panicle length and number of grains was found to be non-significant and it was positive and significant with all other characters (Table 2).

The present study indicated that panicle weight, number of grains per panicle, number of leaves per plant and days to 50 per cent bloom appeared to be major components for grain yield and selection for these traits will lead to increase in grain yield in grain sorghum.

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ROW SPACING, N AND MULCHING ON YIELD, RUE AND NUTRIENT UPTAKE OF RAINFED WHEAT

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ABSTRACT

Results of two field study (1986-87 and 1987-88) conducted at the Soil Conservation and Water Management farm, Kanpur showed that application of N at 60 kg/ha recorded higher root depth and root weight, grain yield and N,P,K uptake. Method of half drilled at sowing + half foliar application of nitrogen showed better results in comparision to drilling entire dose of N as basal. Grain yield of wheat at a row spacing of 20 cm was at par with 25 cm row spacing, during normal rainfall season. During drought season, 25 cm row spacing registered higher yield. The best development of roots was observed in 30 cm row spacing. Application of maize stalk at 4t/ha performed better in comparison to weeding and hoeing in respect of maximum root expansion, yield, rainfall use efficiency and nutrient uptake.

The yield is significantly influenced by the plant population per unit area. Generally spacing exerts its effects in two ways: firstly under wider spacing, individual plant may yield more with low yield per hectare whereas under narrow spacing, individual plant may yield low with more yield per hectare due to variation in plant population. Thus, optimum plant population must be ensured. The favourable effect of mulches on soil moisture status and microclimate conditions have resulted in to higher crop yields at many places. The extent of increase in yield was, however, much dependent upon nature of mulch, mulching method, soil and rainfall characters of the area. Experiments conducted in different parts of the country have clearly shown that surface mulching increased the yield of rainfed. Fertilizer application to wheat had great importance in raising the production. Nitrogen is an universally deficient nutrient in majority of our soil and need maximum attention ance of soil fertility.

MATERIALS AND METHODS

The field experiment on rainfed wheat (*Triticum aestivum* L.) variety 'C 306' was conducted during *rabi* seasons of 1986-87 and 1987-88 at Kanpur on sandy loam soil (56.8% sand, 21.6% silt and 20.0% clay), slightly alkaline (pH 7.8), low in organic carbon (0.29%) and total-N (0.030%), medium in available P_2O_5 (16.6 kg/ha) and available K_2O (138 kg/ha) with field capacity as 19.5 per cent, wilting point 6.2 per cent and bulk density 1.5 g/cc. The rainfall of 38.5 mm and 25.0 mm during *rabi* season of 1986-87 and 1987-88, respectively, was received effectively. At sowing time natural available soil moisture in100 cm soil profile was 23.4 and 23.2 cm during 1986-87 and 1987-88, respectively. The treatments consisted of three row spacings *viz.* 20, 25 and 30 cm; two mulching practices *viz.* weeding and hoeing twice and maize stalk mulch at 4t/ha; four nitrogen levels *viz.* 0, 30, 60 and 90 kg/ha and two

Table 1. Root development and yield of wheat as affected by various treatments (Pooled data of 1986-87 and 1987-88)

Treatments	Root depth (cm)	No. of primary roots / plant	Dry wt. of root / plant (g)	Dry matter yield (g/ha)			Grain yield (g/ha)			Straw yield (g/ha)		
				1986-87	1987-88	Mean	1986-87	1987-88	Mean	1986-87	1987-88	Mean
Row spacing - cm												
20	25.7	11.0	1.38	49.22	35.61	42.41	17.65	12.37	15.01	31.57	23.24	27.40
25	31.3	14.9	1.55	48.59	43.11	45.85	17.33	15.97	16.65	31.26	27.14	29.20
30	35.5	19.9	1.76	43.77	33.80	38.78	16.06	12.33	14.19	27.71	21.47	24.59
C.D. at 5%	-	-	-	0.92	2.00	-	0.45	0.91	-	0.78	1.67	-
Mulching Practices												
Weeding & hoeing twice	27.0	12.1	1.52	43.62	34.19	38.91	15.47	12.11	13.79	28.15	22.08	25.12
Maize stalk mulch	34.6	18.5	1.62	50.77	40.84	45.80	18.56	15.01	16.78	32.21	25.83	29.02
C.D. at 5%	-	-	-	3.50	2.38	-	0.36	0.74	-	0.63	1.36	-
N - Kg/ha												
0	20.5	7.2	1.10	34.59	24.72	29.65	12.44	8.90	10.67	22.15	15.82	18.98
30	25.2	10.6	1.37	44.82	34.96	39.89	16.16	12.67	14.41	28.66	22.29	25.48
60	35.5	18.8	1.75	49.86	39.41	44.63	17.97	14.28	16.12	31.89	25.13	28.51
90	31.7	16.6	1.59	46.90	38.15	42.53	16.91	13.72	15.32	29.99	24.43	27.21
C.D. at 5%	-	-	-	1.94	2.25	-	0.23	0.26	-	0.45	0.51	-
N - methods												
Full basal at sowing	28.0	12.0	1.49	45.67	36.25	40.96	16.47	13.10	14.78	29.20	23.15	26.18
Half basal at sowing + half foliar spray	33.6	18.6	1.65	48.75	38.79	43.77	17.59	14.04	15.81	31.16	24.75	27.96
C.D. at 5%	-	-	-	1.43	1.88	-	0.19	0.21	-	0.36	0.42	-

methods of nitrogen application *viz.* full basal and half basal+half applied through foliar spray (2.5% urea) in three split doses at 50, 57 and 63 days after sowing. The experiment was laidout in a split plot design with three replications having combinations of row spacings and mulching practices in main plots and levels and methods of N application in sub-plots. P_2O_5 at 30 kg/ha and K_2O at 30 kg/ha were applied uniformly to all the treatments at the time of sowing. The crop was sown on October 26 in 1986 and October 28 in 1987 and harvested on March 31 in 1987 and March 24 in 1988. The crop was adequately protected from insect pests and diseases.

The rainfaill received during *kharif* 1986 was 856.7 mm while it was only 383.4 mm during *kharif* 1987. The problem of scanty rainfall during *kharif* 1987 was further aggravated by low winter rains, higher mean maximum temperature and wind velocity particularly from flowering to maturity stage of the crop which led to greater evaporation losses and lower relative humidity in the atmosphere resulting in lower moisture storage in the soil.

RESULTS AND DISCUSSION

Root Studies

Plant spaced at 20 cm showed the poorest root development in respect of root depth, no. of primary roots and the dry root weight/plant, while the best development of root was observed in 30 cm row spacing. A net increases of about 5.6 cm and 9.8 cm in root depth was observed in 25 cm and 30 cm row spacing, respectively, over that of 20 cm (Table 1). The plots having maize stalk mulch showed an increase in root depth, no. of primary roots and root weight/plant by 28.1 per cent, 52.9 per cent and 6.6 per cent, respectively, over weeding and hoeing plots. Root development increased gradually with the application of nitrogen upto 60 kg/ha. Higher dose of 90 mgN/ha had a depressing effect on root development. As regards the methods of N application, half basal at sowing + half applied through foliar application produced deeper roots, increased no. of primary roots and root weight (1.65g/plant).

Table 2. Total water use, rainfall use efficiency, concentration and uptake of N, P and K in wheat grain as affected by various treatments

Treatments	Total water use (mm)	Rainfall use efficiency		Concentration (%)			Uptake (kg/ha)		
		Kg grain/ ha/mm	kg drymatter/ ha/mm	N	P	K	N	P	K
Row spacing - cm									
20	136.2	11.02	31.14	2.18	0.27	0.46	32.7	4.0	7.3
25	132.6	12.56	34.58	2.20	0.29	0.47	35.0	5.4	7.5
30	129.3	10.97	30.00	2.30	0.30	0.48	32.1	4.0	6.7
C.D. at 5%	-	-	-	0.02	0.01	0.01	1.8	1.1	0.6
Mulching Practices									
Weeding & hoeing twice	135.3	10.19	28.76	2.17	0.27	0.46	29.8	3.7	6.5
Maize stalk mulch	130.2	12.89	35.18	2.20	0.28	0.48	36.7	4.5	7.8
C.D. at 5%	-	-	-	0.02	0.01	0.02	3.4	0.6	1.1
N - Kg/ha									
0	124.7	8.56	23.78	1.83	0.26	0.46	19.4	2.8	4.8
30	128.3	11.23	31.09	2.13	0.27	0.47	30.5	3.8	6.7
60	135.8	11.87	32.86	2.20	0.28	0.48	35.4	4.4	7.7
90	134.0	11.43	31.74	2.21	0.29	0.49	33.8	4.1	7.1
C.D. at 5%	-	-	-	0.01	0.01	0.01	1.5	0.2	0.5
N - methods									
Full basal at sowing	130.2	11.31	31.45	2.17	0.27	0.46	31.8	3.9	6.9
Half basal at sowing + half foliar spray	135.3	11.69	32.37	2.20	0.28	0.49	34.7	4.3	7.4
C.D. at 5%	-	-	-	0.02	0.01	0.02	2.3	0.3	0.3

Yield

Grain and straw yield of wheat were maximum under the row spacing of 20cm during 1986-87, having adequate pre-and post sowing rainfall but during 1987-88 when the rainfall was inadequate, row spacing of 25 cm performed better (Table 2). During 1986-87, the amount of total rainfall was sufficient and higher plant population at 20cm row spacing did not suffer for want of adequate moisture during its entire growth period. At 25 and 30 cm row spacing, a decrease in total plant population was probably responsible for low crop yield. However, the optimum row spacing with regard to grain and straw yield during 1987-88 was found to be 25 cm. The yield was comparatively lower at 20cm as well as 30cm row spacings during this year. This trend of yield might be attributed to fact that a higher plant population under narrow row spacing of 20 cm under drier weather conditions during the year tended to exhaust limited available soil moisture at relatively fast rate during earlier stages of growth leaving little moisture in the soil for crop use during later stages. On the other hand, a medium row spacing of 25 cm tended to afford medium plant population which resulted in availability of moisture till the later stages of growth. The lower yield under 30cm row spacing as compared to other row spacings during both the years might be attributed to sub-optimum plant population.

Water use and rainfall use efficiency

The crop sown in rows of 20cm apart showed a slightly higher amount of water use than the wider rows at 25cm and 30cm apart (Table 2). It was seen that closer row spacing depleted the soil moisture rapidly in early stages due to higher rate of canopy development which resulted more evapotrans piration while it was maintained at a normal rate throughout the season in 25cm and 30cm spacings. Maximum RUE observed under 25cm row spacing in both grain and drymatter due to higher grain as well as drymatter yield. This is in confirmity with the findings of Singh *et al.* (1986). Mulching practice i.e. maize stalk mulch showed lowest (130.2mm) water use which may be attributed to

simultaneous to checking of soil moisture losses through evaporation and maximum (135.3mm) water use was recorded under weeding and hoeing treatment. RUE was observed higher under maize stalk mulch treatment due to increase in yield in higher magnitude as compared to weeding and hoeings treatment. The unfertilized-N crop gave the lowest water use (124.7mm) as well as RUE (8.56 mg grain/ha/mm and 23.78 kg drymatter/ha/mm) which gradually increased with increasing dose of N, the maximum water use (135.8mm) as well as RUE (11.87 kg grain/ha/mm and 32.86 kg dry matter/ha/mm) but thereafter slightly declined under higher dose of 90 kg N/ha. Method of 1/2 basal + 1/2 foliar application of N led to higher water use and RUE than under full basal at sowing. These results are in conformity with the findings of Singh and Ramakrishna (1975).

Uptake of N, P and K

It is evident from the data that increase in row spacing resulted in significant increase in N, P and K contents in wheat grain upto 30cm row spacing but the highest N, P and K uptake by grain was observed with 25cm row spacing due to higher grain yield. Maize stalk mulch increased all the three nutrients as compared to weeding and hoeings plot due to the conservation of higher amount of moisture in the soil and in the presence of optimum amount of moisture, nutrient availability increased and plant tapped them easily. Application of N improved N, P and K contents in grain with each increase in dose of nitrogen, N, P and K uptake increased significantly upto 60 kg N/ha due to the highest grain yield at this level. Beyond this level, a gradual reduction in uptake was noticed. Rathore and Singh (1978) also observed similar trend in case of nutrient uptake in wheat. Nutrient content and uptake by grain under the treatment of half basal at sowing + half applied through foliar application was significantly higher as compared to drilling of its full basal at sowing.

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BIOSYNTHATE PRODUCTION BY DIFFERENT RICE BASED CROPPING SYSTEMS

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ABSTRACT

Experiments conducted with five different rice based cropping systems, two irrigation regimes and two fertilizer levels, at Madurai, revealed that the production of biosynthates *viz.*, carbo hydrate, fat and protein was higher in rice-rice-greengram, groundnut + blackgram-rice-sesamum and sorghum + vegetable cowpea- rice-soybean systems in that order. The bio-synthates production was higher with irrigation to the rice crop to 5cm depth on the day of disappearance of ponded water and irrigating the *kharif* and summer crops at 0.75 and 0.60 IW/CPE ratios, respectively. Application of N, P and K as per soil test recommendations recorded higher carbohydrate output in the first year only.

Focussing attention on the output of biosynthates (carbohydrate, fat and protein) by multiple cropping systems is a recently added dimension and has attracted increased attention in view of the need to overcome the problem of malnutrition and undernutrition of the increasing population in developing countries. Protein is one of the most important food factors supplying building materials for the body and replenishing lost tissues needs hardly any reiteration. But the protein content in rural diet is dismally modest and there is therefore an imperative need to improve the same.