
Growth Promoters	NAA 50 ppm.	1.07	4.70	11.13	12.99	1.02	4.16	10.02	11.49	1.03	2.94	6.35	7.66
	NAA 100 ppm.	1.07	4.68	11.30	13.13	1.02	4.16	10.04	11.54	1.03	2.94	6.36	7.45
	NAA 50 ppm.	1.07	4.66	11.34	13.06	1.02	4.10	10.22	11.59	1.03	2.90	6.50	7.66
	GA_3 100 ppm.	1.07	4.65	11.35	13.12	1.02	4.14	10.14	11.50	1.03	2.91	6.55	7.67
Growth Retardants	Alar 500 ppm.	1.07	4.54	10.45	11.75	1.02	3.97	9.56	10.70	1.03	2.95	6.50	7.20
	Alar 1000 ppm.	1.07	4.59	10.24	11.81	1.02	3.99	9.33	10.56	1.03	2.87	6.45	7.54
	Ethrel 500 ppm.	1.07	4.38	9.88	10.51	1.02	3.82	8.85	10.01	1.03	3.01	6.34	7.23
	Ethrel 1000 ppm.	1.07	4.43	9.85	10.39	1.02	3.86	8.63	9.75	1.03	3.02	6.65	7.24
Antitranspirants	PMA 5×10^{-5} M	1.07	4.42	10.47	11.70	1.02	3.89	9.29	10.70	1.03	3.02	6.27	7.41
	PMA 1×10^{-4} M	1.07	4.42	10.37	11.62	1.02	3.89	9.27	10.53	1.03	3.01	6.36	7.26
	Sulphonate 1×10^{-2} M	1.07	4.44	10.28	11.55	1.02	3.82	9.27	10.54	1.03	3.00	6.16	7.26
	Sulphonate 5×10^{-2} M	1.07	4.39	10.41	11.55	1.02	3.83	9.18	10.54	1.03	3.07	6.24	7.30
	Mean	1.07	4.53	10.60	12.00	1.02	3.97	9.50	10.80	1.03	2.98	6.42	7.43
L.S.D. 0.05													
	Irrigation	N.S.	0.37	0.13	0.15								
	Substances	-	N.S.	0.26	0.31								

Table (37): Effect of growth regulators and antitranspirents on dry matter accumulation in different organs of wheat plant at various stages of growth grown under low soil moisture stress during season 1981 /1982 (g. / plant).

	Different organs	Roots				Leaf blades				Sheath				Stem			Heads	
	Weeks after sowing / Treatments	5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	0.19	1.05	0.95	0.89	0.66	1.69	2.17	1.73	0.23	0.81	1.29	1.22	1.04	4.12	3.93	1.96	4.52
Growth Promoters	NAA 50 ppm.	0.19	1.00	0.93	0.81	0.66	1.81	2.31	1.90	0.23	0.86	1.39	1.31	1.01	4.66	4.35	2.04	4.79
	NAA 100 ppm.	0.19	0.98	0.89	0.82	0.66	1.83	2.38	1.91	0.23	0.87	1.41	1.32	1.04	4.65	4.42	2.05	5.12
	GA_3 50 ppm.	0.19	0.96	0.90	0.82	0.66	1.79	2.39	1.87	0.23	0.86	1.38	1.31	1.00	4.58	4.44	2.09	5.21
	GA_3 100 ppm.	0.19	0.97	0.86	0.79	0.66	1.77	2.32	1.92	0.23	0.85	1.42	1.33	0.99	4.62	4.43	2.03	5.19
Growth Retardants	Alar 500 ppm.	0.19	1.01	1.06	0.98	0.66	1.72	2.28	1.74	0.23	0.75	1.29	1.20	0.93	3.78	3.52	1.74	4.30
	Alar 1000 ppm.	0.19	1.10	1.11	0.96	0.66	1.74	2.30	1.69	0.23	0.76	1.25	1.19	0.91	3.79	3.57	1.71	4.35
	Ethrel 500 ppm.	0.19	1.12	1.11	1.03	0.66	1.65	2.22	1.74	0.23	0.73	1.17	1.11	0.86	3.68	3.55	1.39	3.59
	Ethrel 1000 ppm.	0.19	1.12	1.12	1.01	0.66	1.68	2.24	1.76	0.23	0.74	1.18	1.10	0.88	3.65	3.52	1.47	3.51
Antitranspi-rants	PMA 5×10^{-5} M	0.19	1.08	1.01	0.98	0.66	1.59	2.12	1.75	0.23	0.73	1.30	1.21	0.85	4.13	3.88	1.47	4.60
	PMA 1×10^{-4} M	0.19	1.09	0.98	0.91	0.66	1.56	2.16	1.79	0.23	0.71	1.27	1.23	0.88	4.03	3.81	1.59	4.61
	Sulphonate 1×10^{-2} M	0.19	1.09	1.00	0.95	0.66	1.55	2.10	1.70	0.23	0.75	1.34	1.19	0.86	4.11	3.85	1.46	4.42
	Sulphonate 5×10^{-2} M	0.19	1.11	1.03	0.94	0.66	1.57	2.08	1.61	0.23	0.76	1.27	1.20	0.84	4.09	3.79	1.57	4.35
	Mean	0.19	1.05	1.00	0.91	0.66	1.69	2.24	1.78	0.23	0.78	1.30	1.22	0.93	4.15	3.93	1.74	4.50
	L.S.D. 0.05																	
	Irrigation	N.S.	N.S.	N.S.	N.S.	N.S.	0.18	0.06	0.04	N.S.	0.16	0.03	0.22	0.21	0.09	0.13	0.32	0.15
	Substances	-	N.S.	N.S.	N.S.	-	N.S.	0.12	0.09	-	N.S.	0.07	N.S.	N.S.	0.19	0.28	N.S.	0.31

Table (38): Effect of growth regulators and antitranspirants on dry matter accumulation in different organs of wheat plant at various stages of growth grown under medium soil moisture stress during season 1981 / 1982 (g. / plant)

Different organs / Weeks after sowing / Treatments		Roots				Leaf blades				Sheath				Stem			Heads	
		5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	0.19	1.08	0.95	0.97	0.66	1.62	2.10	1.69	0.23	0.71	1.15	1.08	0.79	3.89	3.62	1.66	3.62
Growth Promoters	NAA 50 ppm.	0.19	1.01	0.95	0.91	0.66	1.73	2.19	1.80	0.23	0.83	1.23	1.16	0.76	4.18	3.85	1.75	3.88
	NAA 100 ppm.	0.19	1.03	0.95	0.94	0.66	1.72	2.17	1.81	0.23	0.83	1.29	1.20	0.74	4.22	3.88	1.80	3.89
	GA_3 50 ppm.	0.19	1.01	0.93	0.88	0.66	1.73	2.20	1.79	0.23	0.82	1.25	1.21	0.75	4.16	3.82	1.77	3.90
	GA_3 100 ppm.	0.19	0.99	0.93	0.84	0.66	1.69	2.22	1.81	0.23	0.80	1.27	1.19	0.73	4.21	3.86	1.81	3.87
Growth Retardants	Alar 500 ppm.	0.19	1.11	1.10	1.02	0.66	1.66	2.16	1.72	0.23	0.72	1.10	1.04	0.62	3.53	3.31	1.60	3.59
	Alar 1000 ppm.	0.19	1.09	1.13	1.05	0.66	1.67	2.18	1.74	0.23	0.67	1.12	1.05	0.64	3.45	3.32	1.48	3.51
	Ethrel 500 ppm.	0.19	1.13	1.14	1.01	0.66	1.65	2.18	1.71	0.23	0.63	1.09	0.94	0.57	3.29	3.15	1.31	2.86
	Ethrel 1000 ppm.	0.19	1.09	1.12	1.00	0.66	1.66	2.20	1.75	0.23	0.65	1.10	0.96	0.58	3.23	3.14	1.35	2.89
Antitranspirants	PMA 5×10^{-5} M	0.19	1.08	1.08	0.99	0.66	1.54	2.11	1.60	0.23	0.69	1.16	1.10	0.64	3.68	3.61	1.66	3.49
	PMA 1×10^{-4} M	0.19	1.06	1.08	1.03	0.66	1.55	2.09	1.62	0.23	0.66	1.13	1.11	0.63	3.64	3.55	1.62	3.46
	Sulphonate 1×10^{-2} M	0.19	1.11	1.05	1.01	0.66	1.51	2.09	1.61	0.23	0.67	1.16	1.09	0.66	3.58	3.52	1.58	3.41
	Sulphonate 5×10^{-2} M	0.19	1.06	1.01	1.02	0.66	1.52	2.11	1.61	0.23	0.68	1.14	1.06	0.65	3.53	3.54	1.43	3.44
	Mean	0.19	1.07	1.03	0.97	0.66	1.63	2.15	1.71	0.23	0.72	1.17	1.09	0.67	3.74	3.55	1.61	3.52
	L.S.D. 0.05																	
	Irrigation	N.S.	N.S.	N.S.	N.S.	N.S.	0.18	0.06	0.04	N.S.	0.16	0.03	0.22	0.21	0.09	0.13	0.32	0.15
	Substances	-	N.S.	N.S.	N.S.	-	N.S.	0.12	0.09	-	N.S.	0.07	N.S.	N.S.	0.19	0.28	N.S.	0.31

Table (39): Effect of growth regulators and antitranspirants on dry matter accumulation in different organs of wheat plant at various stages of growth grown under high soil moisture stress during season 1981 /1982 (g. / plant).

	Different organs	Roots				Leaf blades				Sheath				Stem			Heads	
	Weeks after sowing / Treatments	5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	0.21	0.89	0.91	0.84	0.63	1.29	1.42	1.25	0.20	0.41	0.78	0.64	0.52	2.36	2.22	1.15	2.84
Growth Promoters	NAA 50 ppm.	0.21	0.83	0.81	0.79	0.63	1.33	1.37	1.24	0.20	0.44	0.82	0.69	0.55	2.29	2.10	1.24	2.87
	NAA 100 ppm.	0.21	0.85	0.89	0.83	0.63	1.32	1.44	1.27	0.20	0.44	0.83	0.71	0.55	2.23	2.07	1.15	2.83
	GA_3 50 ppm.	0.21	0.84	0.87	0.81	0.63	1.35	1.32	1.26	0.20	0.43	0.81	0.70	0.56	2.34	2.11	1.11	2.86
	GA_3 100 ppm.	0.21	0.81	0.89	0.78	0.63	1.33	1.51	1.28	0.20	0.45	0.79	0.68	0.57	2.32	2.09	1.12	2.83
Growth Reterdants	Alar 500 ppm.	0.21	0.98	1.03	0.94	0.63	1.28	1.51	1.23	0.20	0.39	0.85	0.73	0.51	2.21	2.05	1.14	2.74
	Alar 1000 ppm.	0.21	0.98	0.99	0.95	0.63	1.24	1.50	1.20	0.20	0.39	0.81	0.69	0.51	2.23	2.06	1.12	2.72
	Ethrel 500 ppm.	0.21	0.96	1.05	0.93	0.63	1.31	1.31	1.18	0.20	0.38	0.81	0.70	0.52	2.29	2.08	1.12	2.75
	Ethre.1000 ppm.	0.21	0.92	0.99	0.94	0.63	1.32	1.36	1.19	0.20	0.40	0.83	0.72	0.52	2.29	2.18	1.06	2.81
Antitranspi-rants	PMA 5×10^{-5} M	0.21	0.85	1.01	0.89	0.63	1.26	1.25	1.17	0.20	0.41	0.80	0.67	0.49	2.38	2.20	1.16	2.71
	PMA 1×10^{-4} M	0.21	0.86	0.99	0.86	0.63	1.25	1.40	1.21	0.20	0.42	0.87	0.74	0.53	2.38	2.20	1.24	2.88
	Sulphonate 1×10^{-2} M	0.21	0.82	0.90	0.84	0.63	1.27	1.32	1.20	0.20	0.41	0.81	0.72	0.51	2.30	2.17	1.08	2.80
	Sulphonate 5×10^{-2} M	0.21	0.83	0.91	0.88	0.63	1.26	1.35	1.17	0.20	0.40	0.83	0.70	0.53	2.33	2.19	1.10	2.67
	Mean	0.21	0.88	0.94	0.87	0.63	1.29	1.39	1.22	0.20	0.41	0.82	0.70	0.53	2.30	2.13	1.14	2.72
	L.S.D. 0.05																	
	Irrigation	N.S.	N.S.	N.S.	N.S.	N.S.	0.18	0.06	0.04	N.S.	0.16	0.03	0.22	0.21	0.09	0.13	0.32	0.15
	Substances	-	N.S.	N.S.	N.S.	-	N.S.	0.12	0.09	-	N.S.	0.07	N.S.	N.S.	0.19	0.28	N.S.	0.31

Table (40): Effect of growth regulators , antitranspirants and soil moisture stress on dry matter of whole wheat plant at various stages of growth during season 1981 / 1982 (g. / plant).

Soil moisture stress			Wet (30% depletion)				Medium (60% depletion)				Dry (90% depletion)			
Weeks after sowing Substances			5	10	15	18	5	10	15	18	5	10	5	18
	Control		1.08	4.59	10.49	12.29	1.08	4.20	9.75	10.98	1.04	3.11	6.62	7.79
Growth Promoters	NAA	50 ppm.	1.08	4.68	11.33	13.16	1.08	4.33	10.30	11.60	1.04	3.15	6.53	7.69
	NAA	100 ppm.	1.08	4.72	11.38	13.95	1.08	4.32	10.43	11.72	1.04	3.16	6.54	7.71
	GA_3	50 ppm.	1.08	4.61	11.34	13.65	1.08	4.31	10.31	11.60	1.04	3.18	6.45	7.74
	GA_3	100 ppm.	1.08	4.57	11.25	13.66	1.08	4.21	10.44	11.57	1.04	3.16	6.63	7.66
Growth Retardants	Alar	500 ppm.	1.08	4.41	10.15	11.74	1.08	4.11	9.49	10.68	1.04	3.16	6.74	7.69
	Alar	1000 ppm.	1.08	4.51	10.16	11.76	1.08	4.07	9.36	10.67	1.04	3.12	6.65	7.62
	Ethrel	500 ppm.	1.08	4.36	9.57	11.02	1.08	3.98	9.01	9.67	1.04	3.17	6.58	7.64
	Ethrel	1000 ppm.	1.08	4.42	9.66	10.90	1.08	3.98	9.00	9.74	1.04	3.16	6.53	7.84
Antitranspirants	PMA	5×10^{-5} M	1.08	4.25	10.03	12.42	1.08	3.95	9.69	10.79	1.04	3.01	6.60	7.64
	PMA	1×10^{-4} M	1.08	4.24	10.03	12.35	1.08	3.90	9.56	10.77	1.04	3.06	6.88	7.89
	Sulphonate	1×10^{-2} M	1.08	4.25	10.01	12.11	1.08	3.95	9.46	10.64	1.04	3.01	6.41	7.73
	Sulphonate	5×10^{-2} M	1.08	4.28	10.04	11.89	1.08	3.91	9.28	10.67	1.04	3.02	6.52	7.61
Mean			1.08	4.45	12.35	10.42	1.08	4.09	9.70	10.85	1.04	3.11	6.59	7.71
L.S.D. 0.05														
Irrigation			N.S.	0.21	0.11	0.14								
Substances			-	N.S.	0.23	0.29								

Table (41): Effect of growth regulators and antitranspirants on percentage distribution of different plant organs at various stages of growth as related to the whole wheat plant grown under low soil moisture stress (season 1980 1981)

	Different organs	Roots				Leaf blades				Sheath				Stem			Heads	
	Weeks after sowing / Treatments	5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	20.6	22.1	9.6	7.7	59.8	38.9	20.1	14.3	19.6	18.1	11.5	9.3	21.0	39.0	32.0	19.8	36.6
Growth Promoters	NAA 50 ppm.	20.6	19.4	8.0	7.7	59.8	39.8	20.6	14.2	19.6	18.5	12.1	9.9	22.3	40.8	32.9	18.5	38.4
	NAA 100 ppm.	20.6	19.9	8.1	6.7	59.8	39.5	20.2	14.2	19.6	18.0	12.3	9.5	22.7	40.4	33.6	19.1	39.0
	GA_3 50 ppm.	20.6	19.5	8.2	6.4	59.8	39.5	19.9	14.5	19.6	18.2	12.3	9.3	22.8	40.5	33.1	19.1	39.7
	GA_3 100 ppm.	20.6	19.8	7.8	6.5	59.8	40.0	20.1	14.4	19.6	17.9	12.2	9.5	22.4	40.4	33.5	19.6	39.2
Growth Retardants	Alar 500 ppm.	20.6	23.4	10.8	9.3	59.8	39.9	21.3	15.4	19.6	17.0	11.0	8.8	19.8	36.0	29.7	20.9	36.0
	Alar 1000 ppm.	20.6	23.5	10.9	9.2	59.8	39.9	21.9	15.7	19.6	16.6	11.6	9.3	20.4	36.2	29.7	19.3	35.5
	Ethrel 500 ppm.	20.6	25.3	11.3	10.6	59.8	40.6	22.5	18.0	19.6	16.0	11.1	9.6	18.0	35.9	32.5	19.1	29.4
	Ethrel 1000 ppm.	20.6	25.3	12.3	10.8	59.8	41.1	22.9	18.7	19.6	16.0	11.1	9.9	17.6	36.1	32.6	17.5	28.0
Antitranspirants	PMA 5×10^{-5} M	20.6	23.8	10.1	8.0	59.8	38.2	20.2	13.8	19.6	17.2	10.8	9.3	23.8	38.8	31.5	20.1	36.0
	PMA 1×10^{-4} M	20.6	23.8	9.7	8.2	59.8	37.8	20.4	13.9	19.6	17.4	10.8	9.0	21.0	38.7	31.4	20.3	36.2
	Sulphonate 1×10^{-3} M	20.6	24.1	10.0	8.0	59.8	37.6	20.4	14.0	19.6	17.8	11.0	9.2	20.3	39.5	31.3	19.1	36.8
	Sulphonate 5×10^{-3} M	20.6	23.2	10.1	8.1	59.8	38.3	20.3	14.3	19.6	18.5	10.7	9.1	20.1	39.2	31.3	19.8	36.5
	Mean	20.6	22.5	10.5	8.2	59.8	39.3	20.8	15.0	19.6	17.5	11.4	9.4	20.9	38.6	31.9	19.4	35.9

(Low soil moisture stress = 30 % depletion in available Water)

Table (42): Effect of growth regulators and antitranspirants on percentage distribution of different plant organs at various stages of growth as related to the whole wheat plant grown under medium soil moisture stress (season 1980 /1981)

	Different organs	ROOts				Leaf blades				Sheath				Stem			Heads	
	Weeks after sowing / Treatments	5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control	0.19	25.1	10.7	9.1	0.60	39.1	20.8	15.0	0.21	16.7	11.6	9.6	19.2	39.1	31.8	17.8	34.5
Growth Promoters	NAA 50 ppm.	0.19	21.4	8.9	7.6	0.60	39.9	20.7	15.0	0.21	18.5	11.7	9.5	20.2	40.5	33.9	18.3	34.0
	NAA 100 ppm.	0.19	21.2	8.8	7.5	0.60	39.7	21.1	14.8	0.21	18.3	11.8	9.2	20.9	40.2	34.3	18.1	34.2
	GA_3 50 ppm.	0.19	20.2	8.9	7.6	0.60	40.0	20.2	15.2	0.21	18.8	11.7	9.6	21.0	39.4	33.7	19.8	33.9
	GA_3 100 ppm.	0.19	21.3	8.7	6.9	0.60	40.3	20.8	15.2	0.21	18.1	12.2	9.8	20.3	40.1	33.7	18.1	34.3
Growth Retardants	Alar 500 ppm.	0.19	26.4	11.7	9.8	0.60	40.1	22.5	16.0	0.21	15.9	10.9	9.3	17.6	35.9	30.1	19.0	34.8
	Alar 1000 ppm.	0.19	26.8	12.2	9.7	0.60	39.3	22.9	16.1	0.21	16.0	10.8	9.6	17.8	36.1	30.1	17.9	34.6
	Ethrel 500 ppm.	0.19	27.7	12.2	10.8	0.60	40.8	23.6	16.9	0.21	15.2	10.8	8.9	16.2	36.5	31.7	16.8	31.8
	Ethrel 1000 ppm.	0.19	27.2	12.3	9.4	0.60	40.9	23.9	16.6	0.21	15.8	11.5	8.5	16.1	37.1	32.7	15.3	32.7
Antitranspirants	PMA 5×10^{-5} M	0.19	26.7	10.9	9.5	0.60	40.6	20.9	14.6	0.21	15.7	11.4	9.4	19.0	39.9	31.8	16.9	34.7
	PMA 1×10^{-4} M	0.19	25.4	10.6	9.1	0.60	38.6	21.0	14.7	0.21	16.5	11.5	9.7	19.0	39.4	31.4	17.5	35.0
	Sulphonate 1×10^{-2} M	0.19	25.7	10.1	9.6	0.60	39.8	21.1	14.7	0.21	17.0	11.2	9.6	18.8	39.3	31.8	18.2	34.3
	Sulphonate 5×10^{-2} M	0.19	26.6	11.0	10.0	0.60	38.9	21.5	14.4	0.21	15.9	11.4	9.4	18.5	38.6	31.3	17.5	34.9
	Mean	0.19	24.8	10.5	9.0	0.60	39.9	21.6	15.3	0.21	16.8	11.4	9.4	18.8	38.6	32.2	17.8	34.1

(Medium soil moisture stress = 60 % depletion in available water)

Table (46): Effect of growth regulators and antitranspirants on percentage distribution of different plant organs at various stages of growth as related to the whole wheat plant grown under high soil moisture stress (season 1981 / 1982).

Different organs / Weeks after sowing / Treatments			Roots				Leaf blades				Sheath				Stem			Heads	
			5	IO	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control		20.2	28.6	13.7	10.8	60.6	41.5	21.5	16.0	19.2	13.2	11.8	8.2	16.7	35.6	28.5	17.4	36.5
Growth Promoters	NAA	50 ppm.	20.2	26.3	12.4	10.3	60.6	42.2	21.0	16.1	19.2	14.0	12.6	9.0	17.5	35.1	27.3	19.0	36.3
	NAA	100 ppm.	20.2	26.9	13.6	10.8	60.6	41.8	22.0	16.5	19.2	13.9	12.7	9.2	17.4	34.1	26.8	17.6	36.7
	GA_3	50 ppm.	20.2	26.4	13.5	10.5	60.6	42.5	20.5	16.3	19.2	13.5	12.6	9.0	17.6	36.3	27.3	17.2	37.0
	GA_3	100 ppm.	20.2	25.6	13.4	10.2	60.6	42.1	22.8	16.7	19.2	14.2	11.9	8.8	18.0	35.0	27.0	16.9	36.9
Growth Retardants	Alar	500 ppm.	20.2	31.0	15.3	12.4	60.6	40.5	22.4	16.0	19.2	12.3	12.6	9.5	16.1	32.8	26.7	16.9	35.6
	Alar	1000 ppm.	20.2	3L;4	14.9	12.5	60.6	39.7	22.6	15.7	19.2	12.5	12.2	9.1	16.3	33.5	27.0	16.8	35.7
	Ethrel	500 ppm.	20.2	30.3	16.0	12.2	60.6	41.3	19.9	15.4	19.2	12.0	12.3	9.2	16.4	35.1	27.2	17.0	36.0
	Ethrel	1000 ppm.	20.2	29.1	15.2	12.0	60.6	41.8	20.8	15.2	19.2	12.7	12.7	9.2	16.5	35.1	27.8	16.2	35.8
Antitranspi-rants	PMA	5×10^{-5}M	20.2	28.2	15.3	11.6	60.6	41.9	18.9	15.3	19.2	13.6	12.1	8.8	16.3	36.1	28.8	17.6	35.5
	PMA	1×10^{-4}M	20.2	28.1	14.4	10.9	60.6	40.8	20.3	15.3	19.2	13.7	12.6	9.4	17.3	34.6	27.9	18.0	36.5
	Sulphonate	1×10^{-2}M	20.2	27.2	14.0	10.9	60.6	42.2	20.6	15.5	19.2	13.6	12.6	9.3	16.9	35.9	28.1	16.8	36.2
	Sulphonate	5×10^{-2}M	20.2	27.5	14.0	11.6	60.6	42.1	20.7	15.4	19.2	13.2	L2.7	9.2	17.5	35.7	28.8	16.9	35.1
Mean			20.2	28.2	14.3	11.3	60.6	41.6	21.1	15.8	19.2	13.3	12.4	9.1	17.0	35.0	27.6	17.3	36.1

(High soil moisture stress = 90 % depletion in available water)

Table (45): Effect of growth regulators and antitranspirants on percentage distribution of different plant organs at various stages of growth as related to the whole wheat plant grown under medium soil moisture stress (season 1981 / 1982).

Different organs / Weeks after sowing / Treatments			Roots				Leaf blades				Sheath				Stem			Heads	
			5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	15	18
	Control		17.6	25.7	9.7	8.8	61.1	38.6	21.5	15.4	21.3	16.9	11.8	9.8	18.8	39.9	33.0	17.0	33.0
Growth Promoters	NAA	50 ppm.	17.6	23.3	9.2	7.8	61.1	40.0	21.3	15.5	21.3	19.2	11.9	10.0	17.6	40.6	33.2	17.0	33.4
	NAA	100 ppm.	17.6	23.8	9.1	8.0	61.1	39.8	20.8	15.4	21.3	19.2	12.4	10.2	17.1	40.5	33.1	17.3	33.2
	GA_3	50 ppm.	17.6	23.4	9.0	7.6	61.1	40.1	20.6	15.4	21.3	19.0	12.1	10.4	17.4	40.3	32.9	17.2	33.6
	GA_3	100 ppm.	17.6	23.5	8.9	7.3	61.1	40.1	21.3	15.6	21.3	19.0	12.2	10.1	17.3	40.3	32.9	17.3	33.4
Growth Retardants	Alar	500 ppm.	17.6	27.0	11.6	9.6	61.1	40.4	22.8	16.1	21.3	17.5	11.6	9.7	15.1	37.2	31.0	16.9	33.1
	Alar	1000 ppm.	17.6	26.8	12.1	9.8	61.1	41.0	23.3	16.3	21.3	16.5	12.0	9.8	15.7	36.9	31.1	15.8	32.9
	Ethrel	500 ppm.	17.6	28.4	12.7	10.4	61.1	41.5	24.2	17.7	21.3	15.8	12.1	9.7	14.3	36.5	32.6	14.5	29.6
	Ethrel	1000 ppm.	17.6	27.4	12.4	10.3	61.1	41.7	24.4	18.0	21.3	16.3	12.2	9.9	14.6	35.9	32.2	15.0	29.7
Antitranspirants	PMA	5×10^{-5} M	17.6	27.3	11.1	9.2	61.1	39.0	21.8	14.8	21.3	17.5	11.8	10.2	16.2	38.1	33.5	17.1	32.3
	PMA	1×10^{-4} M	17.6	27.2	11.0	9.6	61.1	39.7	21.9	15.0	21.3	17.0	11.8	10.3	16.2	38.1	33.0	16.9	32.1
	Sulphonate	1×10^{-2} M	17.6	28.1	11.1	9.5	61.1	38.2	22.1	15.1	21.3	17.0	12.3	10.2	16.7	37.8	33.1	16.7	32.0
	Sulphonate	5×10^{-2} M	17.6	27.1	11.9	9.6	61.1	38.9	22.7	15.1	21.3	17.4	12.3	9.9	16.7	38.0	33.2	16.1	32.2
	Mean		17.6	26.1	10.7	9.0	61.1	39.9	22.2	15.8	21.3	17.6	12.1	10.0	16.4	38.5	32.7	16.5	32.3

(Medium soil moisture stress = 60 % depletion in available water)

Table (44): Effect of growth regulators and antitranspirants on percentage distribution of different plant organs at various stages of growth as related to the whole wheat plant grown under low soil moisture stress (season 1981 / 1982).

	Different organs / Weeks after sowing / Treatments		Roots				Leaf blades				Sheath				Stem			Heads	
			5	10	15	18	5	10	15	18	5	10	15	18	10	15	18	10	18
	Control		17.6	22.9	8.2	7.2	61.1	36.8	20.7	14.1	21.3	17.6	12.3	9.9	22.7	39.3	32.0	18.7	36.8
Growth Promoters	NAA	50 ppm.	17.6	21.4	7.5	6.2	61.1	38.7	20.4	14.4	21.3	18.4	12.3	10.0	21.6	41.1	33.1	18.0	36.4
	NAA	100 ppm.	17.6	20.8	7.8	6.0	61.1	38.8	20.9	14.1	21.3	18.4	12.4	9.7	22.0	40.9	32.5	18.0	37.7
	GA_3	50 ppm.	17.6	20.8	7.9	6.0	61.1	38.8	21.1	13.7	21.3	18.7	12.2	9.6	21.7	40.4	32.5	18.4	38.2
	GA_3	100 ppm.	17.6	21.2	7.6	5.8	61.1	38.6	20.6	14.1	21.3	18.6	12.6	9.7	21.6	41.1	32.4	18.0	38.0
Growth Retardants	Alar	500 ppm.	17.6	22.9	10.4	8.4	61.1	39.0	22.5	14.8	21.3	17.0	12.7	10.2	21.1	37.2	30.0	17.1	36.6
	Alar	1000 ppm.	17.6	22.2	10.9	8.2	61.1	38.6	22.6	14.4	21.3	16.9	12.3	10.1	20.2	37.3	30.4	16.8	37.0
	Ethrel	500 ppm.	17.6	25.7	11.6	9.3	61.1	37.8	23.2	15.8	21.3	16.7	12.2	10.1	19.7	38.5	32.2	14.5	32.6
	Ethrel	1000 ppm.	17.6	25.3	11.6	9.3	61.1	38.0	23.2	16.1	21.3	16.7	12.2	10.1	19.9	37.8	32.3	15.2	32.2
Antitranspi-rants	PMA	5×10^{-5} M	17.6	25.4	10.1	7.9	61.1	37.4	21.1	14.1	21.3	17.2	13.0	9.7	20.0	41.2	31.7	14.7	37.0
	PMA	1×10^{-4} M	17.6	25.7	9.8	7.4	61.1	36.8	21.5	14.5	21.3	16.8	12.7	10.0	20.8	40.2	30.9	15.9	37.3
	Sulphonate	1×10^{-2} M	17.6	25.6	10.0	7.7	61.1	36.5	21.0	14.6	21.3	17.6	13.4	9.7	20.2	41.1	32.1	14.6	35.9
	Sulphonate	5×10^{-2} M	17.6	25.9	10.3	7.8	61.1	36.7	20.7	14.1	21.3	17.8	12.6	9.9	19.6	40.7	32.2	15.6	36.6
	Mean		17.6	23.5	9.5	7.5	61.1	37.9	21.5	14.5	21.3	17.6	12.5	9.5	20.9	39.8	31.9	16.6	36.3

(Low soil moisture stress = 30 % depletion in available water)

that, the accumulation of dry matter was very low as the plant directed its effort for grain filling. Dry matter of various plant parts i.e roots , leaf blades, sheath and stem , increased with time to reach its maximum value nearly at heading and early milk stage , then declined after that . This trend can be related to the increase in plant height. The exception of that is roots which reached its maximum value during shooting stage and slightly decreased . The slight decrease in dry matter accumulation of leaf blades, sheath and stem at later stages of wheat growth cycle, can be discussed on the basis that some organic and inorganic compounds can be moved partially to the growing reproductive organs . It can be mention that dry matter production in reproductive organs (heads) increased from flowering till maturity stage . This trend of results had been observed by Imam and Miseha (1978) .

Regarding the distribution pattern of the different plant parts of wheat (Tables from 33 to 46), data revealed that leaf blades comprise the main plant dry matter component during the first and second periods of growth (35 to 70 days from planting). Morever, stem seemed to have the highest proportion at heading and early milk stage (105 days after sowing) . However, later on , (Dough stage , 126 days after sowing) wheat heads was found to be the domenant organ followed by stem in the whole plant . From the previous results, it can be mentioned that there were a variable developmental changes in dry matter of individual plant parts, and that affected the final growth changes of the whole plant . These results may be also interpreted on the assumption that wheat plant directed its effort to stimulate relatively a higher proportion of dry matter for developing leaves during tillering stage. Whereas,plant directed its growth in buliding up its stem through shooting or jointing. At later stages , wheat plant tend to build up its reproductive and storage organs during the period of grain filling. In other words,dry matter is redistributed from leaves either to the developing stem during shooting or jointing stage (stem elongation) or to the developing reproductive organs (wheat heads) at later periods of growth cycle . These findings may be explained on the basis of that here is a regulating mechanism that redistributes dry matter within the plant parts and that depends on the character of vegetative and reproductive growth period .

Concerning the effect of soil moisture levels on dry matter production of various parts of wheat as well as the entire plant , The data presented in Tables (33, 34, 35 , 36 , 37 , 38 , 39 and 40) revealed that soil moisture stress exhibit a highly significant response on the accumulation of dry matter in wheat . This was found to be true at the various stages of wheat growth . Increasing soil moisture stress did result in a highly significant decrease in dry matter produced by wheat plant . This trend revealed that dry matter accumulation is favoured by high soil moisture conditions and plant growth decreased gradually as soil moisture stress increased , and ceased when it falls down to wilting point . In this respect Kalia and Elonen (1970) , Wardlaw (1971) and Russell (1975) pointed out that water shortage decreased the dry matter production .

The highest dry weight of wheat plant through its growth cycle was gained from the wet treatment which was irrigated after the depletion of 30 % in available water followed by the medium level and the least was obtained from plants allowed to remove water near wilting point. These findings may show the importance of maintaining soil moisture at high level for maximum accumulation of dry matter in various wheat plant parts . This trend may be attributed to the multiple effects of water stress on plant growth and thereby on the dry matter accumulation. In this connection , Richards and Wadleigh (1952) and Stanhill (1957) concluded that there is a close relationship between decreasing soil water and decreased growth of plants . A good explanation on the effect of water stress on plant growth and dry matter production has been pointed out by Kramer (1969) . He concluded that water stress can reduce photosynthesis by reduction in leaf area, closure of stomata , and reduction in activity of the dehydrated protoplasmic machinery . The most serious effect of drought is to reduce photosynthetic surface and the production of dry matter . However, reduction in the rate per unit of surface is also important . The large decrease in photosynthesis per unit of leaf area which occurs in plants subjected to water stress is usually attributed to stomatal closure .

In evaluating the effect of moisture stress on dry matter accumulation by various parts of wheat ,results exhibit different phenomena according to the stage of growth. Early in the season, leaves were found to be the most sensitive part to water deficit . However, at shooting and flowering, stem was more sensitive to such stress. Its dry weight decreased more than any other part by severe moisture stress . At later stages,reproductive organs showed a great reduction in dry matter accumulation due to lack of soil moisture . In this connection, Slatyer (1957) found that a marked reduction in stem elongation occured at about 10 atm. of soil moisture . Hagen et al. (1957) found that total green weight production and shoot elongation were reduced significantly with decreasing soil moisture . Also , Denmead and Shaw (1960) pointed out that stress imposed when the plant is actively expanding , retarded enlargement . Also , Parker (1968) pointed out that leaves are often the most sensitive part of the plant to drought and at the same time they are essential for the process of food manufacture .

With respect to the effect of growth promoting substances (NAA and GA_3) , data clearly show that dry matter production in the various organs of wheat plant increased over the control and that seemed to be mostly connected with plant age as well as the organ itself . This was observed from the variable amount of dry matter gained by the various organs . During the early period of vegetative growth - 70 days after planting - the increase in dry weight of leaf blades,sheath and stem was very slight and was found to be insignificant. Later on, such promoters increased significantly dry matter accumulation in most plant parts except that of roots, which was slightly decreased. The most pronounced enhancing effect was gained through stem. It can be mentioned that either NAA or GA_3 seemed to increase stem dry matter proportionally over the other plant parts . In other words, the promotive effect of such chemical is directed mainly through stem than other plant organs . This trend can be attributed to the acceleration of shoot growth caused by such promoters and that is mostly pronounced on the stem which may also result in an increase in the whole plant foliage.

It is intersting to mention that under lack of soil moisture the promotive effect of either NAA or GA_3 was inhibited . In this respect , Bukovac and Wittwer(1956) and Gosheh et al. (1963) concluded that the direct effect of GA_3 was its influence on increasing fresh and dry weight of plant tops. Also, Gray (1957) and Scurfield and Bell (1958) pointed out that GA_3 treatment increased plant dry weight .

With regard to the effect of growth retardants (Alar & Ethrel) on the dry matter production , data show that both substances reduced dry matter accumulation in the entire plant, and the reduction was found to be more in case of Ethrel rather than Alar . Such decrease is occured in some plant parts than others . The most plant organs which showed a decrease in dry matter accumulation was stem and sheath whereas, leaves and roots slightly increased . Also, a great reduction in dry weight of wheat heads was observed in plants treated with Ethrel , while in case of Alar no clear reduction was observed . The previous results may be interpreted on the assumption that such compounds prevent gibberellin synthesis and thus retard the growth of higher plants and therby reduced shoot growth . In this connection , Vandam (1974) found that Ethephon(Ethrel) reduced the height of wheat plant and markedly decreased fertility .

As for the effect of antitranspirants on dry matter accumulation by wheat plant, data indicate that dry weight of various plant parts was decreased through out the period of their use . After that , such reduction was disappeared . This trend can be observed from the later periods of growth . These results may be due to the role of antitranspirants on the closure of stomata which affect the carbon dioxide intake and therby reduced photosynthesis . These results are in agreement with those reported by Waggoner (1965) and Imam and Miseha (1978) who observed a reduction in dry weight of shoot of treated plants with PMA antitranspirant.

In the view of the previous results , it can be concluded that the availability of water proves to be one of the cheif constrains on dry matter productivity of wheat plant. Total net photosynthesis is determined by the availability of light , CO_2 , water and nutrients by the growth pattern of the plant that determines both photosynthesis rate and the reinvestment rate, and by the response of plant to stress . The regulating effect of growth substances and antitranspirants on plant growth seemed to be through the regulation of the proportion of dry matter accumulation and/or redistribution of such dry matter within the plant. These results lead to the assumption that growth substances and water supply may affect the nature of regulating mechanism in which is finally reflected on the distribution of dry matter accumulation .

4.3. YIELD COMPONENT AND YIELD

4.3.1. Yield Component

Yield components of wheat during the two seasons of study were analyzed for their response to growth regulators and antitranspirants at three soil moisture stresses . Such results are shown in Tables (47 and 48).

4.3.1.1. Number of Tillers /Plant

Number of tillers /plant as affected by growth substances , antitranspirants and soil moisture levels are presented in Tables (47 and 48). Analysis of variance showed that either growth regulators or antitranspirants had no effect upon number of tillers / plant . On the contrary , soil moisture stress had a significant response on number of tillers /plant . As soil moisture stress increased up to 90 % depletion in available water, a significant reduction in number of tillers/plant was observed . Such results may demonstrate that soil moisture level is an important factor controling tiller formation . In this respect, Dastane et. al. (1970) concluded that tillering is the most sensitive stage for moisture in case of wheat .

4.3.1.2. Number of Heads/Plant

Tables (47 and 48) showed the number of heads/plant under the various treatments. It is

Table (47): Effect of growth regulators , antitranspirants and soil moisture levels on different yield components of wheat (season 1980 / 1981).

Yield components / Soil moisture levels / Substances		No. of tillers/plant				No. of heads / plant				Weight of grains / head in g.				No. of grains / head				Weight of 1000 grains in g.			
		Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean
	Control	4.3	3.5	3.2	3.7	4.3	4.1	3.1	3.8	1.08	0.96	0.78	0.94	29	27	28	28	37.2	36.6	28.0	34.0
Growth Promoters	NAA 50 ppm.	4.5	3.7	3.3	3.8	4.6	4.4	3.2	4.1	1.15	1.04	0.83	1.01	29	28	28	28	39.3	36.9	29.2	35.1
	NAA 100 ppm.	4.4	3.6	3.5	3.8	4.8	4.3	3.4	4.2	1.19	1.06	0.87	1.04	29	28	28	28	39.6	37.4	28.8	35.3
	GA_3 50 ppm.	4.6	3.7	4.1	4.1	4.6	4.3	3.4	4.1	1.20	1.07	0.85	1.04	30	26	28	28	39.5	37.6	28.8	35.3
	GA_3 100 ppm.	4.4	4.0	3.1	3.8	4.6	4.4	3.3	4.1	1.21	1.08	0.86	1.05	30	26	28	28	39.3	37.3	30.6	35.7
Growth Retardants	Alar 500 ppm.	4.1	3.4	2.9	3.5	4.5	4.0	2.9	3.8	1.05	1.01	0.76	0.94	28	29	27	28	37.4	35.8	29.5	34.2
	Alar 1000 ppm.	4.5	3.9	3.2	3.9	4.2	4.2	3.0	3.8	1.04	0.99	0.68	0.90	32	30	26	29	36.0	35.3	26.4	32.6
	Ethrel 500 ppm.	5.2	4.2	3.7	4.4	3.9	3.9	2.5	3.4	0.92	0.79	0.81	0.84	31	29	27	29	30.1	27.6	27.3	28.3
	Ethre.1000 ppm.	5.1	4.2	3.9	4.4	4.2	3.7	2.6	3.5	0.83	0.73	0.71	0.76	28	28	29	28	29.7	26.6	24.2	26.8
Antitranspirants	PMA 5×10^{-5} M	4.3	3.7	3.0	3.7	4.5	4.1	2.9	3.8	1.05	1.04	0.83	0.97	28	28	27	28	37.6	36.6	29.8	34.7
	PMA 1×10^{-4} M	4.1	3.6	3.0	3.6	4.4	4.2	2.7	3.8	1.10	1.01	0.78	0.96	29	29	29	29	37.7	35.3	27.7	33.6
	Sulphonate 1×10^{-2} M	4.1	3.7	2.9	3.6	4.4	4.2	2.5	3.7	1.08	1.04	0.76	0.96	29	30	30	29	36.8	34.6	28.7	33.4
	Sulphonate 5×10^{-2} M	4.2	3.5	3.0	3.6	4.2	4.1	2.8	3.7	1.05	0.99	0.68	0.91	28	30	27	28	36.6	33.0	25.4	31.7
	Mean	4.4	3.7	3.3		4.4	4.1	2.9		1.10	0.99	0.78		29	28	28		36.7	34.7	28.0	
	L.S.D. 0.05																				
	Irrigation		0.41				0.14				0.05				N.S.				0.60		
	Substances		N.S.				0.30				0.10				N.S.				1.14		

Wet = 30 % depletion in available water
Medium= 60 % depletion in available water
Dry = 90 % depletion in available water

Table (48): Effect of growth regulators , antitranspirants and soil moisture levels on different yield components of wheat (season 1981 / 1982)

	Yield components	No. of tillers/plant				No. of heads / plant				Weight of grains / head in g.				No. of grains / head				Weight of 1000 grains in g.			
	Soil moidture levels Substances	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean
	Control	4.2	3.7	3.3	3.7	4.2	4.3	3.2	3.9	1.06	0.89	0.76	0.90	29	25	25	26	37.5	35.8	30.3	34.5
Growth Promoters	NAA 50 ppm.	4.5	4.0	3.3	3.9	4.5	4.5	3.3	4.1	1.17	0.99	0.82	0.99	28	26	26	27	39.5	36.9	30.3	35.6
	NAA 100 ppm.	4.3	4.1	3.5	4.0	4.8	4.4	3.2	4.1	1.18	0.99	0.80	0.99	28	27	26	27	39.3	37.2	30.7	35.7
	GA_3 50 ppm.	4.5	4.0	3.6	4.0	4.6	4.4	3.6	4.2	1.17	0.97	0.83	0.99	29	27	25	27	39.8	36.7	31.0	35.5
	GA_3 100 ppm.	4.3	3.8	3.5	3.9	4.7	4.4	3.2	4.1	1.21	0.98	0.82	1.00	30	27	24	27	39.9	37.7	31.7	36.4
Growth Retardants	Alar 500 ppm.	4.0	3.5	3.2	3.6	4.1	4.2	3.0	3.8	1.06	0.90	0.81	0.92	29	25	28	27	37.3	36.0	30.0	34.4
	Alar 1000 ppm.	4.4	3.4	3.4	3.7	4.5	4.3	3.2	4.0	0.96	0.88	0.77	0.87	27	24	27	26	35.5	36.3	29.0	33.6
	Ethrel 500 ppm.	4.9	4.0	3.9	4.3	3.7	3.8	3.3	3.6	0.86	0.82	0.77	0.82	31	29	27	29	28.3	28.7	29.0	28.7
	Ethrel 1000 ppm.	5.1	4.8	3.5	4.5	3.8	4.0	3.3	3.7	0.83	0.76	0.74	0.78	28	27	26	27	29.8	28.0	28.7	28.2
Antitranspi-rants	PMA 5×10^{-5} M	4.2	3.4	3.4	3.7	4.3	4.0	3.2	3.8	1.04	0.95	0.81	0.93	28	27	27	27	36.7	35.7	30.3	34.2
	PMA 1×10^{-4} M	4.3	3.5	3.2	3.7	4.2	4.2	3.0	3.8	1.05	0.86	0.81	0.91	28	24	26	26	37.5	35.3	32.0	34.9
	Sulphonate 1×10^{-2} M	4.2	3.4	3.1	3.6	4.3	3.9	3.4	3.9	1.03	0.98	0.75	0.92	29	28	25	27	36.2	34.7	31.3	34.1
	Sulphonate 5×10^{-2} M	4.3	3.5	3.1	3.6	4.1	4.1	3.3	3.8	1.00	0.90	0.74	0.88	28	27	27	27	36.1	33.3	27.0	32.1
	Mean	4.4	3.8	3.4		4.3	4.2	3.2		1.05	0.91	0.79		29	26	26		34.4	34.8	30.1	
	L.S.D. 0.5																				
	Irrigation		0.35				0.08				0.04				N.S.				0.50		
	Substances		N.S.				0.17				0.08				N.S.				1.01		

Wet = 30 % depletion in available water
Medium = 60 % depletion in available water
Dry = 90 % depletion in available water

obvious that irrigation treatments affect greatly the number of heads / plant. Such effect was found to be significant statistically . Maintaining soil moisture at a high level did result in higher number of heads/ plant . These results may demonstrate the importance of irrigation for increasing number of heads / plant . The obtained data are in full agreement with those reported by Dastane et. al. (1971) who concluded that lack of adequate soil moisture affect ear-head number.

Concerning the effect of growth promoters , NAA or GA_3 , results indicate that both of them increased number of heads/plant over the control under wet conditions while under dry level the effect was hindered.Such increase was found to be significant . These results are in line with those reported by Batch (1981) who concluded that wheat plants treated with GA_3 had similar or higher number of ears than the control.

As for the effect of growth retardants (Alar or Ethrel), results indicate that Alar had no effect upon number of heads /plant while Ethrel decreased such number significantly over the control. In case of anti-transpirants, the data showed no response followed such application . Similar results was observed by Imam and Miseha (1978) who found that spraying wheat plants with PMA had no effect on number of heads / plant .

It is intersting to mention that the response of soil moisture level on number of heads / plant was more conspicuous than growth promoting substances (NAA or GA_3) .

4.3.1.3. Weight of Grains/Head

Data recorded in Tables (47 and 48) represent the effect of growth regulators and antitranspirants at three soil moisture levels . Statistical analysis proved that either growth regulators or water regime had a significant response upon weight of grains per head .

With respect to soil moisture level treatments , results indicate that as soil moisture stress increased grain weight /head decreased significantly . This result may demonstrate that the level of soil water remained prior irrigation is an important factor controlling such character . The obtained data are in line with those reported by Imam and Miseha (1978) who mentioned that increasing soil moisture up to 80 % depletion in available water did result in a high significant decrease in weight of grains/head .

Growth promoting substances i.e. NAA or GA_3 increased the weight of grains / head in both concentrations. However, no more increase was observed as a result of higher doses of such growth promoters (more than 50ppm). This trend means that the use of growth promoters enhanced the accumulation of dry matter in grains of wheat.

As for the effect of growth retardants, data indicate that the use of Alar did not cause any conspicuous decrease in weight of grains/head, while Ethrel decreased such weight significantlythan the control one. In case of antitranspirant, results showed no effect on such weight and the values were about the same as those recorded in the control treatment.

The increase in grain weight of wheat head followed the use of NAA or GA_3 was found to be very clear under wet conditions while disappeared under severe soil moisture stress . In other words, the enhancing effect of growth promoter may be hindered when plants imposed to high moisture stress . This pattern may be due to the effect of water stress on physiological processes in plant growth . Gale et. al. (1967) reported that enzyme-mediated processes are presumably controlled more directly by the water potential .

4.3.1.4. Number of Grains / Head

From the available data presented in Tables (47 and 48), it can be noticed that no significant changes in number of grains/head followed the application of either growth regulators or antitranspirants under the various soil moisture levels . These results may indicate that such character was not affected by the different treatments . However, a slight decrease in number of grains/head was observed under high soil moisture stress.

4.3.1.5. Seed Index(Weight of 1000 grains)

The effect of growth substances and antitranspirants under different water regime on seed index are presented in Tables (47 and 48). Statistical analysis indicated that the differences due to growth substances and soil moisture stress were significant in both seasons . The results show a similar trend to that obtained from weight of grains / head .

Soil moisture stress exhibit a measurable differences in seed index . These differences were found to be highly significant . Maximum grain mass was obtained from the wet treatment , and the lowest from dry one , while medium water level falls in between . In other words, increasing soil moisture stress did result in producing smaller grains and lighter in their weight. These results may prove the importance of keeping the soil moisture at high level in order to produce larger wheat grains and heavier in their weight. These results are in full agreement with those reported by Seif-ElYazal (1971) , Imam and Miseha (1978) who concluded that increasing soil moisture stress did result in a decrease in weight of 100 grains .

Regarding the effect of growth promoting substances, maximum values were scored from pots treated with NAA or GA_3 and irrigated after the removal of 30 % depletion of available water. On the contrary, such increase due to the application of growth promoters was disappeared when soil moisture prior irrigation increased up to 90 % depletion .

From the same Tables , it is clear that either Alar or antitranspirants decreased slightly the weight of 1000 grains . Such decrease was found to be insignificant . However , the reduction in grain mass was more when Ethrel was applied.

In this connection, China et. al. (1981) pointed out that foliar spray with NAA promoted grain filling and increased the weight of 1000 grains .

4.3.2. Grain Yield

Grain yield of wheat expressed in g. / pot as influenced by various treatments i.e, growth regulators and antitranspirants in combination with soil moisture stress as well as relative increase or decrease percentage is shown in Tables (49 , 50 and 51). Statistical analysis of the variance proved that either growth substances or soil moisture levels had a highly significant effect upon grain yield of wheat in both seasons .

The effect of soil moisture stress on grain yield of wheat can be observed from data presented in Tables (49, 50 and 51). The results show that the wet soil moisture level (irrigated after the depletion of 30 % in available water) yielded the maximum production

Table (49): Effect of growth regulators, antitranspirants and soil moisture levels on grain and straw yield of wheat (g. / pot). in season 1980 /1981

	Soil moisture levels / Substances	Grain Yield(g./pot)				Straw Yield (g./pot)			
		Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean
	Control	38.13	32.83	19.65	30.20	66.80	62.11	45.65	58.19
Growth Promoters	NAA 50 ppm.	41.36	35.55	19.86	32.26	70.10	65.81	46.76	60.89
	NAA 100 ppm.	43.28	36.12	19.39	32.93	72.31	66.66	47.57	62.18
	GA_3 50 ppm.	43.16	34.87	19.45	32.49	72.38	66.97	46.93	62.09
	GA_3 100 ppm.	43.13	35.75	20.35	33.08	73.35	67.54	46.58	62.49
Growth Retardants	Alar 500 ppm.	37.24	34.59	19.39	30.41	62.97	58.09	45.07	55.38
	Alar 1000 ppm.	36.40	33.01	18.07	29.16	61.09	58.41	44.67	54.72
	Ethrel 500 ppm.	30.83	28.04	17.67	25.51	28.02	55.46	44.05	52.57
	Ethre.1000 ppm.	29.75	26.90	16.53	24.39	57.44	55.49	44.68	52.54
Antitransp-irants	PMA 5 x 10^{-5}M	38.72	33.41	18.45	30.29	64.71	61.52	45.18	57.14
	PMA 1 x 10^{-4}M	38.00	33.81	18.85	30.22	63.94	60.03	44.21	56.06
	Sulphonate 1 x 10^{-2}M	36.54	33.99	16.99	29.17	63.45	59.15	43.03	55.21
	Sulphonate 5 x 10^{-2}M	34.83	32.23	16.04	27.70	62.56	59.75	43.85	55.39
	Mean	37.80	33.16	18.59		65.33	61.31	45.25	
	L.S.D. 0.05								
	Irrigation		1.05				1.34		
	Substances		2.18				2.79		

Table (50): Effect of growth regulators, antitranspirants and soil moisture levels on grain and straw yield of wheat (g. / pot) in season 1981 /1982

	Soil moisture levels / Substances	Grain Yield (g./ pot)				Straw Yield (g./ pot)			
		Wet	Medium	Dry	Mean	Wet	Medium	Dry	Mean
	Control	36.21	30.55	20.84	29.20	65.58	60.73	47.65	57.99
Growth Promoters	NAA 50 ppm.	38.92	33.57	20.50	31.00	69.85	64.61	48.76	61.07
	NAA 100 ppm.	40.28	34.54	20.84	31.89	71.75	65.08	49.57	62.13
	GA_3 50 ppm.	41.55	34.32	21.67	32.51	71.84	65.27	48.58	61.90
	GA_3 100 ppm.	41.53	35.06	20.97	32.52	70.96	66.98	48.93	62.29
Growth Retardants	Alar 500 ppm.	34.68	31.34	19.47	28.50	62.12	56.34	47.07	55.18
	Alar 1000 ppm.	34.02	29.92	19.96	27.97	60.34	55.69	46.67	54.23
	Ethrel 500 ppm.	29.77	25.05	20.60	24.14	55.92	52.22	25.05	51.06
	Ethre.1000 ppm.	29.51	24.48	19.34	24.44	55.66	53.18	45.68	51.51
Antitranspi-rants	PMA 5×10^{-5} M	36.01	30.88	20.71	29.20	64.65	59.64	46.18	56.82
	PMA 1×10^{-4} M	36.51	29.18	19.24	28.31	63.89	58.66	43.92	55.49
	Sulphonate 1×10^{-2} M	34.66	30.62	20.09	28.46	62.52	58.09	43.63	54.74
	Sulphonate 5×10^{-2} M	33.05	29.13	19.60	27.26	62.08	57.61	45.11	54.93
	Mean	35.90	30.66	20.29		64.40	59.55	46.68	
	L.S.D. 0.05								
	Irrigation		1.15				1.43		
	Substances		2.39				2.98		

Table (51): Relative increase or decrease percentage in grain and straw yield of wheat under the various treatments (mean of two seasons).

Soil moisture levels / Substances			Grain Yield %			Straw Yield %		
			Wet	Medium	Dry	Wet	Medium	Dry
	Control		183.6	156.5	100.0	141.9	131.7	100.0
Growth Promoters	NAA	50 ppm.	198.2	170.7	99.7	150.0	139.8	102.4
	NAA	100 ppm.	206.3	174.5	99.3	154.4	141.2	104.1
	GA_3	50 ppm.	209.2	170.8	101.5	154.6	141.7	102.4
	GA_3	100 ppm.	209.0	174.8	102.0	154.7	144.2	102.4
Growth Retardants	Alar	500 ppm.	177.6	162.8	96.0	134.1	122.6	98.8
	Alar	1000 ppm.	173.9	155.4	93.9	130.2	122.3	97.9
	Ethrel	500 ppm.	149.6	131.1	94.5	122.3	151.4	95.5
	Ethre.	1000 ppm.	146.3	126.9	88.6	121.2	161.5	96.8
Antitranspi-rants	PMA	5×10^{-5} <u>M</u>	184.5	158.7	96.7	138.6	129.9	97.9
	PMA	1×10^{-4} <u>M</u>	184.0	155.5	94.0	137.0	127.2	94.5
	Sulp-honate	1×10^{-2} <u>M</u>	175.8	159.5	91.6	135.0	125.7	92.9
	Sulp-honate	5×10^{-2} <u>M</u>	167.6	151.5	88.0	133.6	125.8	95.3

followed by the medium soil moisture stress (60 % depletion) and the lowest yields were obtained by irrigating wheat at 90 % depletion in available water. Statistical analysis proved that the difference in grain yield was significant between the wet and other levels of soil water . This means that maintaining soil moisture at high level by irrigating wheat at a depletion of 30 % in available water maximized grain production . This trend may be due to the multiple effects of water stress on plant growth which in turn was reflected on grain yield .

In this respect, Kramer (1969) stated that water stress reduces photosynthesis by closure of stomata which decreases the supply of CO_2 , but water stress reduces also the capacity of the protoplasm to carry on photosynthesis . The reduction in photosynthesis decreasrd translocation of carbohydrates and growth regulators , and distrubance of nitrogen metabolism all added to the effects of reduced turgor in reducing growth . In turn , reduced growth reduce the photosynthetic surface, further decreasing the relative amount of carbohydrate available for growth, as compared with unstressed plants .

The above mentioned results are in full agreement with those reported by Mohamed (1976), Muhel (1976) and Imam and Miseha (1978) who concluded that increasing soil moisture stress before irrigation depressed the yield of wheat .

As for the effect of NAA or GA_3 at the two used rates on grain yield of wheat, the data indicate that such growth substances increased grain yield significantly over the control treatment. Also, it can be mentioned that increasing the rate of NAA or GA_3 more than 50 ppm did not cause any appricable increase in grain yield of wheat . These findings may be due to the promoting effect of the used substances on the growth of wheat which was reflected on the final product or grain yield . These results are in full agreement with those reported by China et al. (1981) who found that foliar spray with NAA increased grain yield of wheat . Also, Singh and Darra (1971) reported that GA_3 at 50 or 100 ppm increased grain yield of wheat , however above that concentration , the activity of GA_3 either ceased or decreased .

Regarding the role of Alar and Ethrel, on grain production of wheat, results illustrated in Tables (49, 50 and 51) revealed that spraying Alar on wheat plant failed to cause any increase in grain yield but slightly decreased it compared with the control. Such decrease was insignificant at the two concentrations used . However, in case of Ethrel application, grain yield was sharply decreased at both concentrations. The reduction in grain production was significant in the two seasons of study . These results may indicate that Ethrel did not retard wheat growth but also reduced grain production . In this respect, Rowland (1973) in trials with wheat found that grain yield was reduced when plants sprayed with Ethrel at the age of 25 , 35 and 45 days .

It may be of interest to mention that - in the present study - spraying wheat plants with antitransp-irant (PMA) did not cause any significant decrease in grain production and the values are similar to those observed in the control. This type of results can be related to the time of application as the spraying took place early in the season before heading period . In this connection, Brengle (1968) concluded that app-lying PMA antitranspirant at tillering or shooting time on spring wheat have a trend towards higher yields while spraying PMA at flowering caused damage to wheat heads which affected the final yield.

However, a decline was observed in grain yield of wheat followed the application of α hydroxy sulphonate specially at higher concentration. These results can be attributed to the adverse effect of such compound on photosynthesis .

Comparing the combined effect between growth regulators and soil moisture stress, it can be noticed that the promotion effect of either NAA or GA_3 was found to be very clear under low and medium soil moisture stresses. However, under severe moisture stress, the stimulating effect of such substances in grain production was musked . In other words, it can be concluded that under severe moisture stress (90% depletion in available water) growth promoting substances had no effect on increasing grain yield of wheat. In this respect, Kramer (1969) pointed out that the reduced synthesis of growth regulators such as cytokinins and gibberellins in the root is an important factor in the reduction of growth observed in plants subjected to water stress . Also, Nowakowski and Iubanska (1975) concluded that IAA and GA_3 increased the photosynthetic intensity of wheat under high soil moisture level (30% of maximum soil moisture holding capacity) but had no effect at low moisture level (60 %).

In the light of the previous information obtained, it can be concluded that higher yield production is probably attained when not more than 30 % available water is depleted in the soil . Soil moisture depletion beyond this value decreased yield production . Also , high moisture level is also important to ensure the enhancing effect of growth promoting substances (NAA or GA_3) in order to increase grain yield of wheat .

4.3.3. Straw Yield

Data of straw production of wheat under the various treatments during the period of study as well as relative increase or decrease percentage are presented in Tables (49 , 50 and 51). The trend of straw are nearly identical to those observed with grain yields. Statistical analysis of the variance showed that either growth substances or soil moisture level had a highly significant effect upon straw yield . There was a possitive association between moisture level and wheat straw yield . Maximum value of straw was scored from the wet treatment followed by the medium soil moisture stress and the least was gained from the dry one . These results demonstrate that high moisture level is essential for straw production of wheat. The obtained data are in accordance with those reported by Seif El-Yazal (1971) and Imam and Miseha (1978).

With regard to the effect of growth promoting substances , weight of wheat straw was significantly increased by the application of NAA or GA_3 . In other words , growth promoting substances had an additive effect for enhancing the vegetative growth and that reflected on straw yield . The pronounced stimulative effect was found to be more than that observed in case of grain yield.

Growth retardants or antitranspirants tended to decrease straw yield of wheat significantly .

4.4. WATER USE EFFICIENCY

Water use efficiency is defined as the quotient of dry matter or marketable weight of a crop produced per unit area over the depth of water required in evapotranspiration to produce the crop . This term has been used to evaluate different agronomic practices with respect to water . Water use efficiency can be increased either by increasing crop productivity or by decreasing losses due to evapotranspiration. Crop productivity depends on such plant factors as gains due to photosynthesis versus losses due to diseases and pests. Hence, water use efficiency can be influenced by such means as the choice of crop and genetic improvement of its productivity and adaptation to the particular environment as well as by improvement of water, air and nutrient supply to the roots and of light and carbon dioxide supply to the foliage .

4.4.1. Dry Matter Production

A summary of water use efficiency at various stages of wheat growth expressed as g. dry matter/1000 g. water consumed for the different treatments in Tables (52 and 53). Results clearly show that water use efficiency was much lower early in the season as the plant vegetation was not established yet. Then increased gradually to reach a maximum value during the period from shooting to early milk stages (rapid vegetative

Table (52): Water use efficiency by wheat (g. dry matter / 1000 g water consumed) at various stages of growth under the different treatments .

(Season 1980 / 1981)

	Soil moisture levels	Wet (30% depletion)				Medium (60% depletion)				Dry (90% depletion)			
	Weeks after sowing § / Substances	0 - 5	6 - 10	11-15	16 -18	0 - 5	6 - 10	11 -15	16 -18	0 - 5	6 - 10	11- 15	16 -18
	Control	2.89	3.73	4.49	2.03	2.91	3.81	4.49	1.93	2.95	2.91	3.46	1.82
Growth Promoters	NAA 50 ppm.	2.89	3.75	4.68	2.05	2.91	3.97	4.52	1.85	2.95	2.76	3.16	2.39
	NAA 100 ppm.	2.89	3.67	4.74	2.01	2.91	4.00	4.54	1.90	2.95	2.75	3.21	1.98
	GA_3 50 ppm.	2.89	3.68	4.85	1.99	2.91	3.87	4.67	1.80	2.95	2.65	3.34	2.15
	GA_3 100 ppm.	2.89	3.61	4.84	1.98	2.91	3.95	4.57	1.74	2.95	2.73	3.36	2.02
Growth Retardants	Alar 500 ppm.	2.89	3.78	4.85	1.77	2.91	3.91	4.91	1.69	2.95	2.82	3.51	1.38
	Alar 1000 ppm.	2.89	3.86	4.67	2.20	2.91	3.91	4.78	1.83	2.95	2.75	3.50	2.15
	Ethrel 500ppm.	2.89	3.72	4.46	0.91	2.91	3.53	4.39	1.70	2.95	3.02	3.28	1.75
	Ethrel 1000 ppm.	2.89	3.77	4.45	0.75	2.91	3.65	4.17	1.72	2.95	3.02	3.56	1.16
Antitranspi-rants	PMA 5×10^{-5} M	2.89	4.16	4.82	1.71	2.91	4.25	4.62	2.10	2.95	3.18	3.29	2.25
	PMA 1×10^{-4} M	2.89	4.50	5.07	1.71	2.91	4.56	4.79	1.87	2.95	3.32	3.44	1.78
	Sulph-onate 1×10^{-2} M	2.89	3.92	4.42	1.68	2.91	3.76	4.53	1.83	2.95	3.07	3.00	2.10
	Sulph-onate 5×10^{-2} M	2.89	3.94	4.62	1.49	2.91	3.94	4.42	1.98	2.95	3.18	3. 06	2.03
	Mean	2.89	3.85	4.69	1.71	2.91	3.93	4.57	1.84	2.95	2.94	3.32	1.92

§ 0 - 5 = from sowing to early tillering
6 -10 = from early tillering to shooting
11 - 15 = from shooting to early milk stage
16 - 18 = from early milk to dough stage

Table (53): Water use efficiency by wheat (g. dry matter / 1000 g water consumed) at various stages of growth under the different treatments.

(Season 1981 / 1982)

Soil moisture levels / Weeks after sowing § / Substances		Wet (30% depletion)				Medium (60% depletion)				Dry (90% depletion			
		0 - 5	6 -10	11 -15	16-18	0 - 5	6 - 10	11-15	16-18	0 - 5	6 -10	11-15	16- 18
	Control	3.20	3.92	4.48	2.42	3.25	4.00	4.56	1.84	3.18	3.10	3.32	2.26
Growth Promoters	NAA 50 ppm.	3.20	3.89	4.55	2.24	3.25	3.99	4.61	1.72	3.18	3.10	3.13	2.16
	NAA 100 ppm.	3.20	3.92	4.70	2.65	3.25	3.96	4.67	1.71	3.18	3.11	3.14	2.18
	GA_3 50 ppm.	3.20	3.77	4.66	2.79	3.25	4.06	4.54	1.75	3.18	3.12	3.04	2.45
	GA_3 100 ppm.	3.20	3.83	4.73	2.86	3.25	3.88	4.76	1.47	3.18	3.11	3.20	1.98
Growth Retardants	Alar 500 ppm.	3.20	4.09	4.70	2.11	3.25	3.99	4.65	1.86	3.18	3.18	3.54	1.89
	Alar 1000 ppm.	3.20	4.05	4.61	2.31	3.25	3.97	4.61	2.11	3.18	3.16	3.44	1.97
	Ethrel 500 ppm.	3.20	3.93	4.34	2.02	3.25	3.82	4.38	1.05	3.18	3.22	3.36	2.13
	Ethrel 1000 ppm.	3.20	4.00	4.30	1.80	3.25	3.80	4.37	1.21	3.18	3.21	3.37	2.63
Antitranspirants	PMA 5×10^{-5} M	3.20	4.39	4.70	3.22	3.25	4.32	4.81	1.77	3.18	3.19	3.58	2.03
	PMA 1×10^{-4} M	3.20	4.59	4.90	3.21	3.25	4.39	4.82	1.96	3.18	3.41	3.92	1.96
	Sulphonate 1×10^{-2} M	3.20	3.91	4.40	2.91	3.25	4.11	4.65	1.74	3.18	3.16	3.33	2.54
	Sulphonate 5×10^{-2} M	3.20	4.00	4.50	2.57	3.25	4.21	4.52	2.06	3.18	3.23	3.43	2.12
	Mean	3.20	4.02	4.58	2.54	3.25	4.04	4.61	1.71	3.18	3.18	3.37	2.18

§ 0 - 5 = from sowing to early tillering

6 - 10 = from early tillering to shooting

11 - 15 = from shooting to early milk stage

16 - 18 = from early milk to dough stage

growth). Thereafter, Water use efficiency values falls down to a minmim when plants gowing to maturity . These may indicate the importance of adequate water supply through the period of rapid vegetative growth as water utilization shows its maximum rate .

The lower water use efficiency value early in the season can be explained on the basis that when plants are very small they intercept only a small fraction of the total radiation , however, the evaporation rate will be high because of the exposed , freely evaporating soil surface . Dry matter production was at a minmim rate and hence water use efficiency was very low. Water use efficiency values increased as the plant developed and its leaf area increased. The maximum water use efficiency values through shooting to early milk stage can be related to that wheat plant attained its highest vegetative growth through this period. It is well known that light interception by plants increases with the increase in leaf area index. Photosynthesis and growth are proportional to the amount of light intercepted by the canopy and, therefore, to the leaf area index. On the other hand, evaporation from a field is not necessarly proportional to the leaf area index because evaporation occurs from both soil and plant surface.Therefore, water utilization was at its maximum rate through this period of plant growth. Later on, the decrease in water use efficiency is probably due to maturation and photosynthesis was at a minmial as well as plant-dependent factor .

The previous results are in full agreement with those reported by Ritchie and Burnett (1971) who concluded that water use efficiency was extremely low at the beginning of the growing season and increased gradually to a maximum during the period of most rapid vegetative growth . Also, Ritchie (1974) concluded that, water use efficiency is lower early in the growing season of annual plants because growth rates are slow and a relatively large fraction of the evaporation flux is from soil surface in comparison to the amount from plant surface . He added that rapid growth rates per unit area of land would improve the efficiency of water use .

Concerning the effect of soil moisture stress on water use efficiency by wheat during its growth cycle, data presented in Tables (52 and 53) revealed that under low or medium soil moisture stress , water use efficiency values wer higher than those under severe soil moisture stress (90 % depletion in available soil moisture). In other words, increasing soil moisture stress more than 60 % depletion did result in a sharp decrease in water use efficiency through the period of rapid vegetative growth whereas, other stages was found to be less in this respect . This trend is mainly due to less dry matter produced per unit of water utilized in complete evapotranspiration.

These results can be explained on the basis that plants subjected to severe water deficits are smaller than those plants subjected to moist or moderate water levels . Reduced cell turgor is the most important reason for reduced plant size . Plant turgidity is important in relation to the opening and closing of stomata , expansion of leaves and flowers and movement of water and nutrients to various parts of the plant. The amount of turgidity may not directly influence the actual exchange of gases required in photosynthesis , but it will affect net photosynthesis indirectly through regulation of stomata opening . All of these reduce dry matter accumulation in plants subjected to severe moisture stress per unit of water consumed which result in lower water use efficiency values .

The previous results may indicate the importance of maintaining soil moisture at high level through the period of shooting to early milk stage for maximum utilization of both water and net radiation to enshure high water use efficiency by wheat . These results are in harmony with those reported by Ritchie and Burnett (1971) who concluded that water deficit during the growing season of a crop that resulted in reduced transpiration caused a proportionally larger reduction in dry matter production and water use efficiency . Also, Salter and Goode (1967) pointed out that plant water deficit at certain stages of plant growth may cause more injury or yield reduction than other stages . Ritchie (1974) stated that the critical periods for many agronomic plants are when reproductive organs are formed and when pollenation occurs.

With regard to the effect of growth promoting substances on water use efficiency by wheat at various stages of growth results illustrated in Tables (52 and 53)showed no obvious effect on such values at earlier stages of wheat growth (tillering to shooting).However, later on (from shooting to heading), growth promoters improved water use efficiency figures with respect to the control under low or medium soil moisture stress . However, under severe moisture stress no clear trend was observed . These results reveal that the enhancing effect of either NAA or GA_3 on dry matter production was found to be more than the increase in water consumption by such application .

Regarding the role of growth retardants (Alar or Ethrel) on water use efficiency, results showed a similar trend to that observed with growth promoters in Alar only . On the contrary , Ethrel application reduced slightly such values compared with the control treatment .

As for the effect of antitranspirants, results presented in Tables (52 and 53) indicate that water use efficiency value was increased at earlier stages than either growth substances or retardants during the period of their use (35 - 70 days after sowing). Such increase was extended to later stages of wheat growth with PMA only ,however remained unchanged or slightly decreased in case of sulphonate . This trend may show that film forming antitranspirant (PMA) may improve water use efficiency by decreasing transpiration more than photosynthesis which resulting in an increase in water use efficiency values . Such improvement was found to be clear under high or medium soil moisture levels while disapperaed or retarded under severe moisture stress (90 % depletion).

Similar results were obtained by Zelitich (1961), and Waggoner (1962) who reported that PMA antitranspirant increased stomatal resistance accomplished by reducing transpiration more than photosynthesis resulting in favourable photosynthesis/transpiration ratio. Zelitch (1971) found that stomata represent a smaller portion of the total resistance to CO_2 than to water vapour diffusion . Thus, a partial closure of stomata may reduce transpiration more than photosynthesis resulting in improving water use efficiency.

In the light of the previous results, it can be concluded that plant water deficits affect partically every aspect of plant growth by modifying the morphology and physiology of plants . Growth of plants will be limited by lack of soil moisture thereby dry matter productivity . Thus, the control of evapotranspiration by a crop must be considered in relation to the effect on photosynthesis or dry matter productivity . The use of growth promoting substances may increase dry matter production more than evapotranspiration resulting in an increase in water use efficiency . The same was true with antitranspirants . Such chemicals can improve the efficiency of water utilization expressed as dry matter produced per unit of water consumed under high moisture level but failled to cause any increase under lack of water .

4.4.2. Marketable Yield

In crop production , our attention should be directed not only to plant growth but also to marketable yield (grain yield). Table (54) represent the effect of growth regulators, antitranspirants and water regime variables on water use efficiency by wheat (g. of grains / 1000 g. water consumed). Soil moisture stress induced a great response upon water use efficiency values . The highest water use efficiency values were produced from the wet treatment followed by the

Table (54) : Water use efficiency by wheat (g. grains/ 1000 g. water consumed) under the different treatments during the period of study.

Seasons / Soil moisture levels / Substances			Season 1980 / 1981			Season 1981 / 1982		
			Wet	Medium	Dry	Wet	Medium	Dry
	Control		1.200	1.158	0.810	1.170	1.088	0.854
Growth Promoters	NAA	50 ppm.	1.230	1.194	0.808	1.172	1.132	0.827
	NAA	100 ppm.	1.285	1.219	0.788	1.228	1.161	0.835
	GA_3	50 ppm.	1.296	1.178	0.790	1.255	1.160	0.876
	GA_3	100 ppm.	1.279	1.198	0.827	1.268	1.178	0.848
Growth Retardants	Alar	500 ppm.	1.240	1.275	0.821	1.172	1.163	0.815
	Alar	1000 ppm.	1.211	1.225	0.766	1.163	1.116	0.837
	Ethrel	500 ppm.	1.030	1.023	0.754	1.023	0.932	0.866
	Ethrel	1000 ppm.	0.994	1.036	0.703	1.019	0.915	0.817
Antitranspirants	PMA	5×10^{-5} M	1.321	1.258	0.802	1.244	1.171	0.879
	PMA	1×10^{-4} M	1.343	1.304	0.834	1.305	1.120	0.883
	Sulphonate	1×10^{-2} M	1.194	1.230	0.708	1.155	1.124	0.843
	Sulphonate	5×10^{-2} M	1.148	1.179	0.679	1.115	1.076	0.828
	Mean		1.213	1.191	0.776	1.181	1.103	0.843

medium level with a slight differences between them . This trend means that the relative decrease in seasonal evapotranspiration by increasing soil moisture stress from 30 % to 60 % depletion in available water did result in a similar decrease in wheat yield which was reflected on water use efficiency values . However , under severe soil moisture stress (90 % depletion) the values were sharply decreased . Such pattern may explain that the relative decrease in grain production by high soil moisture stress was found to be much more than the decrease in seasonal water consumption. All of these resulted in lower water use efficiency values. These findings indicate that the lower the soil moisture stress, the higher are the values of water use efficiency. In this respect, Ritchie (1974) concluded that some water conservation benefits can be derived from allowing plants to experince moderate water stress . It is well known that plant roots extract soil water from greater depths than plants kept irrigated to optimum levels , thus, water stored in the profile is used more efficiently .

Efficiency of water use as modified by growth regulators and antitranspirants can be detected from data presented un Table (54). Growth promoters i.e. NAA or GA_3 increased the efficiency of water utilization under wet and medium soil moisture levels whereas, under dry conditions did not cause any increase compared with the control treatment . Also, PMA antitranspira t had a similar trend to that found with growth promoters . However, the use of α-hydroxy sulphonate did not cause any increase in water use efficiency values but slightly decreased it . This pattern may suggest that either growth promoters or PMA antitranspirant can improve the efficiency of water utilization by improving crop yield in the former or decreasing seasonal evapotranspiration in the later . In this connection, Tinus (1974) concluded that water use efficiency improved by optimizing the factors that promote growth . He added that adequate soil moisture is necessary for antitranspirants to be effective , and the stomata should be partially opened for increasing CO_2 concentrations to have any effect .

Concerning the role of growth retardants on water use efficiency by wheat, results indicate that the use of ALar did not cause any appricable increase in such values . However, the application of Ethrel resulted in a great reduction in such values . This may be due to the effect of Ethrel on crop productivity or grain yield of wheat .

4.5. CHEMICAL COMPOSITION

4.5.1. Protein Content

Quality characteristics of wheat as influenced by available soil moisture and growth substances are important. Protein content of wheat grain is an important factor affecting backing quality. The nutritive value of the protein can be connected with their solubility in the different normal known solvents .Protein quantity and quality may be influenced by soil moisture and growth regulators .

Variations in protein content as affected by growth regulators and antitranspirants on the high and medium soil moisture levels as well as with limited irrigation , are presented in Table (55). Results clearly show that the level of soil moisture is an important factor controling protein content of wheat grains . As soil moisture stress increased , wheat protein increased . These results may indicate that protein content of wheat decreased as yield increased by irrigation . These findings are in line with those reported by Brengle (1960) and Imam and Miseha (1978) who concluded that protein content of wheat grains increased as the available soil moisture decreased .

As protein content of wheat grains is inversly related to soil moisture availability, therefore, it is possible to correlate protein content expressed as

Table (55): Effect of growth regulators , antitranspirants and soil moisture stress on protein fractions of wheat grains expressed as mmg. / g. dry weight in season 1980/1981 .

Soil moisture stress			Wet (30 % depletion)						Medium (60 % depletion)						Dry (90 % depletion)					
	Protein fractions Treatments		F_1	F_2	F_3	F_4	F_5	Total	F_1	F_2	F_3	F_4	F_5	Total	F_1	F_2	F_3	F_4	F_5	Total
	Control		24.21	7.02	31.40	2.93	43.56	109.30	17.80	8.28	36.05	2.88	54.51	118.80	20.13	9.09	34.50	4.55	61.93	130.20
Growth Promoters	NAA	50ppm.	20.13	7.59	21.51	2.36	47.59	99.18	14.95	7.59	31.05	2.88	51.04	107.50	18.63	7.02	32.89	4.60	64.36	127.50
	NAA	100ppm.	20.24	7.02	20.59	2.53	53.12	103.50	14.95	7.48	29.06	2.59	53.72	107.80	19.55	7.94	32.89	3.85	56.47	120.70
	GA_3	50ppm.	19.44	6.67	23.98	2.53	50.90	103.52	15.06	8.51	27.83	2.79	55.21	109.40	21.85	7.59	32.55	4.06	65.25	131.30
	GA_3	100ppm.	20.13	6.33	24.15	2.82	43.17	96.60	15.30	7.82	28.23	2.65	53.50	107.50	19.90	7.82	31.63	4.08	61.97	125.40
Growth Retardants	Alar	500ppm.	18.40	6.90	26.85	3.45	49.50	105.10	15.64	8.86	33.58	4.03	49.19	111.30	16.91	6.90	25.30	4.68	76.21	130.00
	Alar	1000ppm.	17.48	6.90	25.13	3.51	53.28	106.30	20.76	8.40	32.89	3.11	54.24	119.40	15.18	8.74	20.59	5.75	76.04	126.30
	Ethrel	500ppm.	19.09	7.82	24.73	3.57	46.86	102.07	17.25	7.82	28.12	3.45	58.36	115.00	15.64	8.28	26.99	5.87	70.46	127.24
	Ethrel	1000ppm.	17.37	8.17	31.63	3.45	47.20	107.82	16.56	8.17	28.75	3.19	60.23	116.90	17.14	9.43	29.50	5.64	56.19	126.90
Antitranspi-rants	PMA	5×10^{-5}M	17.25	6.56	26.97	2.82	48.90	102.50	19.25	8.68	35.54	3.28	52.63	117.83	17.14	8.74	33.27	4.49	62.95	126.59
	PMA	1×10^{-4}M	17.83	6.56	29.96	2.76	47.29	104.40	20.82	7.82	30.94	3.39	54.53	117.50	17.94	8.17	31.51	5.92	61.96	125.50
	Sulphonate	1×10^{-2}M	18.17	7.48	30.30	2.82	44.33	103.10	20.13	7.36	31.83	3.80	45.68	108.80	17.48	8.05	31.05	4.72	71.00	132.30
	Sulphonate	5×10^{-2}M	17.25	7.02	34.67	2.70	41.46	103.10	17.38	6.33	26.45	2.88	53.26	106.30	13.80	8.40	28.26	4.49	76.95	131.90
	Mean		19.00	7.00	27.07	2.96	47.40	103.58	17.22	7.93	30.72	3.15	53.55	112.58	17.79	8.17	30.07	4.82	66.98	127.83

F_1 = Water soluble protein
F_2 = Salt soluble protein
F_3 = Ethanol soluble protein
F_4 = Borate biffer soluble protein
F_5 = Residual non-soluble protein

mg. / g. of wheat grains to the percentage of soil moisture prior to irrigation . Statistical analysis showed that the relation was highly significant with a a orrelation coefficient of + 0.93 . The linear regression has given the best description of such relations. The mathematical equation represent this relationship was found to be as follows :

$$Y = 90.06 + 0.41 X$$

from the model

$$Y = a_o + a_1 X$$

where

Y = protein content of wheat grains expressed as mg. / g.

X = percentage of soil moisture depletion

a_o , a_1 are the constants of the function and was found to be 90.06 , 0.41 respectively .

The previous relationship may illustrates that if a specific proteint content is desired , yield can be controlled by irrigation practices . It can be concluded that with larger yields on higher moisture levels , protein content was lower .

Table (55) represents the protein content of wheat grains as influenced by either growth regulators or antitranspirants . The data indicate that growth promoting substances decreased protein content values . This trend may be related to the increase in wheat growth by such substances and thereby on grain yields. As for the role of growth retardants and antitranspirants , results showed a slight decrease in protein content of wheat grains. These results are in full agreement with those reported by Mohamed (1981) who found that GA_3 application reduced nitrogen content . Also , Imam and Miseha (1978) mentioned that PMA spray decreased protein content of wheat grains.

Protein fractions of wheat grains were extracted as water soluble (albumins like protein) ; salt soluble (5 % NaCl , glubulins like protein); ethanol soluble (prolamines like protein), borate buffer soluble (glutelins like protein) and residual insoluble protein and calculated on dry weight basis . Such results are presented in Table (55).

Results showed that the concentration of residual non-soluble protein was found to be the highest fraction followed by ethanol soluble protein. Those fractions comprise about 75 % of the total protein . However , the least fractions was found to be salt soluble and buffer borate proteins which comprise 10 % . Water soluble fraction shows an intermidate value to comprise about 15 % . These results may indicate that less than half of total amount of wheat protein is said to be insoluble.

As for the effect of soil moisture levels on protein fractions, results indicate that the increase in total amount of protein by high soil moisture stress is restricted mainly through the residual non-soluble protein. However, other fractions changed slightly to a less extent .

Regarding the effect of growth regulators and antitranspirants , results illustrated in Table (55) revealed that such substances reduced the total amount of protein fractions . The most pronounced reduction was found to be clear in both water soluble and ethanol soluble protein fractions . This pattern may show that growth regulators play a role in nitrogen metabolism. In this connection , Thomas et. al. (1973) concluded that specific biosynthesis of protein in the developing seeds may take place in two ways : (a) by condensation of amino acids translocated from green leaves to elsewhere, or (b) by reactions in which carbohydrates , amids and amonium salts may partecipate . Also , Pozar (1968) and Abdel-Hamid et.al. (1981) pointed out that growth promoters such as GA_3 and auxins seemed to control protein metabolism .

4.5.2. Carbohydrate

Data of soluble sugars calculated as mg. equivalent glucose per one gram dry matter for the various parts of wheat in two successive sampling i.e; shooting and heading under different treatments are recorded in Tables (56 , 57 and 58). The term soluble

Table(56): Effect of growth regulators and antitranspirants on the concentration of soluble sugars as mg. equivalent glucose/g. dry matter in the various parts of wheat plant grown under low soil moisture stress(1980/ 81).

	Plant organs / Plant age in weeks / Substances		Leaf blades		Sheath		Stem		Heads
			10	15	10	15	10	15	15
	Control		16.6	20.9	14.3	17.6	34.3	55.4	96.9
Growth Promoters	NAA	50 ppm.	19.4	24.6	15.9	18.2	38.5	60.4	99.3
	NAA	100 ppm.	20.3	22.8	15.1	18.4	35.9	58.6	100.1
	GA_3	50 ppm.	20.6	23.9	17.2	17.9	36.4	59.9	101.4
	GA_3	100 ppm.	23.1	25.2	18.1	19.1	35.6	59.4	98.8
Growth Retardants	Alar	500 ppm.	17.2	21.7	15.8	16.3	36.1	56.2	92.4
	Alar	1000 ppm.	14.6	21.1	15.1	16.3	30.4	57.3	96.2
	Ethrel	500 ppm.	17.3	20.4	13.9	16.2	34.3	54.5	92.9
	Ethrel	1000 ppm.	14.3	19.2	14.2	17.1	36.2	50.4	82.8
Antitranspirants	PMA	5×10^{-5} M	15.1	21.1	13.9	15.6	33.5	51.6	91.9
	PMA	1×10^{-4} M	13.9	20.4	15.4	17.4	34.2	54.8	97.2
	Sulphonate	1×10^{-2} M	15.4	21.2	15.2	16.8	32.3	57.9	91.3
	Sulphonate	5×10^{-2} M	13.8	19.6	14.3	16.6	29.8	58.3	94.6
	Mean		17.1	21.7	15.3	17.2	34.5	56.5	95.1

Table (57): Effect of growth regulators and antitranspirants on the concentration of soluble sugars as mg. equivalent glucose/g. dry matter in the various parts of wheat plant grown under medium soil moisture stress(1980/81).

	Plant organs / Plant age in weeks / Substances		Leaf blades		Sheath		Stem		Heads
			10	15	10	15	10	15	15
	Control		16.5	16.4	14.6	18.3	33.2	57.2	95.4
Growth Promoters	NAA	50 ppm.	18.6	22.5	15.1	19.2	34.6	61.3	100.2
	NAA	100 ppm.	18.9	20.6	17.2	17.8	38.2	59.2	98.6
	GA_3	50 ppm.	17.6	21.3	16.9	18.8	35.6	59.4	98.3
	GA_3	100 ppm.	20.6	22.4	15.6	16.9	35.6	58.8	100.1
Growth Retardants	Alar	500 ppm.	14.9	19.9	17.2	15.6	29.6	56.4	102.2
	Alar	1000 ppm.	16.3	20.6	14.9	15.7	30.2	57.1	96.8
	Ethrel	500 ppm.	14.8	18.9	13.8	16.6	30.2	54.2	98.2
	Ethrel	1000 ppm.	13.6	19.3	14.2	17.3	29.9	53.6	89.9
Antitranspi-rants	PMA	5×10^{-5} M	15.6	18.7	15.1	13.9	32.5	57.4	92.4
	PMA	1×10^{-4} M	13.8	19.5	15.3	14.9	32.5	56.8	96.5
	Sulphonate	1×10^{-2} M	13.8	18.3	17.2	14.8	33.4	57.1	98.9
	Sulphonate	5×10^{-2} M	13.8	17.9	16.4	15.3	32.7	56.3	96.2
	Mean		16.1	20.0	15.7	16.5	32.9	57.3	97.2

Table (58): Effect of growth regulators and antitranspirants on the concentration of soluble sugars as mg. equivalent glucose/g. dry matter in the various parts of wheat plant grown under high soil moisture stress (1980 /81).

Plant organs / Plant age in weeks / Substances			Leaf blades		Sheath		Stem		Heads
			10	15	10	15	10	15	15
	Control		13.7	17.3	13.3	14.9	29.2	48.1	88.5
Growth Promoters	NAA	50 ppm.	15.2	17.6	12.6	16.1	27.9	49.6	92.4
	NAA	100 ppm.	14.1	17.4	13.1	15.3	29.9	50.8	90.1
	GA_3	50 ppm.	13.9	15.6	12.4	14.8	27.3	49.2	85.2
	GA_3	100 ppm.	14.6	16.3	13.4	14.8	27.7	48.9	89.3
Growth Retardants	Alar	500 ppm.	10.9	16.8	11.6	14.9	26.4	49.9	85.9
	Alar	1000 ppm.	11.5	17.2	12.6	16.1	28.3	49.9	82.3
	Ethrel	500 ppm.	15.3	17.1	11.9	13.8	28.3	50.3	92.6
	Ethrel	1000 ppm.	14.7	18.2	14.2	16.2	29.4	51.2	86.3
Antitranspirants	PMA	5×10^{-5} M	11.6	17.8	10.6	17.3	29.5	48.9	96.3
	PMA	1×10^{-4} M	12.8	15.6	11.5	16.3	28.3	47.3	88.6
	Sulphonate	1×10^{-2} M	13.2	16.2	13.1	12.5	26.2	49.4	88.4
	Sulphonate	5×10^{-2} M	13.1	16.2	10.8	12.9	30.3	49.4	82.2
	Mean		13.4	16.9	12.4	15.1	28.4	49.5	88.3

sugars used in the following discussion refers to the direct reducing value plus sucrose . Results of soluble sugars as a general trend show a continous increase in the concentration of sugars from shooting to heading time . This trend was found to be true in all tested wheat parts . It can be generally observed that in most samples , soluble sugars present at a higher level in stem than either leaf blades or sheath , whereas, the later organs are similar in such concentration.The higher concentration of soluble sugars present in wheat heads may be due to that wheat plant directed an appreciable amount of their sugars to the developing grains.

As for the effect of water stress on the concentration of soluble sugars, it seems that such values were lower in plants subjected to severe moisture stress . This trend is true in all tested plant organs. Such results may be related to the changes in enzyme activity as well as the reduced carbon dioxide intake under stress conditions due to stomatal closure .In this respect , Kramer (1969) concluded that there are important differences among species in the effects of water stress in carbohydrate metabolism . The reaction is complacted by the fact that respiration often decreases more slowly than photosynthesis causing depletion of total reserve and changes in the proportions of various carbohydrates.

As for the effect of growth substances and antitranspirants on soluble sugar concentration, it can be noted that growth promoting substances seemed to cause an increase in sugar concentration especially in wheat heads . However , other substances (growth retardants and antitranspirants) showed a quite changes in such concentration.

From the previous results, it is revealed that the concentration of soluble sugars were quite different according to the used growth substances , the age of the plant and the level of soil moisture as well as the tested plant parts . Consequently, there is a clear link between the control of wheat growth and carbohydrate metabolism. Therefore, it is suggested that the controlling effect of the different used substances and soil moisture level may be partialy due to its effect on carbohydrate metabolism .