creation of more variability and breaking undesirable linkages, and then purelines can be developed by pedigree method.

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YIELD, WATER USE AND NUTRIENTS UPTAKE OF WHEAT AS INFLUENCED BY SOWING TIME, IRRIGATION AND NITROGEN LEVELS.

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ABSTRACT

A field experiment was conducted at the Research Farm of Indian Institute of Technology, Kharagpur, India to evaluate the effects of nitrogen and irrigation levels under different sowing times on wheat during winter seasons (November-March) of 1978-79 and 1979-80. The grain yield was highest when sowing was done during the second fortnight of November. Delaying the sowing beyond 30th November resulted in decreased yields. Early sowing also produced significantly less yield as compared to normal sowing time. Grain yield increased significantly upto 100 kg N/ha. Irrigations scheduled at 0.8 IW/CPE ratio recorded the highest grain yield. Nitrogen uptake was maximum when sown at normal time. Water-use efficiency (WUE) decreased with increase in IW/CPE ratio from 0.8 to 1.0. Nonetheless, relatively more moisture was extracted from the upper layer at 1.0 IW/CPE ratio as compared to 0.6 and 0.8 ratios. However, soil moisture extraction from deeper layer was comparatively more under 0.6 IW/CPE than under 0.8 and 1.0. Application of nitrogen favoured the extraction of soil moisture from deeper layer.

KEY WORDS: Winter wheat, Sowing time, Nitrogen uptake, water use Efficiency, Grain yield.

Optimum time of sowing, one of the most important factors in influencing the crop yield, primarily depends on the residual moisture retained after the harvest of the preceding crop, the temperature at the time of sowing and suitability of climatic condition during growth. The main objective of irrigation is to minimize yield reduction due to water deficit. However, irrigation water is a limited resource and therefore, irrigation practices must be rationalized for higher water-use efficiency. It appears that frequent irrigations after pre-

Table 1. Maximum and minimum temperature, relative humidity, evaporation and rainfall.

Months	Temperature (°C)		Relative humidity (%)		Evaporation	Rainfall
	Max.	Min.	Max.	Min.	(mm)	(mm)
NOV 1978	30.2	18.6	92	28	99.6	
1979	32.6	17.8	91	30	102.2	-
DEC 1978	26.3	13.8	86	38	85.0	-
1979	28.0	12.6	88	35	89.4	-
JAN 1979	27.4	10.9	97	32	80.4	15
1980	27.0	10.6	95	35	83.6	15
FEB 1979	30.8	14.7	89	38	109.4	10
1980	31.2	13.6	86	37	113.3	-
MAR 1979	35.3	21.5	81	20	129.1	-
1980	36.8	24.2	79	18	137.3	-

Table 3. Water use and water-use efficiency of wheat as influenced by irrigation schedule and sowing time

Irrigation (IW/CPE)	Date of sowing	Irrigation water including presowing	Profile water contribution	Total water use*	Water-use efficiency
		cm	cm	cm	kg/ha-cm
1978 - 79					
0.6	20 NOV	22	6.12	30.62	67.72
	30 NOV	22	5.68	30.18	64.36
	10 DEC	22	5.53	30.03	44.40
0.8	20 NOV	34	2.93	39.43	78.49
	30 NOV	34	2.77	39.27	71.30
	10 DEC	34	2.78	38.95	48.94
1.0	20 NOV	40	1.87	44.37	69.15
	30 NOV	40	1.83	44.33	63.12
	10 DEC	40	1.70	44.20	47.06
1979 - 80					
0.6	5 NOV	22	6.33	29.93	46.25
	20 NOV	22	7.77	31.27	70.82
	5 DEC	22	7.05	30.55	51.70
0.8	5 NOV	34	3.23	38.73	47.80
	20 NOV	34	3.10	38.60	88.70
	5 DEC	34	3.06	38.55	54.84
1.0	5 NOV	40	2.12	43.62	41.86
	20 NOV	40	2.12	43.33	79.02
	5 DEC	40	1.90	43.40	53.12

* The effective rainfall was 2.5 and 1.5 cm in the year 1978-79 and 1979-80 respectively.

sowing irrigation increases water expense (Prihar *et al.*, 1978) without proportionally increasing yield and therefore, decrease the water-use efficiency. On the other hand, fewer irrigations may not fully meet the water requirements of the crop and may cause reduction in yield. Smaller the amount of post sowing irrigation, the greater was the profile water depletion. Recently the climatological approach had come out to be the most reliable method for scheduling irrigation. Prihar *et al.*(1976) suggested the use of IW/PAN-E ratio as a criterion for scheduling of irrigation, where IW denotes a fixed irrigation and PAN-E is the cumulative open pan evaporation since previous irrigation.

Wheat is one of the most important crops which has shown response of a very high order to chemical fertilizers. Indian soils have generally been found to be low in nitrogen. The suitable sowing time along with judicious water and fertilizer management can ensure higher production. However, precise information is not available on these aspects. Hence, the present investigation was undertaken to study the integrated effect of nitrogen and irrigation levels under varying sowing times on grain yield, moisture extraction pattern and water-use efficiency.

MATERIALS AND METHODS

The experiment was conducted during the winter seasons (November-March) of 1978-79 and 1979-80 on sandy clay loam soil with a pH of 7.3. The field capacity, wilting point and bulk density of the soil were 19.24% and 1.45 g/cc respectively. The soil had total nitrogen, phosphorus and potassium of 0.04%, 0.054% and 0.07% respectively. The treatments consisted of three sowing dates viz. 20th November, 30th November and 10th December in 1978-79 and 5th December in 1979-80, three irrigation schedules viz. 0.6, 0.8 and 1.0 IW /CPE ratios and three levels of nitrogen viz. 50,100 and 150 kg N/ha. The experimeent was laid out in 3 x 3 confounded design with single replication where second order interaction was confounded. Half of the nitrogen as urea applied at sowing and the remaining half at first irrigation (at the time of crown root initiation). A basal dose of 50 kg P2O5/ha as superphosphate and 40 kg K2O/ha as muriate of potash was also applied. Scheduling of irrigation was done on the basis of IW/CPE ratio. Irrigation treatments were imposed after a common irrigation (23-25 days after sowing)at critical root initiation. The total number of irrigations including presowing were seven, six and four under 1.0, 0.8 and 0.6 IW /CPE ratios respectively. A measured quantity of water(6 cm) in each irrigation was added to all the treatments. Rainfall received during the two crop seasons was 2.5 and 1.5 cm in two and one rainy days respectively. Gravimetric method was used for soil moisture estimation. The total water use was computed by summing up water from irrigation, effective rainfall and contribution from soil profiles during entire cropping season. Water use efficiency (WUE) i.e. the ratio of grain yield to total water use of the crop was determined. The grain and straw yields of different treatments were recorded at maturity. Composite samples of grain and straw were analysed for N, P and K by the method described by Jackson (1967) to compute N, P and K uptake. The tempera-

Table 2. Yield, yield attributes, water use and water-use efficiency of wheat as influenced by sowing time, irrigation schedule as nitrogen level.

	Ear heads/m		Grains/ear		Test weight, g		Grain yield, kg/ha		Water use, cm		WUE (kg/ha-cm)	
Treatments	78-79	79-80	78-79	79-80	78-79	79-80	79-79	79-80	78-79	79-80	78-79	79-80
Sowing date												
D_1	60.35	40.83	33.15	24.97	41.92	40.56	2764	1678	37.13	38.78	74.44	43.27
D_2	54.58	73.59	33.19	32.54	41.62	42.69	2522	3033	36.92	39.23	68.31	77.31
D_3	44.37	51.86	26.72	28.29	39.08	40.44	1779	2019	36.90	39.00	48.21	51.69
Irrigation (IW/CPE)												
0.6 (I_1)	42.87	46.29	27.87	26.59	40.66	41.12	1793	1734	29.27	31.84	61.26	54.29
0.8 (I_2)	56.24	58.54	31.92	29.93	41.52	41.72	2608	2471	38.22	40.13	68.24	61.57
1.0 (I_3)	60.13	61.27	31.42	29.28	40.43	40.85	2664	2526	43.32	44.95	61.50	56.20
Nitrogen (kg/ha)												
50 (N_1)	44.29	45.82	27.09	24.30	39.02	39.97	1712	1608	35.01	37.97	48.90	42.41
100 (N_2)	55.88	57.38	31.52	30.74	41.94	42.15	2613	2522	36.11	39.41	72.36	64.00
150 (N_3)	59.06	62.98	33.04	30.78	41.65	41.57	2740	2600	36.68	39.64	74.90	65.59
C.D. at 5%	5.56	5.15	1.92	2.12	1.08	0.69	316	342	-	-	-	-

D_1, D_2 and D_3 in 1978-79 were Nov.20, Nov.30 and Dec.10 and in 1979-80 were Nov.5, Nov.20 and Dec.5 respectively.

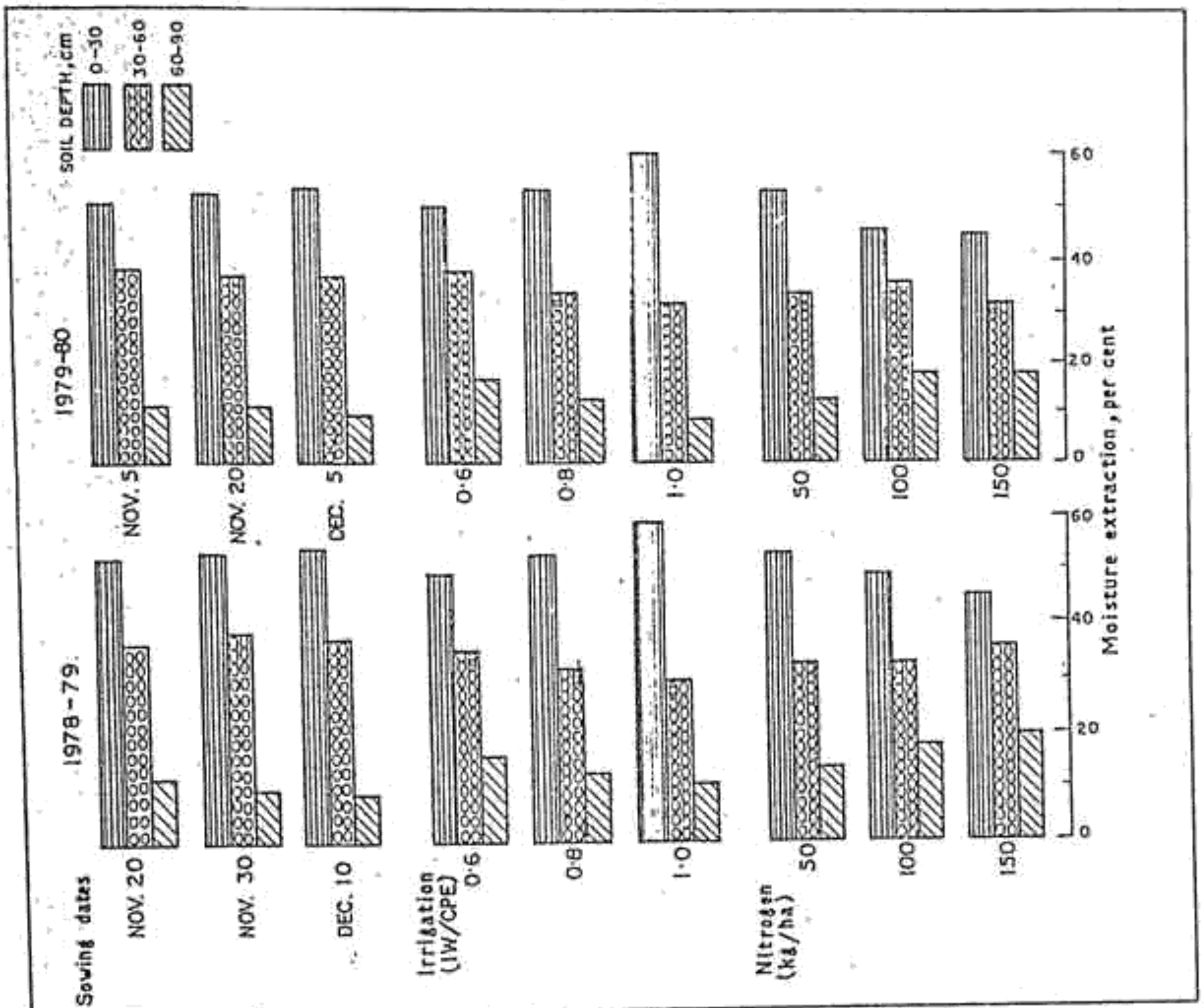

Fig.1. Moisture extraction pattern by wheat as influenced by dates of sowing, irrigation and nitrogen levels

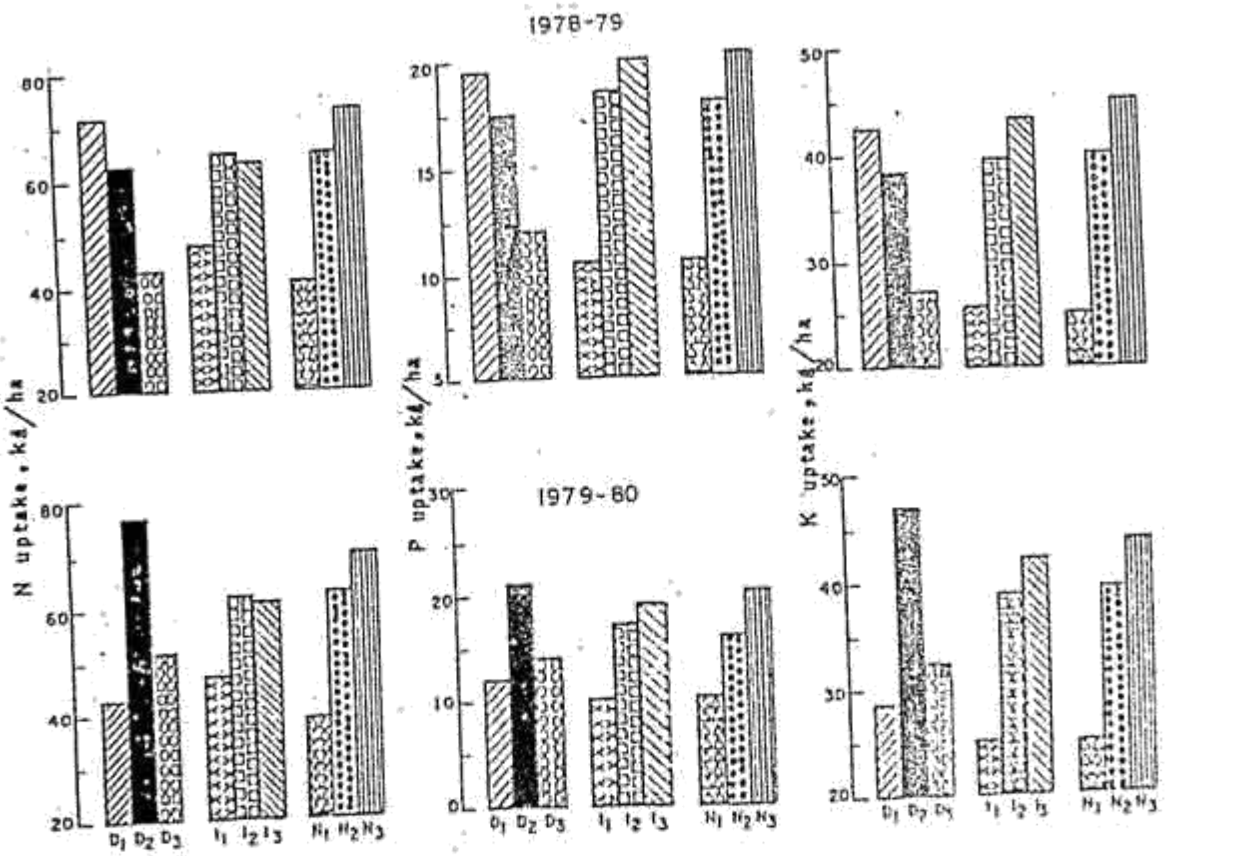

Fig.2. Effect of dates of sowing, irrigation and nitrogen levels on NPK uptake (k) ı ш ant

ture, relative humidity, evaporation and rainfall data recorded during the course of study are given in Table 1.

RESULTS AND DISCUSSION

Grain Yield

The sowing time of winter crops directly depends upon the optimum temperature for the germination of seeds and throughout the crop growth. The perusal of Table 3 indicates that significantlly higer seed yield was obtained under second fortnight of November seeding as compared to early and late sowings in both years. The yield was reduced substantially when the sowing was delayed to the first week oof December. Delay in sowing time caused higher temperature in the later part of the crop season which forced the late sown crop to mature almost alongwith the early sown crop. This forced maturity affected the grain filling and grain weight through adverse effect on uptake and translocation of nutrients to the developing grains. However, when the crop was sown early, the temperatures were comparatively higher during the early growth phase resulting in poor tillering and early acceleration of heading. The optimum temperatures for tillering, flowering and grain filling for wheat are 22 to 25 °C, 18 to 24 °C and 24 to 26 °C respectively as reported by Evans *et al.* (1972). In the present investigation, it was observed that the crop sown during the second fortnight of November has optimum temperature during the entire growth period. The reduction in yield due to delayed sowing of wheat has also been reported by Mudholkar (1981) and Kapur *et al.* (1982).

The nitrogen application influenced the grain yield of wheat significantly in both the years. Application of 100 kg N/ha caused significantly higher seed yield in both years as compared to 50 kg N/ha. However, further increase in nitrogen level did not have favourable effect on grain yield (Table 3.). Increase in yield was attributed to significant increase in yield contributing components like ear bearing tillers, grains/ear and 1000-seed weight. Similar results have also been reported by Saxena and Singh (1979) and Bapna and Khupse (1980).

The irrigation levels influenced the grain yield.The highest yield was recorded with irrigation applied on the basis of IW/CPE of 1.0. However, there was no significant difference in grain yield between 0.8 and 1.0 IW/CPE ratios. Similar findings were also reported in different parts of the country (Singh *et al.*, 1980 and Reddy and Venkatachari, 1982).

Water use and water-use efficiency

Water use was calculated by summing up the water through irrigation, effective rainfall and profile water depletion. Total water use increased with increase in IW/CPE ratio from 0.6 to 1.0 in both the years (Table 3). The highest water use was recorded at 1.0 IW/CPE during both the years. The data on water-use efficiency (WUE) indicated an increase in WUE with lowering IW/CPE from 1.0 to 0.8. However, irrigation given at IW/CPE of 0.6 decreased the WUE. It may be ascribed to decrease in grain yield due to increase in irrigation interval under lower IW/CPE. Sinclair *et al.* (1975) also concluded that WUE decreased under water stress condition and this may due to increase in stomatal resistance which decreased photosynthetic productivity. The less WUE under IW/CPE of 1.0 is attributed to the last incompletely utilized irrigation (Table 3).

The total water use was not appreciably influenced by different dates of seeding and nitrogen levels. In general, the WUE is a function of the crop yield and total water use. Thus, it was higher where grain yield was higher with less water expense. It was observed that WUE was higher under 20th November sowing than under 30th November and 10th December in the first year and 5th November and 5th December in the second year. The grain yield was also highest under 20th November sowing than other sowing dates. The WUE increased with the increase in nitrogen application from 50th to 150 kg/ha. However, it was noticed that the rate of increase in WUE was greater between 50 to 100 then between 100 to 150 kgN/ha (Table 3).

Moisture extraction pattern

In general, the soil moisture depletion from surface to 30 cm depth of soil profile was maximum followed by 30-60 and 60-90 cm depth in that order (Fig.1). Results show that moisture depletion is largely influenced by the moisture status of the soil because the moisture extraction pattern was appreciably influenced by the various irrigation levels. It was observed that moisture depletion at 1.0 IW/CPE was higher from the upper layers compared to 0.8 and 0.6 IW/CPE ratios in both years. This may be attributed to more proliferation of roots in the upper layer under higher moisture regimes. Similar moisture extraction pattern by wheat was reported by Bapna and Khupse (1980).

The depletion of soil water from different soil layers varied appreciably with the moisture profile which was influenced by the timing of irrigations. The percentage depletion from the surface layer though higher than from the deeper layer, decreased in general, as the irrigation timing was delayed due to lower IW/CPE ratio (Fig.1). When less irrigations were applied under 0.6 IW/CPE ratio, deeper layers were subjected to more moisture depletion since moisture stress under such condition promoted extensive root growth upto lower layers. Prihar *et al.* (1978) also indicated that when adequate water is present in the sub- soil, inadequate irrigations are likely to induce deeper rooting. The increasing water depletion from deeper layers with delay in irrigation may be ascribed to the increased growth and activity of roots in these layers. Singh and Russel (1979) and Misra (1980) also found a higher density of roots in deeper layers when irrigation was delayed.

Different dates of seeding and nitrogen levels did not influence the moisture extraction pattern from different soil layers. However, it was noticed that in comparison to late/early sowing there was slightly more moisture depletion from the deeper layer in the case of normal planting under all the irrigation schedules (Table 2). The interaction effect of irrigation and nitrogen levels on soil moisture extraction pattern was not significant.

NPK Uptake

The uptake of nutrients is a function of crop yield (kg/ha) and nutrient content (%). Nitrogen absorption increased with increasing levels of nitrogen. Delaying the sowing resulted in definite decrease in N, P and K uptake in both the years (Fig.2). The results suggest that under condition of delayed sowing, what did not utilize the extra amount of fertilizer. The optimally sown crop had better root and shoot growth which resulted in an enhancement of N, P and K uptake, perhaps due to increase in the total dry matter production.

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Co 1–A DROUGHT TOLERANT BLOU BUFFEL GRASS

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ABSTRACT

A search and study of the **Cenchrus** germplasm collection resulted in the identification of FS-391, a genotype from Vellakoil taluk of Coimbatore district. It has high green fodder yielding potential of 40 t/ha/yr under rainfed condition with higher DM and CP yield than **C.ciliaris** and **C.glaucus** Local. It was identified to be a type of **C.glaucus** being an aneuploid (2n=42) and an obligate apomict.

KEY WORDS: Blou buffel, Drought tolerant High yielding variety