Response of Cotton to Levels of Moisture and Nitrogen Grown on Ustochrepts, Ustifluvents and Chromusterts

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Abstract: *A potculture experiment was conducted on hirsutum cotton on Typic Ustifluvents, Vertic Ustochrepts and Typic Chromusterts. Growing of cotton on Typic Ustifluvents yielded maximum biomass and seed cotton and also nitrogen uptake. Irrigation at 70-80 per cent field capacity increased the biomass by 43.2 and 15.5, and seed cotton by 82.2 and 28.0 per cent over the irrigation at 50-60 and 60-70 per cent field capacity, respectively. Nitrogen uptake was increased by 35.7 and 9.5 per cent due to irrigation at 70-80 per cent field capacity over 50-60 and 60-70 per cent field capacity, respectively. Nitrogen at 135 kg ha^{-1} gave maximum dry matter, seed cotton and yield and N uptake.*

The synergistic effect of irrigation in increasing the fertilizer use efficieny is well documented. Parihar and Gajari (1988) observed that urea fertilization enhanced crop production through its effect on plant characteristics, regulating evapotranspiration and correcting nutrient deficiency. Nitrogen application enhanced leaf area, leaf area index, root length index and net assimilation rate of cotton (Wankhede & Choudhary 1989). Availability of native and applied N is mainly influenced by soil water availability (Haby *et al.* 1983). Water stress at sensitive stage decreased the efficiency of applied nitrogen and also crop yield (Eck 1984). It is, therefore, attempted to find out the level of water requirement and nitrogen for cotton grown in the Vidarbha region.

MATERIAL AND METHODS

A potculture experiment in split plot factorial design with three replications was conducted on hirsutum cotton (Buri-147) for three seasons. The main treatments consisted of three subgroups of soils (Table 1); Typic Ustifluvents (alluvial soils), Vertic Ustochrepts (medium deep black soil) and Typic Chromusterts (deep black soil); and three sources of N: ammonium sulphate, ammonium sulphate nitrate and urea. The subtreatments were four levels of N (0,45,90 and 135 kg ha^{-1}), and three levels of moisture (50 to 60% - M_1; 60 to 70% - M_2 and 70 to 80% - M_3 of field capacity).

Five to six seeds of cotton (Buri-147) were dibbled in the centre of pot (size 75 x 38 x 22 cm having 22.5 kg soil) and finally two plants were maintained in each pot. The uniform watering was given for establishing the seedlings. Soil moisture was maintained as per treatment throughout the crop growth by adding required amount of water.

TABLE 1. Characteristics of the soils

Properties	Typic Ustifluvents	Vertic Ustochrepts	Typic Chromusterts
Texture	silt loam	clay	clay
pH	7.5	7.8	7.8
Max. WHC (%)	41	54	66
FC (%)	30	38	44
AWC (%)	16	21	23
Wilting point (%)	14	17	21
Total N (%)	0.04	0.05	0.05
Avail. P_2O_5 (kg ha^{-1})	20	22	20
Avail. K_2O (kg ha^{-1})	520	720	820
CEC (cmol (P+)kg^{-1})	30.4	45.5	55.6

FC = Field capacity; WHC = Water holding capacity; AWC = Available water capacity

Nitrogen was applied in split doses: 50 per cent at sowing, and 50 per cent at flowering (60 days from sowing). Basal application of recommended P and K (25:25) was given.

RESULTS AND DISCUSSION

Biomass and seed cotton yield : Cotton grown in Typic Ustifluvents produced biomass and seed cotton per plant higher by 13.7 and 14.2 per cent and by 24.2 and 42.9 per cent than Vertic Ustochrepts and Typic Chromusterts, respectively (Table 2). This was attributed to higher rate of water transmission of Typic Ustifluvents (1.25 cm hr^{-1}) than that of Vertic Ustochrepts (0.50 cm ha^{-1}), and Typic Chromusterts (0.25 cm hr^{-1}). However, Vertic Ustochrepts and Typic Chromusterts did not differ in this respect. This might be due to the differential behaviour of soil in terms of N-water production functions and moisture transmission characteristics of soils affecting the

TABLE 2. Biomass and seed cotton yield (g/plant)

	Bomass	Seed cotton
Soil Type		
Typic Ustifluvents	36.34	9.03
Vertic Ustochrepts	31.97	7.27
Typic Chromusterts	31.81	6.32
SEm (<9E+-)	0.98	0.23
CD (5%)	3.22	0.64
Moisture Levels		
50-60% FC	27.25	5.29
60-70% FC	33.77	7.53
70-80% FC	39.02	9.64
SEm (±)	0.41	0.12
CD (5%)	1.05	0.34
N Sources		
Amm. sulphate	34.55	8.03
Amm. sulphate nitrate	32.05	7.34
Urea	32.61	7.67
SEm (±)	0.98	0.23
CD (5%)	NS	NS
N Levels (kg ha^{-1})		
0	25.09	4.28
45	31.48	6.73
90	36.17	8.89
135	40.69	10.69
SEm (±)	0.45	0.14
CD (5%)	1.26	0.39

TABLE 3. Effect of moisture with soil types and N on seed cotton yield (g/plant)

Moisture levels	Soil Types			N levels (kg ha^{-1})			
	Typic Ustifluvents	Vertic Ustochrepts	Typic Chromusters	0	45	90	135
50-60% FC	6.47	4.98	4.39	2.96	4.98	6.00	6.56
60-70% FC	9.43	7.81	6.43	4.31	6.82	9.17	12.21
70-80% FC	11.27	10.04	8.22	4.90	8.57	11.48	14.30
SEm (±)		0.270					
CD (5%)		0.747					

use of water by the crop (Parihar & Gajari 1988).

A linear increase in biomass and seed cotton yield was observed due to increasing moisture levels. The irrigation at 70- 80 per cent of field capacity resulted in increasing the biomass by 43.2 and 15.5 per cent over that of 50-60 and 60-70 per cent of field capacity, respectively. The increase in seed cotton yield was also maximum and was significantly higher by 82.2 and 28.0 per cent due to irrigation at M_3 level than M_1 and M_2, respectively. The data further indicated that M_2 level was also observed to be superior over M_1. Negative correlation between crop water stress index values of cotton and its yield was also reported by Wanjura *et al.* (1990). Stomatal resistance increased and photosynthetic rate decreased as a result of moisture stress (Ephrath *et al.* 1990).

The different sources of fertilizer nitrogen were comparable in influencing the dry matter and seed cotton yield (Table 2). Similar observations were also reported by Wankhede *et al.* (1992). Significant increase in biomass production and seed cotton yield was noticed due to increasing N levels. The rate of 135 kg N ha^{-1} increased seed cotton yield by 150, 59 and 20 per cent over the rate of 0, 45 and 90 kg N ha^{-1}, respectively. Linear response of N in increasing biomass seed cotton and lint yield was also observed by Satao *et al.* (1984) and Sawan (1986).

Interaction effect of moisture levels with soil types and N dose in respect of seed cotton were significant (Table 3). Soil types behaved differently to moisture levels. At low moisture level (50-60% FC), Ustifluvents recorded higher yield as compared to Ustochrepts and Chromusterts. However, maximum yield was recorded in Ustifluvents at 70-80 per cent F.C. Highest seed cotton yield could be obtained with N fertilization at 135 kg ha^{-1} and at 70-80 per cent FC moisture levels. Thus, nitrogen fertilizer increased the water use efficiency. Similar findings were also reported by Scarsbrook *et al.* (1961) and Pearson (1963).

N uptake by cotton: The uptake of N by cotton was highest in Ustifluvents followed by Ustochrepts and Chromusterts (Table 4).

TABLE 4. N content (%) and uptake (g/plant) by cotton

Treatments	N in straw	N in seed	Uptake
Soil Type			
Typic Ustifluvents	1.386	2.325	0.748
Vertic Ustochrepts	1.082	2.321	0.617
Typic Chromusterts	1.266	2.186	0.534
SEm (±)	0.034	0.030	0.023
CD (5%)	0.110	0.099	0.074
Moisture Levels			
50-60% F.C.	1.465	2.233	0.527
60-70% F.C.	1.334	2.280	0.653
70-80% F.C.	1.137	2.319	0.715
SEm (±)	0.016	0.007	0.006
CD (5%)	0.041	0.023	0.018
N Sources			
Amm. sulphate	1.377	2.350	0.695
Amm. sulphate nitrate	1.260	2.272	0.596
Urea	1.300	2.211	0.623
SEm (±)	0.037	0.030	0.023
CD (5%)	NS	0.099	0.074
N Levels (kg ha^{-1})			
0	0.986	2.107	0.333
45	1.246	2.204	0.510
90	1.408	2.329	0.724
135	1.593	2.471	0.923
SEm (±)	0.018	0.029	0.007
CD (5%)	0.049	0.081	0.020

The content of N in cotton straw decreased with increasing moisture levels from M_1 to M_3. M_1 moisture level recorded significantly higher N concentration in cotton straw than those of M_2 and M_3. It is further interesting to note that reverse trend was recorded in respect of N content in cotton seed. This might be attributed to increasing soil moisture which led to more translocation of N from vegetative to reproductive part of cotton. A progressive increase in N uptake by cotton was observed due to increasing moisture level. Each unit of moisture affected significant increase in N uptake. A rise in soil moisture level probably augmented the absorption of N from the soil resulting in better efficiency of N utilization.

No significant differences were noticed in respect of N concentration in straw due to various N sources. A progressive increase in N content in straw, seed and N uptake by cotton was observed due to increasing levels of N and each successive unit of N increment resulted in conspicuous increase in N content and uptake. Application of N at the rate of 135 kg ha^{-1} caused 177, 81 and 28 per cent increase in N uptake over 0, 45, 90 kg N ha^{-1}, respectively. Similar results were also reported by Kharche (1964). Positive and significant interaction between N and moisture levels on N uptake was recorded (Table 5). Increasing the levels of both the factors, increased N uptake, and highest uptake was found with the fertilization of N at the rate of 135 kg ha^{-1} and irrigation at 70-80 per cent field capacity.

TABLE 5. Effect of nitrogen and moisture on N uptake (g/plant) by cotton

Moisture levels	N levels (kg ha^{-1})			
	0	45	90	135
50-60% FC	0.318	0.470	0.585	0.736
60-70% FC	0.341	0.557	0.747	0.965
70-80% FC	0.337	0.608	0.842	1.069
SEm (±)	0.012			
CD 5%	0.034			

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