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Effect of Varying Soil Moisture Regimes, Plant Population and Levels of Nitrogen on Maize

by
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Introduction: Maize, an important *Kharif* crop, is grown as a rainfed crop in Udaipur region. But average yield of 959 kg/ha (Anon., 1968) in the predominantly maize growing area points to some lapses in our technique of manuring, seeding, optimum plant population and water management. While the crop responds remarkably to N, the degree of response is generally governed by plant population and water management practices, particularly in years of inadequate rainfall. Though the average rainfall of this region is about 70 cm, drought is of common occurrence. The experimental year coincided with an exceptionally dry year and data reported in this paper provide information on the extent to which the supplemental irrigation (irrigating crop at 50% available soil moisture) may be beneficial under varying plant population and levels of nitrogen under such a dry year.

To obtain information on the modifying effect of plant population and supplemental irrigation, particularly late in the life cycle of maize, an experiment employing 2 levels of soil moisture, 3 levels of plant populations and 4 levels of N was planned. In the present paper an attempt has been made to highlight the role of supplemental irrigation on the response of maize to N which is a key factor in maize production.

Review of Literature: In a 20 years experiment with open pollinated corn in Ohio, the maximum grain yields were produced at 14,000 plants per acre (Anon., 1954), while Sommerfeldt (1961) recorded highest yield from a close row spacing of 24" and high density of 22,000 plants per acre under irrigation. Similarly Grigorjan (1961) obtained 6690 kg grain yield with 50,000 plants/ha.

Peterson and Battard (1953) working at Utah Agricultural Experiment Station, Logan, obtained highest yield of corn ear (8.2 tons/acre) with 200 lb N/acre, while in India, Gautam (1962) recommended 80 to 120 lb N and 40 to 60 lb N/acre for hybrid and open pollinated varieties of maize, respectively.

Nandpuri (1960) recorded highest yield with 180 lb N and plant population of 26,000 plants/acre, while Hinkle and Garrett (1961) reported that

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the optimum plant population, when 150 to 180 lb N per acre was applied, lays between 12,0C0 to 16,000 per acre. Relwani (1962) found 24″×9″ spacing and 60 lb N per acre significantly better than wider spacing or lower levels of N. Richey (1933) summarising the results of experiments in South America concluded that optimum stand of corn depended upon size of the plant, moisture supply and soil fertility conditions, being heavier with more favourable conditions.

Alessi and Power (1965) while studying the influence of soil moisture, plant population and nitrogen on corn yields reported that forage and grain yields were directly proportional to total available soil moisture. Under lower levels of soil moisture low plant population produced more silage and grain yields while under higher available soil moisture, yields were not much influenced with the variation in plant population.

Material and Methods: A field trial was conducted during *Kharif* season of 1966–67 at Rajasthan College of Agriculture, Udaipur with 24 treatment combinations. These consisted of two levels of soil moisture regimes viz., dry or unirrigated (I_0) and wet or irrigated when 50% available soil moisture was depleted from 15–30 cm soil depth (I_1), three plant population viz., 40,000 (S_1), 60,000 (S_2) and 80,000 (S_3) plants/ha and four levels of nitrogen viz., 0 kg (N_0), 40 kg (N_1), 80 kg (N_2) and 120 kg (N_3) N/ha. Treatments were replicated four times in a single split plot design with soil moisture regimes as a main treatment and the combination of plant population and levels of N as sub-treatments with a net plot size of 10×4 metre. The average rainfall of the locality is about 70 cm nearly all of which is received during July to October. The rainfall during the period of experimentation i. e. July 23 to November 10 was only 24.4 cm.

The soil of the experimental field was medium in soil fertility and values for field capacity, permanent wilting point and bulk density were 25.5%, 9.5% and 1.42 respectively. Irrigation under I_1 (wet soil moisture regime) was given when 50% of available soil moisture was depleted from 15 to 30 cm soil depth to bring the 45 cm soil column to field capacity while no supplementary irrigation was given under I_0 (dry soil moisture regime). During the entire growing season, 25 cm of irrigation water in addition to rainfall was applied under I_1 treatment. After September 8, 1966 no rain was received till the harvest of the crop.

The seed of Ranjeet hybrid maize was sown on 23rd July 1966 at 50 cm constant row to row distance keeping the plant to plant spacing as a variable factor to obtain the desired number of plants/ha.

A basal dressing of 40 kg P_2O_5 and K_2O/ha each was given to the entire area under experiment. N was applied as ammonium sulphate in three split doses i. e., ½ at sowing, ¼ at knee high stage and ¼ at tasseling stage

Yield of grain, stover and total produce and reproduction efficiency of the crop were studied.

Results: Table 1 shows that grain, stover and total yield (grain +stover)/ha and reproduction efficiency differed significantly between dry and wet soil moisture regimes. Irrigating crop at 50% available soil moisture increased 228%, 68% and 81% grain, stover and total produce respectively over unirrigated ones. The increase in grain yield with each additional inch of irrigation water was 98 5 kg/ha.

Variation in plant population did not affect the grain yield significantly, while stover and total yield were increased significantly by maintaining high plant population. However, the difference between medium (60,000 plants/ha) and high (80,000 plants/ha) plant population was not statistically significant. Increasing plant population from 40,000 to 80,000 decreased reproduction efficiency significantly.

TABLE 1. *Grain, stover, total yield (grain+stover) and reproduction efficiency as influenced by soil moisture regimes, plant population and levels of N.*

Treatments	Grain yield (q/ha)	Stover yield (q/ha)	Total produce (q/ha)	Reproduction efficiency (grain yield / Total yield × 100)
I_0 (Dry or unirrigated)	4 31	39.33	43.64	10.38
I_1 (Wet or irrigated at 50 % available soil moisture)	13.16	66.00	79.16	16 79
S Em ±	0.62	3.44	4 06	0.05
C.D. at 5%	2.79	15.47	18.26	0 22
S_1 (40,000 plants/ha)	8 25	42.60	50.85	15 02
S_2 (60,000 plants/ha)	9.22	55.15	64.37	13.59
S_3 (80,000 plants/ha)	8.75	60.23	68.98	12.15
S.Em. ±	0.32	2.16	2.29	0 51
C.D. at 5%	N.S.	6 10	6.47	1.44
N_0 (No nitrogen)	5.27	39.83	45.10	12.28
N_1 (40 kg N/ha)	9.25	48.66	57.91	15.22
N_2 (80 kg N/ha)	10.27	57.54	67.81	13.88
N_3 (120 kg N/ha)	10.17	64.61	74.78	12.92
S.Em. ±	0.38	3.52	2.63	0.58
C.D. at 5%	1.07	9.94	7.43	1.63

Application of N increased the grain yield significantly over control. However, the differences among higher levels of N were not statistically significant. With increasing levels of N, there was a progressive increase in yields of stover and total prcduce. The differences as between N_0 and N_1, N_1 and N_2 and N_2 and N_3 were not statistically significant in case of stover yield. In terms of total prcduce, N_1 was significantly better than N_0, and N_2 was better than N_0 and N_1, but the difference between N_2 and N_3 was not statistically significant. With the application of 40 kg N/ha reproduction efficiency was increased significantly over N_0 and N_3 treatments.

Effect of interactions of I×N in case of I×S in case of stover yield and I×N and I×S both in case of total produce was found to be statistically significant.

TABLE 2. *Grain and stover yield as influenced by I×N and I×S interactions*

	Grain yield (q/ha)				Stover yield (q/ha)		
	N_0	N_1	N_2	N_3	S_1	S_2	S_3
I_0	3.66	4.16	4.79	4.64	32.93	43.81	41.24
I_1	6.87	14.33	15.75	15.71	52.28	66.50	72.21
S.Em ±		0.53				3 05	
C.D. at 5%		1.50				8.61	

From a critical examination of the results presented in table 2, it is interesting to note that under unirrigated conditon (I_0) application of N did not increase significantly the production of grain, while under irrigated condition (I_1) the application of 40 kg N/ha increased the grain yield significantly over control. However, further increase in level of N under irrigated condition also did not increase the grain yield significantly over N_1 (40kg N/ha).

The production of stover under unirrigated (I_0) condition was increased significantly with S_2 (60,000 plants/ha) over S_1 (40,000 plants/ha) and further increase in plant population did not increase the stover yield. In case of irrigated treatment (I_1) the production of stover was increased significantly with increasing plant population from 40,000 to 80,000 plants/ha.

TABLE 3. *Total production (q/ha) has influenced by I×N and I×S Interactions*

	N_0	N_1	N_2	N_3	S_1	S_2	S_3
I_0	33.96	41.25	47.29	52.08	37.03	48.12	45.78
I_1	55.25	74.58	88.33	97.50	64.68	80.62	92 18
S.Em. ±		3.74				3 24	
C.D. at 5%		10.56				9.15	

Application of 40 kg N/ha under I_0 treatment could not increase the total yield significantly over control, vide Table 3. Yet, the differences between N_3 and N_0, and N_3 and N_1 were statistically significant. Under I_1 treatment, the application of 40 kg N/ha increased the total yield significantly over control. The application of 80 kg N/ha also brought a significant increase over N_1 treatment, while difference between N_2 and N_3 was not statistically significant.

Here it is interesting to note that dry soil moisture regime gave maximum total produce under S_2 (60,000 plants/ha) treatment, while further increase in plant population slightly decreased the production as compared to S_2 treatment. In case of wet soil moisture regime there was statistically significant increase in total production with increasing plant population upto 80,000 plants/ha.

Discussion: Production of grain, stover and total produce and reproduction efficiency increased significantly due to irrigating the crop at 50% available soil moisture as compared to that of unirrigated treatment. As there was no rain after September 8 i. e, from tasseling onwards, and again from October 5 to harvest, crop remained in wilted condition, Therefore, plants under unirrigated condition could not attain full vegetative growth which caused reduction in stover and total yield. Much higher reduction in grain yield and low reproduction efficiency under dry treatment emphasise the importance of irrigation particularly in later part of life cycle for successful grain production. Alessi and Power (1965) have also reported that forage and grain yields were directy proportional to total available soil moisture.

Sowing the crop at 60,000 plants/ha resulted in increased stover and total yield as compared to the crop sown at 40,000 plants/ha under irrigated as well as unirrigated condition but under unirrigated condition further increase in plant population did not increase the production of stover or total produce while under irrigated condition the production of stover and total produce was further increased by increasing plant population from 60,000 to 80,0C0/ha. This differential response clearly indicates that under dry condition, moisture became a limiting factor for supporting a thick plant population, while under wet (I_1) soil moisture regime maximum benefit can be derived by maintaining high plant population. The findings are in close conformity with those of Richey (1933), Sommerfeldt (1961) and Alessi and Power (1965).

The response to N in terms of grain yield was very low under dry condition while under irrigated condition with the application of 40 kg N/ha the increase in the production of grain was 7.46 q/ha (108%) over control. As the crop remained in wilting stage during grain formation period which in turn resulted in poor response to the application of N under dry soil moisture regime. Low response to the higher levels of N under irrigated condition during this typical dry year may be attributed to low relative humidity and high temperature during the grain filling stage. Late sowing due to delayed monsoon may be another factor responsible for low response to the application of N.

Under wet soil moisture regimes application of 80 kg N/ha increased the yield of total produce over N_1 (40 kg N/ha) treatment, while difference between N_1 and N_2 was not significant in case of I_0 treatment. Here also moisture acted as a limiting factor and therefore crop did not respond well to the application of higher doses of N under unirrigated condition.

Summary and Conclusion: Supplimental irrigation applied at 50% available soil moisture increased the yield of grain, stover and total produce and reproduction efficiency of hybrid maize (Ranjeet) significantly, the increase being 228%, 68%, 81% and 62% respectively over unirrigated ones. Application of N under unirrigated condition did not increase grain yield significantly while under irrigated condition application of 40 and 80 kg N/ha increased the grain yield by 108% and 129% respectively over control. Under unirrigated condition 60,000 plants/ha yielded maximum stover and total produce while under irrigated conditions thick sowing i. e. 80,000 plants/ha gave maximum yield of stover and total produce.

The experiment revealed that under a typical dry weather as prevailed during the crop season studied, irrigation is the key factor for successful production of maize crop and crop may be sown at 80,000 plants/ha and a dose of 80 kg N/ha may be applied for maximum production.

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