

5. SUMMARY

The present investigation was carried out to study the effect of growth regulators and antitranspirants in combination with three soil moisture levels on actual evapotranspiration , potential evapotranspiration and crop coefficient at different stages of wheat growth as well as their response on plant growth , yield and chemical composition . Therefore, a pot trial was conducted in Agricultural Research Center, Giza during the two seasons 1980 /1981 and 1981 /1982 using wheat variety Giza 157 . The design of the experiment was completely factorial randomized design with 10 replications. The experiment consisted of 39 treatments and includes two growth promoting substances i.e. NAA and GA_3 at the rate of 50 and 100 ppm. , two growth retardants i.e. Alar and Ethrel at the rate of 500 and 1000 ppm. and two antitranspirants i.e. PMA at the rate of $5 \times 10^{-5}M$ and $1 \times 10^{-4}M$ and -hydroxy sulphonate at the rate of $1 \times 10^{-2}M$ and $5 \times 10^{-2}M$. These substances were combined factorially with three soil moisture levels i.e. 30 , 60 and 90 % depletion in available water . Plants were sprayed three times when aged 35 days after sowing at two-week intervals with the used chemicals .

The main trend of results can be summarized as follows :

I - Actual Evapotranspiration

- 1- Seasonal evapotranspiration vary widely between 394.9 and 555.2 under the various treatments.
- 2- Evapotranspiration values were increased as soil moisture stress decreased. The least water consumption was brought about under dry conditions, whereas, the highest water use was attained under very wet level , while under medium water supply, the values falls in between.
- 3- The relative increase in water consumption by wheat was found to be 28.7 and 16.3 % respectively for wet and medium soil moisture stresses over the dry treatment .
- 4- Evapotranspiration rates by wheat was increased by the application of either NAA or GA_3 (growth promoters) .
- 5- Growth retardants (Alar or Ethrel) did result in a decrease in ET. with about 5 % . Higher concentrations did not cause any more decrease in seasonal ET.
- 6- Antitranspirants (PMA or Sulphonate) decreased water consumption, also the decrease in ET. rates was more pronounced by higher concentrations. It can be noted that seasonal water use by wheat was relatively lower by using PMA than sulphonate.
- 7- The effect of such substances on ET. rates was more pronounced under wet conditions rather than under dry soil moisture .

8- Daily evapotranspiration rates were lower early in the growing season and increased as wheat plants developed till it reached its maximum during March. A decline in evapotranspiration rates occurred at the end of the season as expected with mature plants .

9- Daily water use by wheat can be represented as a continuous function in the form :

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

where

Y = daily evapotranspiration of wheat in mm.

X = relative growth period as percentage

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

This function predicts daily ET. at any period of wheat growth. The parameters in this function differ according to the variables included such as growth regulators , antitranspirants and soil moisture stress .

II- Potential Evapotranspiration

1- Potential evapotranspiration values estimated by radiation, Jensen and Haise , class A pan , Turc and Blaney and Criddle methods were underestimating the mean values of ETp., while Buchet and Penman estimates were overestimating the mean.

2- Methods using radiation (Penman , Radiation , Jensen and Haise , and Turc) as the main variable

provide adequate and reliable estimates of E_{Tp}.
either on short or long period determination .
However, those depend on temperature as the main
parameter (Blaney & Criddle and Bouchet) were
found to be inconsistence when calculated as short
or long period basis .

- 3- Comparing the different formula, it was found that
modified Penman equation gave the most accurate
results, as its values are very close to actual ET.
- 4- Measurements of E_{Tp} by a class A pan is the simplest
method as it is easily operated . However, its values
need a correction factor , which was found to be
under Egyption condition (1.31).
- 5- Jensen & Haise , and Turc formula provide adequate
estimates after calibration. As for Jensen & Haise,
the linear regression line was :

$$Y = 1.24 + 0.85 X$$

where

Y = potential evapotranspiration mm./day

X = evapotranspiration values obtained from
the formula of Jensen & Haise .

However , in case of Turc a new constant was
derived and the modified equation was :

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

when RH is greater than 50 %

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

when RH is less than 50 %

where

ETp = potential evapotranspiration in mm/day

T = mean air temperature in °C

Rs = solar radiation in cal./cm² / day

RH = relative humidity

- 6- Seasonal crop coefficient (K_C) for wheat was 0.89 under normal conditions. Whereas when wheat growth was promoted by NAA or GA₃, K_C increased up to 0.95. On the other hand, retardation of growth reduced K_C values to 0.85.

III- Plant Growth and Yield

- 1- Increasing soil moisture stress resulted in a significant decrease on plant height. Growth promoters increased plant height, whereas growth retardants and antitranspirants had the reverse trend.
- 2- Dry matter accumulation started with low rates at earlier stages of growth then increased rapidly during shooting to early milk stage. Regarding the distribution pattern of the different plant parts, it was found that leaf blades comprise the main plant dry matter component during tillering, while stem was found to be superior during flowering in this respect. However on dough stage, wheat heads was found to be the dominant organ followed by stem.

- 3- The highest values of dry matter was gained from the wet treatment followed by the medium level and the least values were obtained from dry soil moisture treatment.
- 4- The promoting effect of NAA or GA_3 on dry matter accumulation was directed mainly to the stem than other plant organs . With regard to growth retardants , the dry matter production was reduced in the entire plant . As for antitranspirants, dry matter accumulation was reduced throughout the period of their use . The regulating effect of growth substances or antitranspirants on dry matter production seemed to be clear under wet conditions, whereas inhibited when plants were imposed to severe moisture stress .
- 5- Number of tillers /plant was not affected by growth regulators or antitranspirants while soil moisture stress had a pronounced effect on such character. As soil moisture stress increased , tiller production was decreased.
- 6- Number of heads/plant was increased by growth promoters under wet conditions, while under medium or dry levels the effect was hindered. Alar has no effect on number of heads/plant , but Ethrel decreased such number. In case of antitranspirant, the data showed no obvious effect on that character . Concerning the effect of water regime, a similar

trend to that found regarding number of tillers ,
was observed .

- 7- The weight of grains /head increased by using growth promoting substances under wet conditions only .
Using Alar has no effect on the weight of grains / head , while Ethrel decreased such values . As for antitranspirants, no effect was observed . With regard to water regime, it was found that as soil moisture stress increased, grain weight/head decreased significantly .
- 8- Number of grains /head was not affected by various treatments .
- 9- The weight of 1000 grains showed a similar trend to that obtained from weight of grains / head .
- 10- Grain yield of wheat was increased by foliar spray with NAA or GA_3 till 50 ppm. , however , above that concentration no more increase in grain yield was observed . Spraying Alar slightly decreased grain yields, while Ethrel sharply decreased such value . It is interesting to mention that PMA did not cause any significant decrease on grain yields and the values were similar to the control . However , a decline was observed in wheat grain yield followed the application of α -hydroxy sulphonate specially at higher concentrations . Concerning the effect of water regime , it was found that the wet level produced the highest values of grain yield followed

by the medium treatment and the lowest yields were obtained under high soil moisture stress.

11-Straw yield showed a nearly identical values to those obtained from grain yields of wheat .

IV- Water Use Efficiency

1-Water use efficiency was lower early in the season when the plant vegetation was not established yet, then increased gradually to reach a maximum value during the most rapid vegetative growth . Thereafter , the efficiency of water use falls down to a minimum when plants approach maturity .

2-Under low or midum soil moisture stress, water use efficiency values were higher than those obtained under severe soil moisture stress . These results indicate the importance of maintaining high soil moisture levels through shooting to early milk stage .

3- Growth promoting substances have no obvious effect on water use efficiency values at earlier stages of growth (tillering to shooting) . However, later on (from shooting to heading) growth promoters improved such values . Under severe soil moisture stress , no clear trend was observed .

4- Water use efficiency as affected by Alar showed a similar trend to that observed from growth promoters. On the other hand , Ethrel reduced such values.

- 5- Film forming antitranspirant improved water use efficiency by decreasing transpiration more than photosynthesis .
- 6- In general, such chemicals have improved water use efficiency expressed as dry matter produced per unit of water consumed under high soil moisture levels but failed to cause any increase under lack of water .
- 7- As for the marketable yield, water use efficiency values were higher under wet treatment followed by the medium soil moisture with slight differences between both treatments . However, under severe soil moisture stress , the values were sharply decreased .
- 8- With regard to the effect of different substances on the marketable yield of wheat, it was found that the growth promoters and antitranspirant (PMA) had increased the values of water use efficiency under wet and medium soil moisture conditions only. Concerning the role of growth retardants , results indicated that the use of Alar did not cause any increase in such values. However , the use of Ethrel resulted in a great reduction in such values .

V- Chemical Composition

- 1- Results had shown that the level of soil moisture is an important factor controlling protein content of wheat grains . It was found that as water deficit increased , wheat protein increased .
- 2- The relation between water deficit and protein content is said to be a linear function with a correlation coefficient of + 0.93 . The linear representation of this relation is as follows :
$$Y = 90.06 + 0.41 X$$
where
Y = protein content of wheat grains expressed as mg. / g.
X = percentage of soil moisture depletion.
- 3- Growth regulators and antitranspirant seemed to decrease total amount of protein .
- 4- Data indicated that about 50 % of total amount of grain protein is insoluble , while ethanol soluble protein comprises about 25 % .
- 5- The increase in total protein by water deficit is mainly through non-soluble protein .