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EVALUATING WATER USE EFFICIENCY IN SUMMER GREEN GRAM (*VIGNA RADIATA* L. WILCZEK) UNDER CHANGED HYDRO-THERMAL REGIMES

1. Pulses are important in agricultural economy of our country and are also major source of protein in our diet. Being a short duration crop (70 days), summer green gram (*Vigna radiata* L. Wilczek) acts as a catch crop, therefore holds promise for increasing cropping intensity and improving soil productivity by fixing atmospheric nitrogen. Soil Plant Atmospheric Continuum (SPAC) is governed by various factors, broadly by meteorological parameters, besides being influenced by soil condition in which the plant is grown. Water use efficiency is one of the characteristics which can improve productivity when available moisture levels are low (Wright *et al*., 1994) Summer green gram sowing is generally getting delayed due to delayed harvest of wheat. High temperature (> 35° C) and reduced water availability during pre-monsoon summer period restricts the growth of summer green gram. During day time of summer season, relative humidity goes below 40 per cent and hot desiccating winds prevail (Kumar *et al*., 1992). The use of different types of mulches has been reported to lower evaporation losses and to reduce soil temperature fluctuation resulting

TABLE 1

Weekly meteorological data for Ludhiana during the crop growing season 1999 and 2000

Standard week	Mean air temperature (°C)		Mean relative humidity (%)		Cumulative rainfall (mm)		Mean sunshine hours (hrs/day)	
	1999	2000	1999	2000	1999	2000	1999	2000
14 (April)	25.7	23.7	50	51	0.0	0.0	10.8	12.0
15	28.4	26.7	44	47	0.0	0.0	10.3	10.4
16	28.0	30.1	31	42	0.0	0.8	11.6	8.7
17	30.5	29.6	31	39	0.0	0.6	12.1	10.5
18	33.2	30.4	31	36	0.0	23.8	9.4	10.0
19 (May)	31.2	30.9	36	53	0.8	0.0	9.1	7.2
20	32.5	34.0	45	42	0.0	0.0	11.2	8.5
21	30.0	34.6	60	47	17.9	0.0	7.6	5.4
22	30.8	33.6	34	45	0.4	51.6	10.5	9.8
23 (June)	31.3	28.4	48	63	5.4	40.6	11.2	9.7
24	32.4	32.7	58	57	11.6	0.0	10.6	8.6
25	30.9	31.6	68	66	4.4	1.6	9.0	8.4
26	32.4	31.8	66	69	0.0	89.0	7.8	2.2
27 (July)	31.7	32.0	70	71	67.4	0.0	9.5	10.3
28	30.7	29.9	76	81	144.1	51.4	9.2	5.1
29	29.2	28.4	84	87	110.0	29.0	5.9	3.3
30	29.8	29.6	80	82	9.1	10.2	6.7	3.6

TABLE 2

Dates of differential irrigations for first, second and third dates of sowing after a common irrigation at 25 DAS in 1999 and 2000

Treatment	Date of Irrigation					
	I		II		III	
$D_1 I_1 M_1$ $D_1 I_1 M_2$	25 May (43)*	22 May (40)*				
$D_1 I_2 M_1$ $D_1 I_2 M_2$	17 May (35)	18 May (36)	30 May (48)	28 May (47)		
$D_1 I_3 M_1$ $D_1 I_3 M_2$	14 May (32)	16 May (34)	25 May (43)	23 May (41)	1 June (50)	1 June (50)
$D_2 I_1 M_1$ $D_2 I_1 M_2$	31 May (42)	29 May (40)				
$D_2 I_2 M_1$ $D_2 I_2 M_2$	27 May (38)	29 May (34)	8 June (50)	2 June (44)		
$D_2 I_3 M_1$ $D_2 I_3 M_2$	21 May (32)	20 May (31)	30 May (41)	28 May (39)	10 June (52)	
$D_3 I_1 M_1$ $D_3 I_1 M_2$	10 June (36)	17 June (52)				
$D_3 I_2 M_1$ $D_3 I_2 M_2$	3 June (38)	30 June (34)	16 June (51)			
$D_3 I_3 M_1$ $D_3 I_3 M_2$	30 May (34)	27 May (31)	11 June (46)	18 June (53)	20 June (55)	

*Figures in parenthesis show the days after sowing.

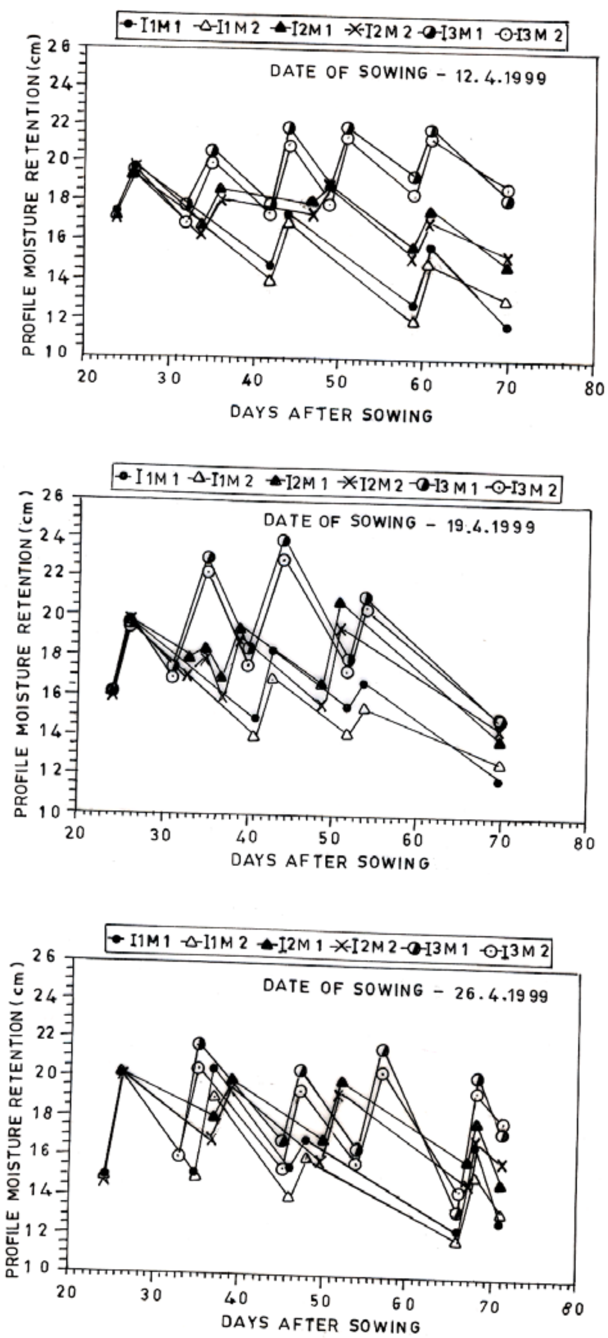

Fig. 1. Profile moisture retention (cm) in summer green gram during 1999 under different sowing dates

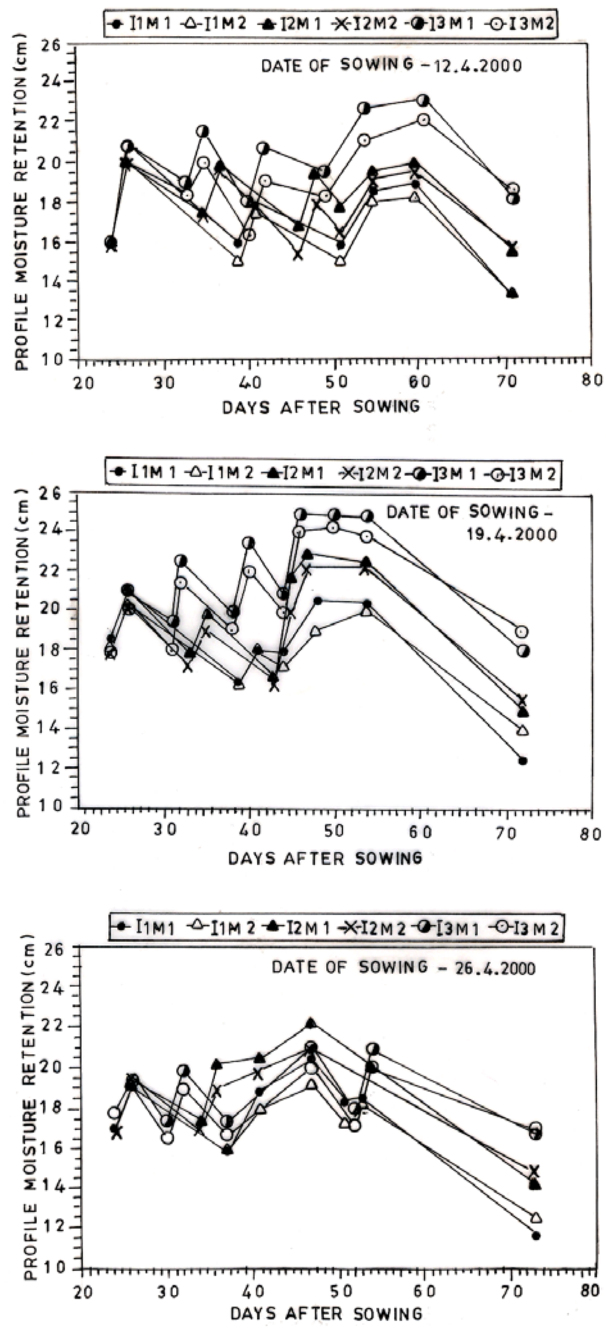

Fig. 2. Profile moisture retention (cm) in summer green gram during 2000 under different sowing dates

into favourable modification of soil hydrothermal regimes. Straw mulch offers a mean of modifying high temperature, conserving moisture and also increasing the crop productivity (Maurya and Lal 1981). Sowing dates and irrigation regimes depict varied performance and productivity of summer green gram due to changed environment plant interactions. Crop grown during April-June needs frequent irrigation due to higher evaporative demand and intense radiation. Keeping this in view the present investigation was planned, to see the effect of modified hydrothermal regimes on soil moisture retention and water use efficiency.

2. The present investigation was carried out at the Research Farm, Department of Agricultural Meteorology, Punjab Agricultural University, Ludhiana, during summer season 1999 and 2000. Ludhiana in located at 30° 54' N latitude and 75° 56' E longitude, at an altitude of 247 m above mean sea level. The area is characterized by semi arid subtropical climate with very hot summer and cold winters during April-June and December-January, respectively. During summer maximum temperature ranges between 40-45° C and occasionally goes up to 47° C while during winter, the minimum air temperature ranges between 5-8° C and occasionally goes as low as 0°C. This region in dominated by hot dry westerly winds during summer season. The weekly meteorological data of summer season 1999 and 2000 is presented in Table 1. The treatments included 3 dates of sowing, *viz*., 12th April (D_1), 19th April (D_2) and 26th April (D_3) (in main plots); 3 irrigation levels, *viz*., 0.5 IW: CPE ratio (I_1), 0.75 IW: CPE ratio (I_2) and 1.0 IW: CPE ratio (I_3) (in sub plots); and mulched (M_1) (@ 5t/ha wheat straw mulch) and unmulched crop (M_2) (in sub-sub plots), in a split-split plot design. All the recommended practices were followed as per the Package and Practices, Punjab Agricultural University, Ludhiana. Dates of differential irrigation are given in Table 2. Standard gravimetric method was used to estimate soil moisture and moisture was calculated on dry weight basis of 0-15, 15-30, 30-45, 45-60, 60-90 and 90-120 cm depths, periodically. Soil moisture retention is shown for each sowing date for different treatments in Figs. 1&2. Water use was calculates for each treatment for whole crop growing season and Water Use Efficiency (WUE) was calculated with the following formula:

$$\text{WUE} = \frac{\text{Grain yield (kg/ha)}}{\text{Water used (cm)}}$$

The total dry matter and seed yield was calculated on plot basis during both the years.

3. Soil moisture is one of the most important aspects of plant growth as it directly influences the nutrient uptake that is governed by root growth and its activity. The crop received 1, 2 and 3 irrigations after a common irrigation on 25 Days After sowing (DAS) except in case of D_2 and D_3 during 2000. During both the years the earlier sowing dates experienced reduced soil moisture due to reduced rainfall during reproductive phase of the crop (Figs. 1&2). The most frequently irrigated crop had higher soil moisture than that of least irrigated. Mulched crop root zone had to higher soil moisture retention than that of unmulched crop, but, at the harvesting stage, there was lower soil moisture in mulched crop due to excessive transpiration from crop having dense foliage than that of unmulched crop. These results are also supported with the findings of Ranjan (1986),

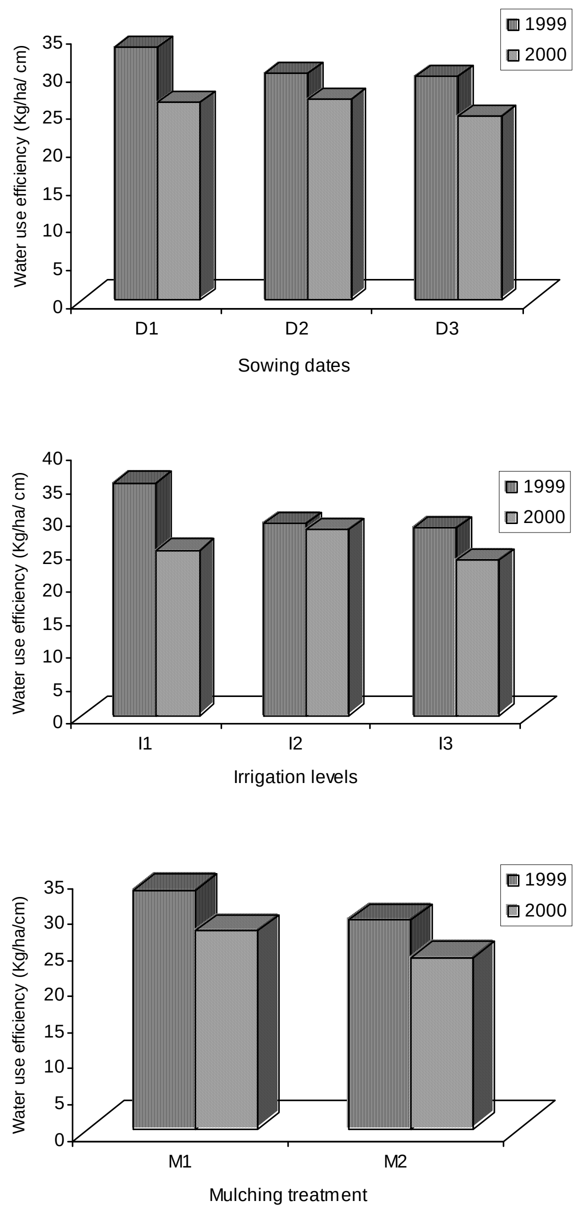

Fig. 3. Total water use efficiency (kg/ha/cm) in summer greengram under different treatments during 1999 and 2000

Khera *et al.* (1993), Gupta and Gupta (1984) and Sekhon *et al.* (1996) in green gram and Lal (1974) in maize.

4. Among sowing dates, water use efficiency in D_1, D_2 and D_3 was 33.41, 30.01 and 29.58 during 1999; and 26.11, 26.54 and 24.29 during 2000 respectively. Among irrigation levels the WUE in I_1, I_2 and I_3 was 35.39, 29.18 and 28.44 during 1999; and 25.11, 28.30 and 23.53, during 2000 respectively. Among mulching and non mulching treatments the WUE was 33.08 and 28.93;

during 1999; and 27.51 and 23.78 during 2000, respectively (Fig. 3). D_1 showed better WUE than D_2 followed by D_3 in both the years respectively. I_3 had the least WUE followed by I_2 and I_1 during 1999, but, during 2000 I_2 had higher WUE than that of I_1 and I_3, respectively. This might be due to frequent rainfall during senescence phase after scheduled irrigation in case of I_1. Yadav *et al.* (1992) under different irrigation levels reported a trend of high water use efficiency with decreased irrigation frequency in summer mungbean. Mulched crop (M_1) showed better WUE than that of unmulched (M_2) crop during both the years. Sandhu *et al.* (1992) and Yadav *et al.* (1992) also reported higher water use efficiency (39%) under mulching treatment (@6t/ha wheat straw mulch) than that of unmulched crop in summer mungbean. In 1999 the WUE was found higher than that of 2000, due to higher rainfall and reduced grain yield in 2000 than 1999.

References

Gupta, J. P. and Gupta, G. N., 1983, "Effect of grass mulching on growth and yield of legumes", *Agric Water Management*, **6**, 375-383.

Khera, K. L., Sandhu, B. S. and Sudheeranjan, M., 1993, "Radiation relationship in mungbean as affected by irrigation and straw mulching", *Tropical Ecology*, **34**, 88-92.

Kumar, K., Mavi, H. S., Khera, K. L., Singh, L., Jhorar, O. P. and Singh, L., 1992, "Effect of shelter belt, mulching and reflectant on field microclimate and yield of green gram (*V. radiata*) in South West Punjab", *Ann. Agric. Res.*, **13**, 355-359.

Lal, R., 1974, "Soil temperature, soil moisture and maize yield from mulched and unmulched tropical soils", *Plant and Soils*, **40**, 129-143.

Maurya, P. R. and Lal, R., 1981, "Effect of different mulching materials on soil properties and the root growth and yield of maize and cowpea", *Field Crop Res.*, **4**, 33-45.

Ranjan, S., 1986, "Growth response of summer mung to soil temperature and soil water as influenced by irrigation and mulching", M.Sc. Thesis, Punjab Agricultural University, Ludhiana, India.

Sandhu, B. S., Khera, K. L. and Ranjan, M. S., 1992, "Response of summer green gram to irrigation and straw mulching on a loamy sand soil in Northern India", *J. Indian Soc. Soil Sci.*, **40**, 240-245.

Sekhon, N. K., Thind, S. S., Sidhu, A. S. and Aggarwal, G. C., 1996, "Water status of green manure crops as affected by moisture stress at different growth stages" *Ann. Agric. Res.*, **17**, 152-157.

Wright, G. C., Nageswararao, R. C. and Farquhar, G. D., 1994, "Water use efficiency and carbon isotope discrimination in peanut water deficient condition", *Crop Sci.*, **34**, 92-97.

Yadav, R. N., Singh, S., Kumar, A. and Singh, S., 1992, "Soil water depletion, consumptive use of water and water use efficiency of mungbean as influenced by soil moisture regimes and mulch application", *Ann. Agric. Res.*, **13**, 77-79.

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