

**Short Communication**

**Irrigation needs and yields of wheat under global warming**

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Doubling of levels of carbon dioxide (CO<sub>2</sub>) from the 2000 level of 370 ppm is expected to occur by 2100 (IPCC, 1990). The rise in temperature for a doubling of CO<sub>2</sub> level will be 3°C (McCarthy *et al.* 2010). Thus, in 2020, 2050 and 2080 the increase in air temperatures will be 0.6, 1.5 and 2.4 °C respectively. The increase for carbon dioxide (CO<sub>2</sub>) will be 20 per cent, 50 per cent and 80 per cent in 2020, 2050 and 2080 respectively. Pramod *et al.* (2018) in their studies on trends in water requirements of wheat in India in future years have concluded that the growing period for wheat in the entire wheat belt will (i) decrease in the period 2021 to 2050 and (ii) increase by 78 per cent in the period 2051-2080. It was, therefore decided to carry out an assessment of changes in field -life duration, irrigation needs and yield of wheat in different regions of the wheat belt in India with progress of global warming. For this, the base year was taken as 2000.

Higher temperatures reduce crop-life duration. Elevated levels of carbon dioxide (CO<sub>2</sub>) reduces transpiratory need of crops. The percentage reduction for unit increase of temperature is independent of the wheat variety but will vary with the ambient crop season temperature. Reduction in field-life durations of wheat for increase in air temperatures of 1, 2 and 3°C for ambient mean crop season air temperature of 15 to 30°C has been given by Venkataraman (2004) . In practice for wheat the mean crop season temperature in India ranges from 15 to 25 °C only.

Now a reduction in crop-life duration means an equivalent reduction in unit area crop water needs on account of the following. In all phases from sowing to harvest, reduction in transpiratory needs per unit area will

equal to the percentage reduction in crop-life duration. From ground-shading to harvest, evaporative loss will be 20 per cent of evaporative power of air. In the phase from sowing to ground-coverage, which is of 2 to 3 weeks in duration, irrigation need will be equal to the transpiratory need of crops and surface irrigation needs. Under global warming there may be no reduction in number of surface irrigations in this phase. Under estimation of evaporative losses in this phase due to use of reduction factor will amount to an extremely negligible fraction of the total crop water needs. For same reasons, an increase in crop-life duration would mean an equivalent increase in water needs.

Evaporative power of air is a major determinant of crop water needs. In recent decades, trends in reduction in observed values of pan evaporation and computed values reference crop evapotranspiration have been reported in many places like India, China, Australia, New Zealand, USA and in many parts of Russia. The above phenomenon is called the “Evaporation Paradox” (Golubev *et al.* 2001; Rao and Wani, 2011) and is attributed to increased cloudiness and/or higher concentration of aerosols of anthropogenic origin.

Elevated levels of carbon dioxide (CO<sub>2</sub>) will reduce transpiratory need of plants due to decrease in stomatal aperture (Goudrian and Unsworth, 1990) which for a doubling of CO<sub>2</sub> averages about 34 per cent (Cure and Acock, 1986). The consequent reduction in transpiration is to the extent of 23 per cent (Cure and Acock, 1986) to 40 per cent (Morison, 1987).

In view of the above for this study reduction in transpiration rate has been taken as 30 per cent for a

**Table 1:** Percentage decrease in (A) field-life duration and (B) irrigation needs and (C) percentage change in yield of wheat

Temperature(°C)	2020			2050			2080		
	A	B	C	A	B	C	A	B	C
15	5	11	+ 1	13	26	- 1	19	38	- 1
20	4	10	+ 2	9	23	+ 4	13	34	+ 6
25	3	9	+ 3	7	21	+ 6	11	32	+ 9

doubling of CO<sub>2</sub> level. Thus, decrease in crop water needs has been taken as 6 per cent, 15 per cent and 24 per cent respectively in years 2020, 2050 and 2080. Doubling of CO<sub>2</sub> level will increase yield of wheat by 28 per cent (Lal *et al.* 1998). So increase in yield due to increase in CO<sub>2</sub> has been taken as 6 per cent, 14 per cent and 22 per cent in 2020, 2050 and 2080 respectively.

In view of the above the percentage (a) reduction in crop-life duration and irrigation needs of wheat and (b) change in yields of wheat in 2020, 2050 and 2080 for the envisaged climatic scenarios were worked out for ambient crop-season temperatures of 15, 20 and 15 °C and are presented in Table 1.

It can be seen from the Table 1 that the percentage reduction in crop-life will increase with a decrease in air temperature and will vary from 3 to 5 per cent, 7 to 13 per cent and 11 to 19 per cent in 2020, 2050 and 2080 respectively, The irrigation need will be lesser in the colder regime and will range from 9-11 per cent, 21 to 26 per cent and 32 to 38 per cent in 2020, 2050 and 2080 respectively. The table also shows that there is no need to worry about effects of global warming on yields of wheat. The contention of Pramod *et al.* (2018) need to be examined further by considering the increase in carbon dioxide and temperature used in their computations to arrive at more reliable estimate.

## REFERENCES

- Cure, J. D. and Acock, B. (1986). Crop responses to carbon dioxide doubling: A literature survey. *Agric. Forest Meteorol.*, 38: 127-145.
- Golubev, V.S., Lawrimore, J.H., Groisman, P.Ya., Speranskaya, N.A., Zhuravin, S.A., Menne, M.J., Peterson, T.C. and Malone, R., (2001). Evaporation changes over the contiguous United States and the former USSR: A reassessment. *Gephys. Res. Lett.*, 28: 2665-2668.
- Goudrian, J, and Unsworth, M.H. (1990). Implications of increasing carbon dioxide and climate change for agricultural productivity and water resources. *Amer. Soc. Agron. Spl. Publication No. 23*: 111-130.
- IPCC (1990). Climate Change. The IPCC Scientific Assessment. Houghton, J.T., Jenkins, G.j. and Ephraums, J.J, (Eds). Cambridge University Press, Cambridge, U.K. 410pp.
- Lal, M., Singh, K.K., Rathore, L.S., Srinivasan, G. and Saseendran, S.A. (1998). Vulnerability of rice and wheat yields in N.W. India to further changes in climate. *Agric. Forest Meteorol.*, 89: 101-116.
- McCarthy, M.P., Best, M.J. and Betts, R.A. (2010). Climate change in cities due to global warming and urban effects. *Geophys. Res. Lett.* 37: L09705 doi:10.1029/2010G102845.
- Morison, J.I.L. (1987). Intercellular CO<sub>2</sub> concentration and stomatal response. In "Stomatal Function". Stanford Univ. Press. Pp 229-251.
- Pramod, V.P., Bapuji Rao, B., Ramakrishna, S.S.V.S., Sandeep, V.M., Patel, N.R., Sarath Chandran, M.A., Rao, V.U.M., Santhibushan Chowdary, P. and Vijaykumar, P. (2018). Trend in water requirements of wheat crop under projected climates in India, *J. Agrometeorol.*, 20(2): 110-116.
- Rao, A.V.R.K. and Wani, S.P. (2011). Evapotranspiration paradox at a semi-arid location in India. *J. Agrometeorol.*, 13(1):3-8.
- Venkataraman, S. (2004). On possible reduction in yields of grain crops in future climate. *J. Agrometeorol.*, 6(special issue): 213-219.