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Response of Wheat to Different Moisture Regimes Under Varying Fertility Levels in Loamy Sand Soil

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ABSTRACT

A field experiment consisting of three moisture regimes viz., 30, 50 and 70 per cent ASM and four fertilizer treatments viz., (i) 150 + 75 + 0, (ii) 150 + 75 + 75, (iii) 200 + 100 + 0 and (iv) 200+100+100 NPK in kg/ha was conducted for two years (1970-71 and 1971-72) on the same plot at College Agronomy Farm under Fertilizer Research Project at Gujarat Agricultural University, Anand. It was observed that at 50 and 70% ASM additional 8·75 and 14·33 quintals of grain per hectare were obtained as compared to 30% ASM. These two treatments gave additional monetary realization of Rs. 1008 and Rs. 1648 per hectare respectively. Net increamental cost benefit ratios (NICBR) were 1:10.08 and 1:11.39 which indicate very high return. From what has been observed so far in respect of yield as well as net realization, it can be concluded that high yielding wheat variety should be grown on irrigation to be given in such a way that the soil never dries out below 70% ASM and that the crop should be given 150 kg N and 75 kg P_2O_5 per hectare. Application of potash is not useful under the sandy loam soils of middle Gujarat.

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INTRODUCTION

THE water requirement of various field crops varies with many factors such as type of soil, nature of crop, variety, growing season, amount of rainfall, temperature etc. Likewise crop of wheat at different available soil moisture has given differential response under varying conditions. Water application to a crop of wheat at 30 per cent (Gupta, Agrawal, Goel and Khanna, 1970), 50 per cent (Gupta and Dargan, 1971; Singh and Dastane, 1971), 60 per cent (Singh and Srivastava, 1971; Srivastava, 1972; Tomar, Singh and Rathi, 1976) 70 per cent (Rathi, Singh, Verma and Yadav 1976) and 75 per cent (Pandey, 1972) available soil moisture has given best yield under various conditions. Misra and Sharma (1971) observed no difference between medium and wet moisture regimes, Dastane, Yusuf and Singh (1971) reported that wheat responded to higher frequency of irrigation. The water requirement also varies with the soil fertility and hence more number of irrigations are required with the increasing levels of fertility (Singh, Siwach and Rathi, 1976). It is a well known fact that the irrigation requirement of a crop largely depends on the agro-climatic regions and that is why research reports differ on the optimum soil moisture regimes for wheat. Because of non availability of required information on this aspect for middle Gujarat, this investigation was undertaken at Agronomy Farm of Gujarat

Agricultural University, Anand Campus, Anand to find out the optimum water requirement and irrigation schedule as well as appropriate dose of NPK for economical and maximum yield in the case of wheat HDM 1593 grown in loamy sand soil of Middle Gujarat.

MATERIALS AND METHODS

The investigation was taken up in 1970-71 and 1971-72. The experiment was conducted at the same site after *kharif* crop of pearl millet in both the years. The soil on which the experiment was conducted is known as *goradu* soil having loamy sand texture with pH 8·0, organic carbon 0·42 per cent, available P_2O_5 and K_2O as 64 and 277 kg/ha respectively. The field capacity, permanent wilting percentage and bulk density were 16·5 per cent, 4·5 per cent and 1·5 g/c c respectively.

The treatments consisted of three moisture status or regimes viz., 30, 50 and 70 per cent available soil moisture and four fertilizer levels viz., (i) 150 + 75 + 0, (ii) 150 + 75 + 75, (iii) 200 + 100 + 0 and (iv) 200 + 100 + 100 NPK in kg/ha. These fertility levels were chosen on the basis of past recommendation (Patel and Patel, 1967). Thus in all twelve treatment combinations were tried in a split plot design with four replications. The gross plot size was 8·0 m × 3·0 m and the net plot was 6·8 m × 1·8 m. Diammonium phosphate (DAP), urea and muriate of potash were the fertilizers ued in the experiment. All P_2O_5 and K_2O and 1/3 of the total nitrogen was applied in plough furrows at the time of preparation of land. Further, 1/3 quantity of N was top-dressed through urea at the time of first irrigation after sowing and the remaining 1/3 quantity of N was similarly applied just before flowering.

First common irrigation at the time of crown root initiation stage was given three weeks after sowing. Subsequent irrigations were scheduled according to the treatments of soil moisture regime. For this purpose, soil samples upto 120 cm depth were drawn layerwise from time to time after each irrigation and when the desired soil moisture level was reached, irrigation was given to bring the soil to field capacity. The quantity of water to be applied to restore the soil moisture to field capacity was determined by the formula: Moisture deficit in cm $= \frac{(FC\% - \text{Actual Moisture } \%)}{100} \times$ Bulk density × Depth in cm. Irrigation water was measured with the help of a Partial flume.

The variety 'HDM 1593' was sown on 29th November in 1970-71 and 18th November in 1971-72 in furrows 20 cm apart @ 80 kg seed/ha. In all, 5, 6 and 8 irrigations in the year 1970-71 and 5, 7 and 9 irrigations in the year 1971-72 were applied in 30, 50 and 70 per cent ASM treatments respectively. Harvesting was done on the 9th April, and 29th March in the year 1970-71 and 1971-72 respectively.

The treatment effects were studied in respect of (i) periodical plant height

as well as plant height at maturity, (ii) yield of grain as well as straw per hectare, (iii) number of effective tillers and grain yield per metre length of crop row and (iv) test weight of seeds. Net profit was worked out by taking into consideration the cost of manuring and irrigation under various treatments.

RESULTS AND DISCUSSION

Effect of Soil Moisture Regime

The results of grain and straw yields along with yield attributes are presented in Table 1. It was evident that the grain yield in both the years was significantly affected due to different moisture regimes. The lowest grain yield was obtained at the lowest available soil moisture (30% ASM) in both the years, which with the increase in the available soil moisture progressively increased. In the first year of study the increase in the grain yield at 50% ASM was 24·9 per cent while at 70% ASM it was 18·4 per cent in comparison with that obtained at 30% ASM. In the second year these increases were 30·5 and 11·4 per cent, respectively. Considering the pooled results, the increases in the grain yields were 28·3 and 14·1 per cent respectively in comparison with the lowest available soil moisture. This indicated that for securing the maximum grain yield in loamy sand soil of this region, it is necessary to apply light but frequent irrigations which also increased the water use efficiency as indicated in Table 2. Dastane *et al.* (1977) also observed that wheat responded to higher frequency of irrigation. The results obtained in the present study are in full agreement with those obtained by Rathi *et al.* (1976) and Pandey (1972) who obtained highest yields in the case of wheat at 70 and 75 per cent ASM respectively.

In the case of straw yield, the trend of the results were quite similar to that of the grain yield results. The increase in grain and straw yields due to higher levels of available soil moisture can be attributed due to the vigorous growth of the crop which is indicated by the plant height and ultimately higher grain yield/metre length. The results of plant height at harvest and grain yield/metre row length were significant in both the years (Table 1). With the increasing available soil moisture both these attributes were favoured. Tomar *et al* (1976) in a similar study have also obtained such effects of moisture regimes on the plant height and total grain yield.

Effect of Fertility Levels

The effect of fertility levels on grain yield was not significant in both the years, while that on straw yield was significant in only one year (1971-72). This indicated that higher levels of fertilizer application do not help in increasing the grain yield, but it might increase vegetative growth as indicated by its significant effect on straw yield in the year 1971-72. This study and the study undertaken by Patel *et al.* (1969) led to the conclusion that for loamy sand soil of this region, high yielding dwarf variety of wheat 'HDM 1593' should be fertilized @ 150 kg N and 75 kg P_2O_5/ha. Application of potash is not useful under the soils of this region.

TABLE 1

Effect of moisture regimes and fertility levels on the wheat yield and yield attributes.

Treatments	*Grain yield in q/ha*			*Straw yield in q/ha*			*Effective tillers/ metre length*		*Grain yield (g) /metre length*		*1000 grain weight (g)*		*Plant height (cm)*	
	1970–71	*1971–72*	*Pooled*	*1970–71*	*1971–72*	*Pooled*	*1970–71*	*1971–72*	*1970–71*	*1971–72*	*1970–71*	*1971–72*	*1970–71*	*1971–72*
Moisture regimes (% ASM):														
30	24·27	37·55	30·92	39·43	46·38	42·91	61·8	53·1	71·2	96·0	34·2	43·6	69·0	66·5
50	30·31	49·02	39·67	44·44	66·90	55·68	61·6	64·4	84·8	119·4	34·2	42·6	72·2	73·0
70	35·90	54·60	45·25	49·78	71·27	60·53	65·1	63·8	94·2	131·4	36·4	43·0	73·8	75·6
C. D. 5%	3·13	5·36	2·78	5·26	8·17	4·41	NS	4·18	7·47	9·48	1·24	NS	3·40	3·30
C. V.%	12·02	13·16	13·15	13·64	15·81	15·29	7·64	8·00	10·35	9·47	4·10	4·37	5·34	5·32
Levels of N + P + K (kg/ha)														
150 + 75 + 0	28·92	46·14	37·54	43·19	57·56	50·38	62·0	59·3	83·4	111·8	34·7	44·1	70·5	70·9
150 + 75 + 75	30·47	45·73	38·10	45·34	57·53	51·44	63·1	60·8	83·7	118·5	35·5	42·8	72·1	71·9
200 + 100 + 0	32·25	47·40	39·83	43·99	61·87	52·93	63·4	60·4	84·1	111·6	35·5	42·2	72·4	71·5
200 + 100 + 100	29·00	48·96	38·98	45·68	69·10	57·40	62·8	61·2	82·5	120·3	34·9	43·2	71·8	72·3
C.D. 5%	NS	NS	NS	NS	6·78	3·84	NS	NS	NS	NS	NS	NS	1·29	NS
C.V.%	12·27	10·40	10·99	10·83	13·16	12·57	7·57	10·53	11·09	10·68	3·39	4·73	2·15	4·65

P & K as P_2O_5 and K_2O

TABLE 2

Economics of wheat grain production as affected by different soil moisture regimes (mean of 1970-71 — 1971-72)

Treatments	*Grain yield (q/ha)*	*Total quantity of water applied (mm)*	*Number of irrigations applied*	*Quantity of water applied per irrigation (mm)*	*Additional yield (q/ha)*	*Additional cost (Rs/ha)*	*Additional monetary realisation (Rs/ha)*	*Net ICBR*	*Water use efficiency (kg/mm/ha)*
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
30% ASM	30·92	369	5·0	73·8	—	—	—	—	8·38
50% ASM	39·67	425	6·5	65·4	8·75	91·00	1008·00	1:10·08	9·33
70% ASM	45·25	436	8·5	51·3	14·33	133·00	1648·00	1:11·39	10·38

Interaction Effects

The interaction effect between the moisture regimes × fertility levels was not found to be significant for any of the attributes studied except plant height in the year 1970-71. This shows that these two factors are independent of each other. Similar non-significant results due to soil moisture regimes × fertility levels were also observed by Rathi *et al.* (1976) and Singh and Dastane (1971).

Economics

To know the economic aspects of irrigation, it was thought necessary to calculate additional cost involved and additional yield obtained at higher available soil moisture percentages. Based on this, additional benefit in Rs/ha and net incremental cost benefit ratios (NICBR) were calculated and are presented in Table 2. It was observed that at 50 and 70% ASM additional 8.75 and 14.33 quintals of grain per hectare were obtained which gave additional monetary realization of Rs. 1008/- and Rs. 1648/- per hectare respectively. Considering the additional cost involved, the net ICBR was calculated which was 1:10.08 and 1:11.39 respectively. This indicated that each additional rupee spent on the irrigation will earn at least Rs. 10. This can be considered a very high return.

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