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Consumptive Water Use Efficiency in Relation to Common Crops and Varieties Raised in Dryland Black Soils

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The figures for per day mean consumptive use of water for twelve varieties under the three crops, cotton, bajra and sorghum lay within a narrow range and did not vary appreciably among varieties or crops. The near constancy of the figures is striking in view of the high variability in the duration and yield of the varieties studied and enables one rapidly to calculate the consumptive use of water by simply multiplying the constant figure obtained above by the duration of the individual crop variety.

Consumptive water use efficiency is a function of yield and total consumptive use of water. Research on water requirement of crops has proved that in a lorge number of cases maximum yield can be obtained with rates of actual evapotranspiration (consumptive use of water) that are far lower than potential evapotranspiration. In other words maximum yields are possible even when the level of soil moisture is not continuously maintained at, or some what below field capacity. Obviously less consumptive use of water and / or higher grain yield act favourably in increasing consumptive use efficiency.

Atar Singh and Bains (1971) have reported that application of 120 kg N par hectare increased the water use efficiency by 30per cent in sorghum. High level of population, viz. 2,72,000 plants per hectare also recorded the maximum water use efficiency. Hunsigi and Virakthmath (1972) concluded that the agronomic manipulations like strip ploughing and furrow sowing not only conserved soil moisture but increased seed cotton yieid, thus, leading to good water use efficiency. Griffin *et al.* (1966) reported that maximum consumptive use, and maximum water use efficiency were obtained by maintaining the soil profile above 50 per cent available moisture in sorghum hybrid. In this paper results of an experiment conducted at All India Coordinated Dryland Agricultural Research Project, Kovilpatti to study the efficiency of different crops/varieties in utilising water are presented.

MATERIAL AND METHODS

The standard experiment 'efficiency of different crops in utilising rainfall and stored water', was laid out in the black soil area of Regional Agricultural Research Station, Kovilpatti, is a split plot design, replicated six times, with three crops (cotton, bajra and sorghum) as the main plots. and four varieties under each crop as sub plots (cotton : MCU.6, Krishna, GS. 23 and K 7; bajra : HB. 1, HB. 3, HB. 4 and K 1; sorghum : ms 2219 x IS 3541, CSH. 1, CSH. 3 and K. 31.

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a) Study of soil moisture : Soil samples were drawn from each plots at three different depths viz. 0-15 cm, 15-30 cm and 30 - 60 cm at the time of sowing and thereafter once in seven days till harvest. If there were rains, the sampling pattern was :

i) One sampling immediately after the rains or within twelve hours after the rains,

ii) next sampling on the fourth of the rains, and

iii) subsequent samplings reverted back to usual course ie. once in seven days.

Soil samples were examined for moisture content by gravimetric method and the percentages of moisture on oven dry basis were used for calculation of consumptive use of water.

b) Calculation of Consumptive Use efficiency (CUE) : Consumptive use efficiency was worked out from the moisture data. The rates of depletion of moisture content at each depth for each individual non-rainy spell during the entire crop growth period were summed up for each treatment, and the mean was struck. This mean was multiplied by the crop duration to get the total moisture depletion at each depth for each treatment. Then the total moisture depletion was multiplied by the bulk density and the depth of soil for each depth. The total depletion for the entire depth (consumptive use) was obtained by adding together the individual depletions for 0-15 cm, 15-30 cm and 30-60 cm. From the consumptive use and hectare yield, consumptive use efficiency (CUE) was worked out as indicated below :

$$\text{C.U.C (Kg/ha/mm)} = \frac{\text{Yield in kg/ha}}{\text{Soil moisture depletion in m.m.}}$$

RESULTS AND DISCUSSION

From Table I it could be seen that among the varieties GS. 23 Cotton, K1 Bajra and ms. 2219 x IS. 3541 Sorghum recorded the highest efficiency followed by MCU.6, HB.4 and CSH.1 respectively, It was also observed that the consumptive use efficiency ranking was almost the same as for yield. It was also interesting to observe that within each crop the figures for total moisture depletion (consumptive use) were roughly the same, thus, accounting for the

TABLE I. Consumptive use efficiency for different crops and varieties

Crops/ Varieties	Total moisture depletion in mm.	Yield in kg/ga	Consumptive use efficiency kg/ha/mm.
COTTON			
MCU. 6	894	380	0.4250
G.S. 23	1213	674	0.5556
Krishna	1140	345	0.3026
K. 7	1254	210	0.1674
BAJRA			
HB. 1	655	460	0.7022
HB. 3	468	502	1.0726
HB. 4	571	728	1.2749
K. 1	434	759	1.7488
SORGHUM			
ms. 2219 x IS. 3541	427	2986	6.9882
CSH. 1	499	2739	5.4889
CSH. 3	614	2945	4.7969
K. 3	534	2238	4.1910

TABLE. II. Per day consumptive use of water by different crops and varieties

Crops and varieties	Duration in days	Total moisture depletion in mm.	Per day depletion in mm	Remarks
COTTON				
MCU. 6	165	894	5.42	Mean : 6.76 mm/day
G.S. 23	165	1213	7.35	S.D. 0.90
Krishna	160	1140	7.12	C.V. 13.31%
K. 7	175	1254	7.16	
BAJRA				
HB. 1	85	655	7.70	Mean : 6.44 mm/day
HB. 3	75	468	6.24	S.D. 1.233
HB. 4	85	571	6.72	C.V. 19.14%
K. 1	85	434	5.10	
SORGHUM				
ms. 2219 x IS. 3541 (KPT. TALL)	101	427	4.22	Mean : 5.08 mm/day
CSH. 1	103	499	4.84	S.D. 0.90
CSH. 3	100	614	6.14	
K. 3	104	534	5.13	C.V. 17.71%
Mean for 12 varieties under 3 crops : 6.09 mm/day				
S.D. 1.145				
C.V. 18.80%				

observation that consumptive use efficiency followed almost the same ranking as yield. It was also observed that for cotton (long duration crop) the figures was high, and for short duration crops like bajra and sorghum the figures were low. To see if the consumptive use was dependent upon duration, consumptive use per day was calculated for all crops and varieties and the figures presented in Table II.

It was interesting to note in Table II that among *Cotton* varieties the per day consumptive use of water for GS. 23, Krishna and K. 7 was almost identical (7.35mm, 7.12mm, and 7.16mm respectively), MCU. 6 recording a slightly lower figure (5.42 mm). The mean per day consumptive use efficiency of water for the four of cotton taken together was 6.76 mm and coefficient of variation (C.V.) was of the low order of 13.31 per cent. Thus, the per day consumptive use of water for the four varieties of cotton was very similar, varying slightly only in the case of MCU. 6. Surprisingly the longer duration Karunganni variety K. 7 recorded a value which was almost the same as for the shorter duration combodia varieties GS. 23 and Krishna

Among *bajra* varieties also per day consumptive use of water, was roughly the same, the hybrids tending to record slightly higher values than the variety K. 1. Coefficient of variation, however, was of the low order 19.14 per cent. Surprisingly the mean value for

bajra (6.44mm/day)was almost identical with that for cotton (6.76 mm per day) in spite of the fact that these two crops are entirely unrelated (monocot *vs.* dicot) and differ very considerably in duration (75 to 85 days *vs.* 160 to 175 days).

In *sorghum* varieties the per day consumptive use of water for the entries ms 2219 x IS. 3541, CSH.1 and K.3 was comparable, the value for CSH. 3 being slightly higher. The per day mean consumptive use water for the sorghum varieties was 5.08 mm/day. The coefficient of variation was 17.41 per cent some what lower than bajra.

Among the twelve varieties under three crops the per day consumptive use of water for cotton GS.23, Krishna, K. 7 and bajra HB. 1 was closely similar (7.35 mm, 7.21 mm, 7.16 mm and 7.70 mm) respectively. Similarly figures for the bajra varieties HB. 3, HB. 4 and sorghum variety CSH. 3 were similar (6.24 mm, 6.72 mm and 6.14 mm) respectively. The corresponding values for MCU. 6 cotton, K. 1 bajra, and K. 3 and CSH. 1 sorghum were 5.42 mm, 5.10 mm, 5.13 mm and 4.84 mm respectively indicating similarity. The lowest value (4.22 mm) was recorded by Kovilpatti Tall sorghum.

Mean consumptive use of water for the twelve varieties under three crops was 6.09 mm per day, similar to the ones for cotton and bajra. The coefficient of variation was 18.8 per cent indicating that the values for the 12 varieties under 3 crops, did not vary appreciably among themselves.

From the above results it follows that the per day mean consumptive use of water for the twelve varieties under the three crops lay within a narrow range and did not vary appreciably among the varieties and crops. This finding greatly simplifies the study of consumptive use of water by various crops and varieties, as the per day consumptive use is nearly constant, and the total consumptive use is dependent mainly on duration. The near constancy of the per day consumptive use of water was a striking future in view of the fact that the corresponding yield figures were highly variable. It is easy to calculate the approximate consumptive use of water rapidly for any variety of the three crops by simply multiplying this constant factor by the individual duration of the given crop variety. Similarly it is also possible to work out the consumptive use efficiency for various crop varieties by dividing the corresponding yield by consumptive use of water calculated by the method indicated above.

By adopting the above simple and rapid method, work of repeated soil moisture estimations by gravimetric method over a long period of time can be avoided, thus, effecting considerable savings. It is also possible, from a rapid calculation of consumptive use efficiency by the above method to take a realistic decision regarding the choice of crops/varieties for a given pattern of soil moisture availability brought about by a known rainfall distribution pattern, and avoid crop failure due to moisture stress.

It would be interesting to determine if the near constancy of per day consumptive use of water would hold good for other crops and other varieties also.

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