Journal of Agrometeorology 6 (2) : 234 - 237 (Dec 2004)

Water balance components and effect of soil moisture on yield of wheat in mid Himalayan region of Uttaranchal*

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ABSTRACT

Weekly water balance using Thornthwaite's book keeping procedure were calculated for Hill Campus, Ranichauri. Water balance study revealed that water surplus was observed during monsoon season and water deficit was restricted to October, November and April to June. Though the moisture adequacy index indicates that the region has sufficient moisture through out the year, the region suffers from moisture stress during *rabi* season due to slope and high seepage losses. Among the treatments tried, sowing at 10% moisture followed by sowing at 20% moisture produced significantly superior yields than the zero tillage and broadcasting seed at the time of harvest and later ploughing.

Key words: Water balance, soil moisture, wheat

The Himalayan region is traversed by several mountain ranges and has altogether different agroclimatic conditions and socio-economic problems. Major crops of the region are wheat, rice, barley, small millets, potato, rice bean, horse gram, soya bean, french bean and lentil. Fruits and vegetables also occupy substantial area in the zone. The mid Himalayan region recorded an average annual rainfall of 1257.7 mm distributed over 75 rainy days and experiences nil or low rainfall during October and November months. Water stress conditions during April, May and partially in June (Murty and Singh, 1998). About 65% of the area is covered under forests and only 14% of the total geographical area is available for agriculture in this region, out of which very limited portion of land is irrigated which is restricted to valleys only and rest is under rainfed and depends on rainfall. Hence, rainfall is a precious resource in this region.

Average weekly water balance components were evaluated from 1985-2000 to get an idea about the water surplus and deficit weeks during the year and their effects on germination and yield of wheat in the mid Himalayan region.

MATERIALS AND METHODS

An experiment with wheat (Cv .HS 240) was conducted at G.B.Pant University

*Paper presented in the National Seminar on "Agrometeorological Research for Sustainable Agricultural Production", held at G.A.U., Anand during 27-28 September 2001.

of Agriculture and Technology, Hill Campus, Ranichauri, Tehri Garhwal (30°15' N latitude, 78°30' longitude and 1900 msl altitude) on silty clay soils. The effect of soil moisture on yield of wheat was studied with eight treatments (Table 1) and three replications in a randomised block design during *rabi* seasons of 1996-99. The dates of sowing were 22.11.96, 7.11.97 and 10.12.98 and dates of harvest were 26.5.97, 20.5.98 and 17.5.99 respectively. The plot size was 3x2 m and fertilizer applied was 60 Kg N and 40 Kg P_2O_5 per hectare as a basal dose. Recommended package of practices were followed. Soil moisture observations were taken at regular intervals through out the crop growing season. The climatic water balance was calculated using the meteorological data collected at Hill Campus, Ranichauri by Thornthwaite's (1955) book keeping procedure for the years 1985 to 2000. The potential evapotranspiration (PET) is calculated using Penman's formula.

RESULTS AND DISCUSSION

The weekly climatic water balance for Hill Campus, Ranichauri was calculated for an average period of 1985 to 2000 (Fig.1). The maximum water holding capacity was taken as 250 mm depending on the soils, plantation types etc. The water need is 997.5 mm while the estimated actual evapotranspiration (AET) is 939.5 mm thereby indicating water deficit of 58 mm which is mainly restricted from 41 to 49 and 14 to 21 standard meteorological weeks (SMW). The highest deficit of 10.3 mm was observed during 22nd week. Water surplus of 304.3 mm occurs during heavy rainfall period i.e., from 29 to 37 SMW. The moisture adequacy index indicates that the region can support good and varied

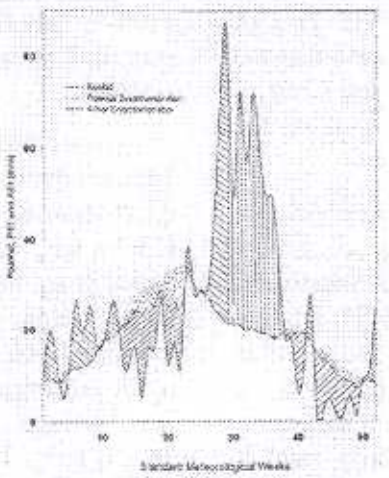

Fig. 1 : Average weekly water balance (1985 - 2000)

Table 1 : Effect of soil moisture status and method of sowing on grain yield (q ha^{-1}) of wheat

Treatments	1996-97	1997-98	1998-99	Pooled
Ploughing immediately after harvesting and sowing	20.61	21.12	3.21	14.98
Broadcasting of seed at the time of harvest and later ploughing	14.93	18.12	2.17	11.74
One week after harvest, ploughing and sowing	19.72	15.84	5.14	13.56
Sowing at 10% moisture	23.16	22.78	8.58	18.17
Sowing at 15% moisture	16.81	17.86	5.95	13.54
Sowing at 20% moisture	23.16	20.00	3.18	15.45
Sowing at 25% moisture	23.73	15.45	7.14	15.44
Zero Tillage	10.37	28.62	2.70	13.90
CD (5%) TreatmentsCD (5%) Seasons X Treatments	4.47	NS	3.79	2.795* 3.953

* pooled analysis for two years (1996-97 and 1998-99).

agricultural crops throughout the year as reported by Subramaniam (1983). Though the water balance studies indicate that the region has sufficient moisture, still it suffers from moisture stress during *rabi* season due to slope and high seepage losses.

Rabi seasons of 1996-97, 97-98 and 98-99 were considered as normal, excess and deficit rainfall seasons respectively. During the *rabi* season of 1996-97, a deficit of 61.7 mm was observed from water balance. It was 177.7 mm during 1998-99 as against average of 43.4 mm indicating severe moisture stress. Similarly, rainfall of 654.4 mm was recorded during 1997-98 as against average rainfall of 377.5 mm. Compared to these, during *rabi* season of 1998-99 only 173.1 mm was recorded which was 61.7% less than the average seasonal rainfall.

Among the treatments tried sowing at 10% soil moisture gave highest yield of 18.2 q ha^{-1} followed by sowing at 20% moisture (15.5 q ha^{-1}, Table 1). During 1998-99, a deficit year , the yields for treatments, with better yields, sowing at 10% and 25% moisture levels were significantly superior to all other treatments. During 1997-98, zero tillage gave the highest yield 28.6 q ha^{-1}. During 1996-97 the results obtained were similar to those of 1998-99. For pooled analysis the year 1997-98 was

excluded due to heterogeneity of error variance and the data of remaining two years were analysed for its significance. From pooled analysis, sowing at 10% moisture followed by 20% moisture produced significantly superior yields than the zero tillage though sowing at 25% moisture gave better yields in individual year. Also the interaction between seasons and treatments was found to be significant. Similarly, Verma *et al* (1999) found that wheat yield significantly increased over the control in all the three years with increase in moisture conditions. Chaudhary (1985) reported that even a small quantity of water applied proved to be highly productive when crop productivity was limited by poor stand establishment due to dry seed bed moisture.

The water balance studies indicate that the region suffers from moisture stress during October and November months and sowing at 10% and 20% moisture may ensure the establishment of crop stand. Due to prevailing low temperature, the crops remain dormant and growth starts from first week of March. Therefore, it can be concluded that during dry years or the years during which the rainfall is less than the normal, sowing at 10% moisture followed by 20% moisture produced significantly superior yields than zero tillage.

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