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RESPONSE OF BERSEEM TO WATER STRESS AND ENVIRONMENT IN NORTHERN PUNJAB

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Berseem variety synthetic -3 was sown under water depletion levels of 50 (M_1), 65 (M_2), 80 (M_3) and 95 % (M_4) depletion of available moisture for two years in Northern Punjab and Actual Evapotranspiration, (EtA, Potential Evapotranspiration (EtP) and Pan Evaporation were calculated. Consumptive use of water during the season was 774, 686, 642 and 594 mm as calculated by gravimetric method and 762, 694, 642 and 615 mm with irrigation method under 50, 65, 80 and 95 % depletion of available moisture. Growing season crop coefficients were 1.00, 0.89, 0.83 and 0.74 (KC_1) and 1.14, 1.02, 0.94 and 0.85 (KC_2), respectively. Green fodder yield decreased significantly with increase in moisture depletion level. Crop water use deficiency for M_1 & M_2 was statistically non-significant whereas crop water use efficiency (CWUE) under M_4 was significantly less as compared to M_1 and M_2.

INTRODUCTION

Crop production is closely related to climatic conditions of the area. Environmental factors like, temperature, rainfall, solar radiation and transpiration are attaining prime importance in this regard as they are used as parameters for computation of water requirements of different crops.

Extensive research is in progress for correct estimation of water requirements all over the world. Many workers have worked out water requirements of berseem by different methods. Kumar and Rai (1979) proved through experimentation that irrigation after seven days was better as compared to 10 and 15 days interval for optimum fodder yield. Consumptive use of water increased with an increase in irrigation frequency but water use efficiency showed decreasing trend with increased availability of soil moisture.

Computation of water requirements by using environmental data is more important and is on scientific lines. By using Pan evaporation as a basis for irrigation scheduling, Shukla et al. (1980) found direct correlation between Pan evaporation and water requirements. They measured Pan evaporation during growth period as 3.5 to 16 mm /day^{-1}. Evapotranspiration is an other important parameter used for water requirements calculation, and is more closely related to actual water use by crop. Diagger et al., (1970) estimated 540, 630 and 860 mm evapotranspiration from three cuttings. They also observed that alfalfa used 11.4 cm of water for one ton of fodder. Average water use was calculated as 4.1, 5.6 and 5.9 mm for lst, 2nd and 3rd cutting. Yield was increased due to increased water application.

Lugg et al., (1986) found that dry forage yields were linearly related with evapotranspiration. Total irrigation applied was 210 to 774 mm and difference regarding water use efficiency was non-significant among cultivars.

Since actual consumptive use data are not available for berseem in different agro-ecological zones of the country, this study was done at Mona Reclamation Experimental Project (WAPDA), Bhalwal, as a part of coordinated programme of PARC, during 1982-83 and 1983-84.

MATERIALS AND METHODS

Berseem variety synthetic - 3 was sown in plots measuring 13.7 x 12.2 meter (1/59 of hectare) and complete factorial design was followed with three replications. Two fertilizer rates i.e. F_1 = 25-50-30 and F_2 = 50-100-30 NPK kg ha^{-1} were applied.

Urea, single super phosphate and potassium sulphate were used as N, P and K sources. Irrigations were applied at 50, 65, 80 and 95 % depletion of available moisture in 30 cm soil depth.

Time required to obtain the desired depth of irrigation for each plot was calculated as:

$$t = \frac{d \times a}{q}$$

Where t is time required to irrigate, d is depth of irrigation to be applied, a is area and q is discharge. First soil sampling for estimation of moisture in soil was done at the time of sowing. Subsequent samplings were carried out just before and after irrigation. Moisture samples were also taken after each rain exceeding 13 mm. Final soil sampling was done at the time of crop harvest, samples were taken from 0-15, 15-30, 30-60, 60-90, 90-120 and 120-150 cm depth respectively. Soil samples were dried in oven for 24 hours at 105°C for moisture %age calculation on dry weight basis. Consumptive use of water was worked out by gravimetric and irrigation methods. Green fodder yield was recorded by earmarking 1 sq. meter in the centre of plot. (Total yield is based on four cuttings at full vegetative growth stage during the season).

RESULTS AND DISCUSSION

Actual consumptive use of water by gravimetric method was 774, 686, 642 and 594 mm when irrigations were applied at 50, 65, 80 and 95 % depletion of available moisture respectively in 30 cm soil depth. With increase in depletion level 88, 132 and 180 mm of water was saved during growing season. Consumptive use by irrigation method for 50, 65, 80 and 95 % depletion levels was 762, 694, 642 and 615 mm, respectively. Consumptive use decreased by 68, 120 and 147 mm when depletion level was raised from 50 to 65, 80 and 95 % level respectively (Table 1)

Fodder yield (Table 2) under F2 was significantly more than that of F1 regardless of moisture depletion level. Maximum fodder yield of 108 tons ha^{-1} was observed under 50% depletion

Table 1. *Consumptive use of water for berseem (mm).*

Moisture level; % depletion of available moisture.		Irrigation method			Gravimetric method		
		1982-83	1983-84	Average	1982-83	1983-84	Average
		mm					
M_1	(50%)	700.4	824.4	762.3	725.1	8.228	774.0
M_2	(65%)	689.8	697.2	693.5	685.7	686.9	686.5
M_3	(80%)	647.4	635.8	641.6	648.3	634.8	641.6
M_4	(95%)	630.0	599.0	614.5	588.5	598.6	593.6
Effective Rainfall (mm)		306.4	100.2	203.3			

Table 2. *Fodder yield of berseem tons* (ha^{-1}).

Moisture level	1982-83		1983-84		Average		Moisture
	F_1	F_2	F_1	F_2	F_1	F_2	
M_1	103.4	116.9	100.6	111.2	102.0	114.1	108.2a
M_2	96.3	110.9	82.5	91.1	89.4	101.0	95.2b
M_3	91.0	94.4	74.1	84.0	82.6	88.5	85.6c
M_4	82.8	83.8	70.5	76.7	76.6	80.2	78.4d

F_1 = 87.66b,

F_2 = 95.95a

Table 3. *Crop water use efficiency for berseem kg ha^{-1} mm^{-1} (CWUE)*

Moisture level	1982-83		1983-84		Average		Moisture
	F_1	F_2	F_1	F_2	F_1	F_2	
M_1	122.3	135.2	152.5	161.7	137.4	148.4	142.94ab
M_2	120.0	132.6	140.5	161.7	130.2	147.2	138.94a
M_3	116.6	132.4	140.4	145.7	128.5	139.0	133.76ab
M_4	115.6	128.1	140.6	142.4	128.1	135.2	131.68b

F_1 = 25-50-30 NPK kg ha^{-1},

F_2 = 50-100-30 NPK kg ha^{-1}

Table 4. *Actual evapotranspiration (EtA), Potential evaporation (EtP), pan evaporation and crop coefficients KC_1 and KC_2 for berseem (mm)*

Moisture EtP and Pan	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	KC_1*	KC_2**
M_1 (50%)	4.76	3.32	3.14	2.85	3.30	4.48	4.64	4.55	1.00	1.14
M_2 (65%)	4.39	3.47	2.85	2.60	2.67	3.07	4.26	3.95	0.89	1.02
M_3 (80%)	4.00	3.29	2.69	2.39	2.47	3.55	4.10	3.85	0.83	0.94
M_4 (95%)	3.83	3.14	2.52	2.02	2.33	2.82	3.15	3.20	0.74	0.35
EtP	4.47	3.55	2.62	2.91	2.77	4.41	6.28	6.20		
Pan Evaporation	4.41	2.81	2.10	2.30q	2.47	3.90	5.86	7.41		

KC_1 = EtA/EtP

KC_2 = EtA/Pan Evaporation

level followed by 95, 86 and 78 tons ha^{-1} for 65, 80 and 95 % depletion of available moisture respectively. Yield decreased significantly with increase in moisture stress. Diagger et al., (1970) and Matulka et al.,(1983) observed similar results.

Crop water use efficiency (CWUE) is a parameter of prime importance as regards water use by any crop. CWUE of 142.9, 138.2, 133.8 and 131.7 kg ha^{-1} mm^{-1} was observed for M1, M2, M3 and M4, respectively. There was no significant difference among moisture treatments upto 80 % depletion level but at 95 % depletion level CWUE decreased significantly. The results are not in line with those of Kumar and Rai (1979), they reported that water use efficiency decreased with more availability of water to crop, but climatic conditions were totally different from those under which this research work was done.

Data regarding daily EtA, EtP and Pan evaporation are presented in Table 4 EtA day^{-1} values recorded at initial stages in October, were 4.76, 4.39, 4.00 and 3.83 mm for 50, 65, 80 and 95 % depletion of available moisture respectively. EtA followed declining trend with minimum values of 2.85, 2.60, 2.39 and 2.2 mm day^{-1}. Actual evapotranspiration increased with gradual increase in temperature after February upto April, when crop was at its maximum growth stage. A slight decrease was observed in May at the time of harvest. EtP and Pan evaporation values also followed almost the same trend with 4.47 and 4.41 mm day^{-1} at initial stage and 6.2 and 7.4 mm day^{-1} at the time of crop harvest. Crop co-efficients were found as 1.00, 0.89, 0.83 and 0.74, respectively for KC_1 and 1.14, 1.02, 0.94 and 0.85 for KC_2. Relationship of EtP with EtA as KC_1 was found to be more close as compared to Pan evaporation. On the other hand Diagger et al., (1970) reported that Pan evaporation is more closely related to EtA.

For optimum fodder production, moisture depletion upto 65 % of available moisture was found to be desireable and EtP is recommended as a parameter for irrigation scheduling for berseem in Northern zone of Punjab.

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