

() , ()

()
(// : // :)

Archive of SID

(Dayton) V2 () V2
%

V2 V1

V2

(Anonymous, 2007)

Rain Water

Productivity (RWP)

art.tavakoli@gmail.com :

*

www.SID.ir

.Zhang and Oweis, 1999; Zhang, 2003)

(Tavakoli et al., 2000, 2003

& 2010)

.(Pala and Studer, 1999)

(WP)

.(Studer and Erskine, 1999)

(Cooper and Gregory, 1987; Harris et al., 1991; Keating *et al.*, 1986; Oweis *et al.*, 1998, 1999 & 2001; Ryan and Matar, 1992; .Tavakkoli and Oweis, 2004, Tavakoli et al., 2010)

(Oweis and Hachum,2004, Tavakoli et al., 2010)

()

() ()

(RWP)

(O'Leary *et al.*, 1985; French

.and Schultz, 1984; Batten and Khan, 1987)

(Oweis and Hachum,

(WP)

.2004)

Zhang and)

.(Oweis, 1999

(I₀)

(Late)

(Normal)

(Early)

- (I₅₀)

(I₁₀₀)

%

+

(I_{50%})

(Kitamura,

1990; Oweis and Hachum, 2004; Schneider and Howell, 1996; Tavakkoli and Oweis, 2004; Zhang *et al.*, 1999;

%

() (I_{100%})

(RWP)

()

, pH= /)

(SAR = / , EC = dS/m

()

)

/ / / /

/

(

()

()

(RWP)

(RWP)

(IWP)

(TWP)

/

/

$$WP = \frac{Yield}{WU} = \begin{cases} RWP = \frac{Yield}{rain} \\ IWP = \frac{\Delta Yield}{IWU} & \Delta Yield = Yield_{Irr} - Yield_{unIrr} \\ WP = \frac{Yield}{TWU} & TWU = IWU + rain \text{ if } IWU = 0 \text{ then } TWP = RWP \end{cases}$$

()

()

:WP

()

:Yield

:RWP ()

:WU

:IWP ()

:IWU ()

/

(WANA)

:TWP ()

()

:TWU

(Oweis and Hachum, 2004)

()

/

)

(Oweis et al., 1999)

(

()

()

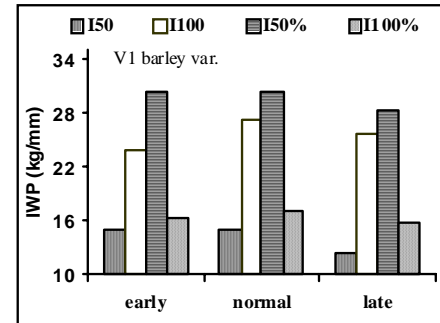
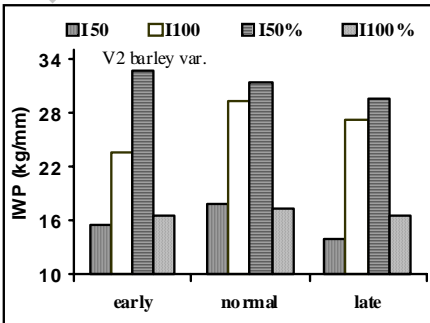
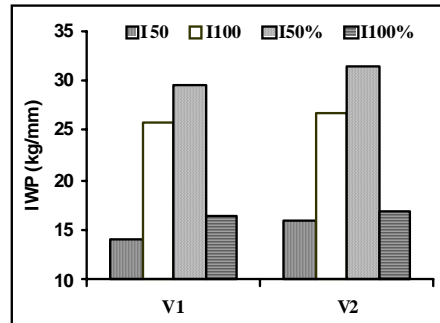
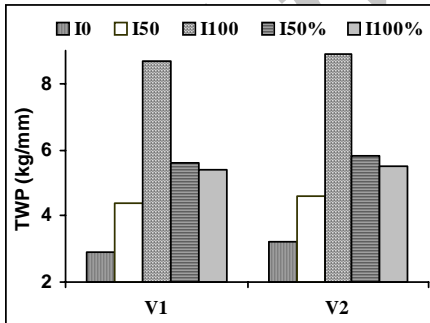
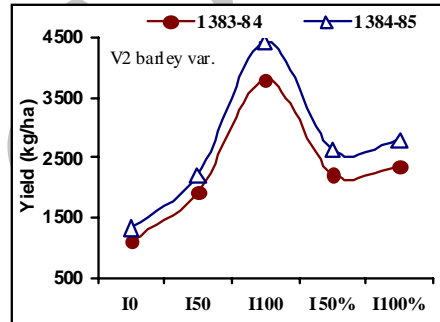
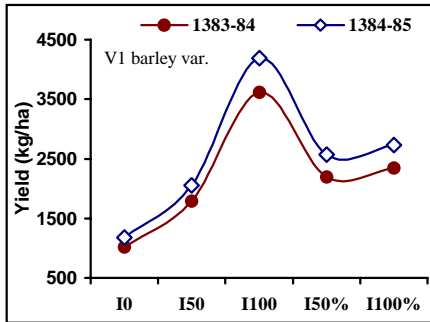
V2

()
/)
V1 ()
)
()

() () ()

()

()



(I₅₀)

(I₁₀₀)

(I_{50%})

(I_{100%})

/ / / /
 / / / I_{100%} I_{50%} I₁₀₀ I₅₀
 / / / I_{100%} I_{50%} I₁₀₀ I₅₀
 ()

(ICARDA, 2003)

Tavakoli and Liaghat,

(2010)

(Oweis and Hachum, 2004; Tavakoli

and Liaghat, 2010)

(/)
 () %
 V2
 ()

Late	Normal	Early
		V1
		V2
		V1
		V2
		I ₅₀
		V1
		V2
		I ₁₀₀
		V1
		V2
		I _{50%}
		V1
		V2
		I _{100%}

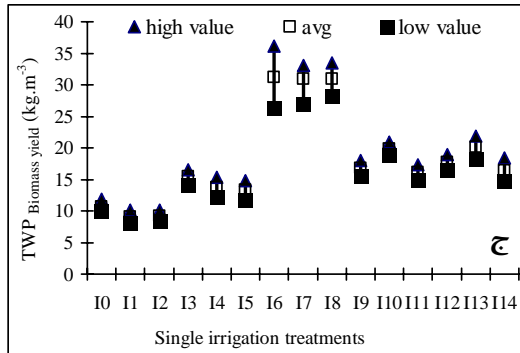
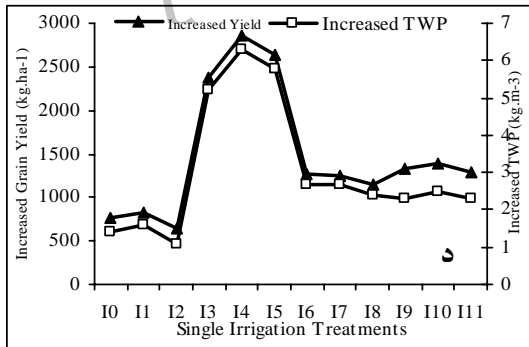
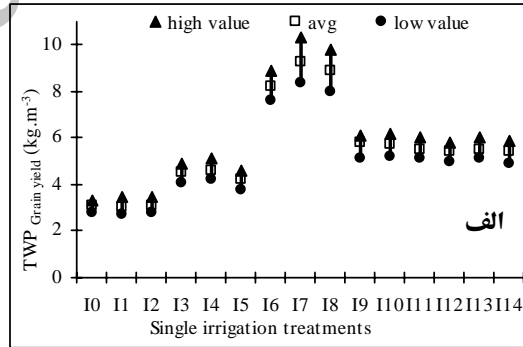
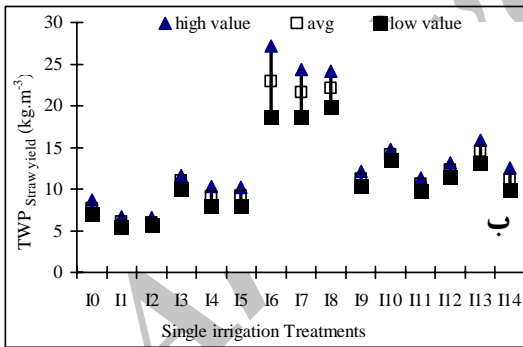
IWP () IWP		IWP		IWP		IWP		IWP	
()		()		()		()		()	
	Late	Normal	Early		Late	Normal	Early		
/	/		/	/	/	/	/	V1	I ₅₀
/	/		/	/	/	/		V2	
	/	/	/		/	/	/		
/	/	/	/	/		/	/	V1	I ₁₀₀
/	/	/	/	/	/		/	V2	
	/	/	/		/	/	/		
/	/	/	/	/	/	/	/	V1	I _{50%}
/	/	/	/	/	/	/		V2	
		/	/		/	/	/		
/	/	/	/	/	/	/	/	V1	I _{100%}
	/	/	/	/	/	/	/	V2	
	/	/	/		/	/	/		
$IWP = \frac{Yield_{irr} - Yield_{ra\ inf\ ed}}{IWU}$				$IWP = \frac{Yield_{irr} - Yield_{ra\ inf\ ed}}{IWU}$					
		TWP							
() IWP									
					Late	Normal	Early		
				/	/	/	/	V1	
				/	/	/	/	V2	
	Late	Normal	Early		/		/		
/	/	/	/	/	/	/	/	V1	I ₅₀
/	/	/	/	/	/	/	/	V2	
	/	/	/		/	/	/		
/	/	/	/	/	/	/	/	V1	I ₁₀₀
/	/	/	/	/	/	/	/	V2	
	/	/	/		/	/	/		
/	/	/	/	/	/	/	/	V1	I _{50%}
/	/	/	/	/	/	/	/	V2	
	/	/	/		/	/	/		
/	/	/	/	/	/	/	/	V1	I _{100%}
/	/	/	/	/	/	/	/	V2	
	/	/	/		/	/	/		
$IWP = \frac{Yield}{IWU}$				$TWP = \frac{Yield}{TWU}$					

()

(Lopez-Casteneda and Richards, 1994)

(Tavakoli et al., 2010)

()



I0=I0 Early, I1= I0 Normal, I2= I0 Late, I3=I50 Early, I4= 150 Normal, I5= 150 Late, I6=I100 Early, I7= I100 Normal, I8= I100 Late, I9=I50% Early, I10= 150% Normal, I11= 150% Late, I12=I100% Early, I13= I100% Normal, I14= I100% Late,

...

:

)

(

(McMaster and Wilhelm, 2003)

(Tavakoli and Liaghat, 2010)

()

(Oweis et al., 1998)

)

(2005) Azim-Zadeh (Haghighati-Maleki, 1998)

(

(Zhang and

()
(Oweis, 1999; Zhang *et al.*, 2000)

(1997) Oweis

(Tallie,

/

()

.2005)

(1999) Oweis et al. (Oweis and Hachum, 2003)

% % %

(Oweis and Hachum, 2009)

Rihane-3

(ICARDA, 1989)

% % %

(Ebro)

(Garabet et al., 1998)

/

(Cantero-Martinez et al., 1995)

()

()

)

(

(Department of Planning and

Statistic, 2001)

.(Somme and Al-Qaise, 2000)

.(Oweis et al., 1998)

) ()

REFERENCES

- Adary, A., Hachum, A., Oweis, T., and Pala, M. (2002). Wheat Productivity under Supplemental Irrigation in Northern Iraq. On-Farm Water Husbandry Research Report Series, No.2. International Center for Agricultural Research in the Dry Areas (ICARDA). Aleppo, Syria.
- Anonymous, (2007). Agro-statistical. Jihed-agriculture, Iran (in Farsi).
- Azim-Zadeh, S.M. (2005). Effects of different levels of nitrogen and supplemental irrigation on barley at north of Khorasan. Final research report, Dryland Agricultural Research Institute (DARI), Iran, No 84/10138. (in Farsi).
- Batten, G.H., and Khan, M.A. (1987). Effect of time of sowing on grain yield, nutrient uptake of wheats with contrasting phenology. *Australian Journal of Experimental Agriculture*, 27(6), 881-887.
- Cantero-Martínez, C., Villar, J.M., Romagosa, I., and Fereres, E. (1995). Growth and yield responses of two contrasting barley cultivars in a Mediterranean environment. *European Journal of Agronomy*, 4(3), 317-326.
- Cooper, P.J.M., and Gregory, P. J. (1987). Soil water management in the rainfed farming systems of the Mediterranean region. *Soil Use & Management*, 3(2), 57-62.
- Department of Planning and Statistics, Ministry of Agriculture and Agrarian Reform. Syrian Arab Republic. (2001). The Annual Agricultural Statistics Abstract for the Year 2000.
- French, R.J., and Schultz, T.E. (1984). Water use efficiency of wheat in a Mediterranean-type environment: I. The relation between yield, water use and climate. *Australian Journal of Agricultural Research*, 35, 743-764.
- Garabet, S., Wood, M., and Ryan, J. (1998). Nitrogen and water effects on wheat yield in a Mediterranean-type climate. I. Growth, water-use and nitrogen accumulation. *Field Crops Research*, 57(3), 309-318.
- Haghighati-Maleki, A. (1998). Study effect of supplemental irrigation and nitrogen on yield of barley. Final research report, Dryland Agricultural Research Institute (DARI), Iran No 77/629. (in Farsi).
- Harris, H.C., Cooper, P.J.M., and Pala, M. (1991). Soil and crop management for improved water use efficiency in rainfed areas. Proceeding of an International Workshop, Ankara, Turkey.15-19 May 1989.ICARDA, Aleppo, Syria.
- ICARDA, (1989). Farm Resource Management Program Annual Report for 1989. International Center for Agricultural Research in the Dry Areas (ICARDA). Aleppo, Syria.
- ICARDA, (2003). ICARDA Annual Report 2002. International Center for Agricultural Research in the Dry Areas (ICARDA). Aleppo, Syria
- Keating, J.D.H., Dennett, M.D., and Roadgers, J. (1986). The influence of precipitation regime on the management of dry areas in northern Syria. *Field Crops Research*, 13, 239-249.
- Kitamura, Y. (1990). Management of an irrigation system for double cropping culture in the tropical monsoon area. Technical bulletin 27, Tropical Agricultural Research Center, Ministry of Agriculture, Forestry and Fisheries, Tsukuba, Ibaraki, Japan.
- López-Castañeda, C., and Richards, R. A. (1994). Variation in temperate cereals in rainfed environments III. Water use and water-use efficiency. *Field Crop Research*, 39, 85-98
- McMaster, G. S., and Wilhelm, W. W. (2003). Phenological responses of wheat and barley to water and temperature: improving simulation

- models. *Journal of Agricultural Science*, 141, 129–147
- O'Leary, G.J., Connor, D.J., and White, D.H. (1985). Effect of sowing time on growth; yield and water use of rainfed wheat in the Wimmera, Vic. Aust. *Journal of Agricultural Research*, 36, 187-196.
- Oweis, T. (1997). Supplemental irrigation: a highly efficient water use practice. ICARDA, Aleppo, Syria, 16pp.
- Oweis, T., and Hachum, A. (2004). Water harvesting and supplemental irrigation for improved water productivity of dry farming systems in West Asia and North Africa. 4th international crop science congress 26th. September to 1st October 2004, Queensland, Australia.
- Oweis, T., and Hachum, A. (2009). Optimizing supplemental irrigation: Tradeoffs between profitability and sustainability. *Agricultural Water Management*, 96(3), 511-516.
- Oweis, T., and Zhang, H. (1996). Water use efficiency: Index for optimizing supplemental irrigation of wheat in water scarce areas. *Journal of Applied Irrigation science*, 33(2), 321-336.
- Oweis, T., Hachum, A., and Kijne, J. (1999). Water harvesting and supplemental irrigation for improved water use efficiency in dry areas. International Water Management Institute, Colombo, Sri Lanka, SWIM paper 7, 38pp.
- Oweis, T., Pala, M., and Ryan, J. (1998). Stabilizing rainfed wheat yields with supplemental irrigation and nitrogen in a Mediterranean Climate. *Agronomy Journal*, 90(5), 672-681.
- Oweis, T., Salkini, A., Zhang, H., Ilbeyi, A., Hustun, H., Dernek, Z., and Erdem, G. (2001). Supplemental irrigation potential for wheat in the central Anatolian plateau of Turkey, ICARDA.
- Pala, M., and Studer, C. (1999). Cropping systems management for improved water use efficiency in dryland agriculture. Paper presented at the International Conference on Water Resource Conversation and Management in Dry Areas, 3-6 December 1999, Amman, Jordan.
- Photiades, L., and Hadjichristodoulou, A. (1984). Sowing date, sowing depth, seed rate and row spacing on wheat and barley under dryland conditions. *Field Crops Research*. 9(2), 151-162.
- Ryan, J., and Matar, A. (ed.). (1992). Fertilizer use efficiency under rainfed agriculture in West Asia and North Africa. ICARDA. Aleppo, Syria.
- Schneider, A.D., and Howell, T.A. (1996). Methods, amounts and timing of sprinkler irrigation for winter wheat. *Journal. of Transaction of ASAE*, 40(1), 137-142.
- Somme, G., and Al-Qaise. (2000). Supplemental irrigation in the Syrian Arab Republic. In: Drought and Sustainable Agricultural Development Forum, University of Aleppo, May, 23–25, 2000. The Higher Council of Science, Damascus, Syria, pp. 401–436.
- Studer, C., and Erskine, W. (1999). Integrating germplasm improvement and agricultural management to achieve more efficient water use in dry area crop production. Paper presented at the International Conference on Water Resource Conversation and Management in Dry Areas, 3-6 December 1999, Amman, Jordan.
- Tallie, A. A. (2005). Response of rainfed barley (Sararood 1) to supplemental irrigation and nitrogen (on-farm). Final research report, Dryland Agricultural Research Institute (DARI), Iran, (in Farsi).
- Tavakkoli, A.R., and Oweis, T. (2004). The role of supplemental irrigation and nitrogen in producing bread wheat in the highlands of Iran. *Agricultural Water Management*, 65(3), 225-236.
- Tavakoli, A.R., and Liaghat, A. (2010). Optimization of Single Irrigation and Sowing Date for Rainfed Wheat Varieties under Dryland Condition. *Journal of Water and Soil researches*, 41(2), 179-188. (in Farsi)
- Tavakoli, A.R., Belson, V., Ferri, F., and Razavi, R. (2003). Response of rainfed wheat to supplemental irrigation and nitrogen rates. Final Research Report, Dryland Agricultural Research Institute (DARI), Maragheh, Iran. (in Farsi)
- Tavakoli, A.R., Belson, W., and Ferri, F. (2000). Impacts of supplemental irrigation on advanced lines of wheat. Final Research Report, Dryland Agricultural Research Institute (DARI), Maragheh, Iran. (in Farsi)
- Tavakoli, A.R., Oweis, T., Ashrafi, Sh., Asadi, H., Siadat, H., and Liaghat, A. (2010). Improving rainwater productivity with supplemental irrigation in upper Karkheh river basin of Iran. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria, 123pp.
- Tavakoli, A.R., Oweis, T., Ferri, F., Haghghati, A., Belson, V., Pala, M., Siadat, H., and Ketata, H. (2005). Supplemental Irrigation in Iran: Increasing and Stabilizing Wheat Yield in Rainfed Highlands. On-Farm Water Husbandry Research Report Series No.5. ICARDA, 46 pp.
- Zhang, H., and Oweis T. (1999). Water – yield relations and optimal irrigation scheduling of wheat in the Mediterranean region. *Agricultural Water Management*, 38(3), 195-211.
- Zhang, H., Pala, M., Oweis, T., and Harris, H. (2000). Water use and water use efficiency of chickpea and lentil in a Mediterranean environment. Water use and water use efficiency of chickpea and lentil in a Mediterranean environment. *Australian Journal of Agricultural Research*, 51(2), 295-304.
- Zhang, H., Wang, X., You, M., and Liu, C. (1999). Water-yield relations and water use efficiency of winter wheat in North China Plain. *Irrigation Science*, 19(1), 37-45.
- Zhang, H. (2003). Improving water productivity through deficit irrigation: Examples from Syria, the north China plain and Oregon, USA. In: Kijne, J.W., Barker, R., and Molden, D. (Eds) Water Productivity in Agriculture, limits and opportunities for improvement, International Water Management Institute (IWMI), Colombo, Sri Lanka. PP.301-309.