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INFLUENCE OF VARYING MOISTURE LEVELS AND SPACING ON PRODUCTIVITY AND B:C RATIO OF HYBRID MAIZE UNDER SUBSURFACE DRIP IRRIGATION

M. NIVEDITHA, A.V. NAGAVANI*, V. SUMATHI AND V. UMAMAHESH

Department of Agronomy, S. V. Agricultural College, Tirupathi-517502, ANGRAU (A.P.), India.

ABSTRACT

A field experiment was conducted during *rabi* season, 2013 to study the effect of different IW : CPE ratios and crop geometry on yield and economics of maize. The IW: CPE ratio of 1.0 produced significantly higher grain and stover yield which was at par with I_2 (IW: CPE ratio of 0.8). With regard to crop geometry, significantly higher grain yield was obtained at a spacing of 30/90 × 20 cm, whereas higher stover yield was obtained at a spacing of 60 × 15 cm. The highest B:C ratio was obtained at IW:CPE ratio of 1.0 with a spacing of 30/90 × 20 cm.

KEY WORDS: Crop geometry, Irrigation, *Rabi* maize

INTRODUCTION

Water is considered as the most critical resource for sustainable agricultural development, which is often costly and limiting input use efficiency, particularly in semi arid tropics and needs judicious use of water to reap the maximum benefit from other inputs. Since, agriculture is the major water user, efficient use of water in agriculture is needed for the conservation of this limited resource. Increase in water use-efficiency (WUE) for enhanced drought tolerance can be achieved by strategies like change in crops, which are capable of producing acceptable yields under deficit irrigation or rainfed situations (Zwart and Bastiaanssen, 2004 and Farre and Maria, 2006).

Maize is the third most important cereal crop after wheat and rice. It is the most efficient coarse cereal crop in utilizing radiant energy and has the highest capacity to generate carbohydrates per day as compared to other cereals. The cost of production per kg of grain is less compared to other cereals, which lead to drawing the attention of the farmers of Andhra Pradesh and India.

In India it is cultivated in an area of 8.71 million hectares with grain production of 21.57 million tones and productivity of 2476 kg ha^{-1} (www.indiastat.com). In Andhra Pradesh, it is cultivated in an area of 0.86 million hectares with grain production of 3.7 million tones and productivity of 4232 kg ha^{-1}. Maize yield is a function of climate, soil, variety and cultural practices. Correlating these functions to produce the highest possible yields with the greatest efficacy has been the aim of research workers ever since the maize production began. Since, there is a limited scope to increase the area under maize cultivation because of competition from other cereals and commercial crops, the only alternative is through increasing the productivity of maize by various management factors. Among the factors limiting the grain yield of maize in many areas is inadequate irrigation and low plant population.

Drip irrigation plays an important role in water scarcity areas by maintaining the optimum soil moisture in crop root zone with increased yield. Drip irrigation provides the efficient use of limited water with higher water use efficiency. Subsurface drip irrigation method facilitate optimum moisture content near to the crop root zone with negligible evaporation losses compared to surface drip irrigation. The utilization of soil moisture by crop varies with method and time of irrigation. IW : CPE is one of the method for scheduling irrigation water.

In addition to irrigation management, optimum plant population also play a crucial role in enhancement of crop productivity. It is an established fact that higher yield depends on optimum plant population and adequate nutrient application, particularly nitrogen. In addition to plant population, it is the proper crop geometry which is important from the point of intercepting sunlight for photosynthesis besides efficient use of nutrients and moisture from soil. Correlating these functions to produce

*Corresponding author, E-mail: vaniayitepalli@yahoo.com

the highest possible yields, there is a need to investigate the optimum crop geometry with suitable irrigation schedule through IW : CPE ratio under subsurface drip irrigation to hybrid maize in sandy loam soils. Therefore, the present study was undertaken to study the effect of different IW : CPE ratios and crop geometries on yield and economics of hybrid maize.

MATERIAL AND METHODS

A field experiment was conducted during *rabi*, 2013 at College Farm, S.V. Agricultural College, Tirupati, Acharya NG Ranga Agricultural University. The soil of the experimental site was sandy clay loam and it was slightly alkaline in reaction with a pH of 7.9, Electrical Conductivity of 0.24 dSm^{-1} low in organic carbon (0.29%) and available nitrogen (186 kg ha^{-1}), medium in available phosphorous (23.4 kg P_2O_5 ha^{-1}) and high in available potassium (174.3 kg K_2O ha^{-1}). In the subsurface drip layout, the laterals are placed 1 feet below the soil surface. Spacing between the laterals in 1.5 m. Spacing between the emitters is 40 cm. Main line and lateral diameters are 75 mm and 16 mm respectively. Dripper discharge rate is 4 lph. The experiment was laid out in a split plot design and replicated thrice. The treatments consisted of three IW : CPE ratios of 0.6, 0.8 and 1.0 and four crop geometries *viz.,* 60 × 15 cm, 30/90 × 15 cm, 60 × 20 cm and 30/90 × 20 cm. Maize hybrid DHM-117 which matures in 100-105 days was tested in this experiment. Recommended dose of fertilizers (150, 60 and 40 kg N, P_2O_5 and K_2O ha^{-1}) was applied. Nitrogen, phosphorous and potassium were applied in the form of urea, single super phosphate and muriate of potash. Nitrogen was applied in three splits *i.e.,* one fourth at the time of sowing, half at 35 DAS and one fourth at tasselling stage. The entire phosphorous and potassium were applied as basal at the time of sowing. Atrazine @ 1.5 kg *a.i.* ha^{-1} was applied as pre-emergence followed by one hand weeding at 30 DAS. Irrigation was given based on IW: CPE ratio and a total of 4, 5 and 6 irrigations had been given to IW: CPE ratio of 0.6, 0.8 and 1.0, respectively. Economics was calculated based on present market price of yield and inputs.

RESULTS AND DISCUSSION

Yield

The grain and stover yield of hybrid maize was significantly influenced by different irrigation levels and crop geometries (Table 1). The highest grain and stover yield were recorded with the highest level of irrigation tried *i.e.,* IW: CPE ratio of 1.0 (I_3), which was however comparable with IW: CPE ratio of 0.8 (I_2), and both of them were significantly higher than with IW: CPE ratio of 0.6 (I_1), which has resulted in the lowest yield. The highest grain yield at IW : CPE ratio of 1.0 might be accounted to their favorable influence on the crop growth lead to enhanced growth and yield attributes (Ertek and Kara, 2013). The increased stover yield might be due to better vegetative growth and higher dry matter production at frequent irrigations (Vijay Kumar Choudhary *et al.*, 2006).

As regards the crop geometry practices, the highest grain yield was recorded with a spacing of 30/90 × 20 cm, which was at par with 60 × 20 cm followed by paired row spacing of 30/90 × 15 cm and 60 × 15 cm with no significant difference between them, which produced the lowest grain yield (Table 2). As plant density increased, changes may occur in the allocation of assimilates to different plant parts as a result of which a greater proportion of plants may become barren and also there may be a critical period for light interception in relation to grain formation at higher populations (Ummedsingh *et al.*, 2012). Significantly higher stover yield was recorded with 60 × 15 cm, which was comparable with paired row spacing of 30/90 × 15 cm. The next best treatment was 60 × 20 cm which was at par with 30/90 × 20 cm which produced the lowest stover yield. This is due to increased number of plants per unit area and increased growth of plants *i.e.,* plant height, leaf area, dry matter production (Ummed Singh *et al.*, 2012).

The interaction effect of irrigation levels and crop geometry practices with respect to grain yield was significant. The highest yield being produced with IW : CPE ratio of 1.0 at a paired row spacing of 30/90 × 20 cm and the lowest grain yield was produced with IW : CPE ratio of 0.6 at crop geometry of 60 × 15 cm (Table 3). This is due to more number of cobs ha^{-1} under adequate moisture availability which had direct bearing on the production of highest yield (Salah E. El- Hendawy *et al.*, 2008). The interaction effect of irrigation levels and crop geometry practices with respect to stover yield was significant and the highest stover yield being produced with I_3G_1 (the highest level of irrigation in combination with a spacing of 60 × 15 cm) and I_1G_4 (the lowest level of irrigation in combination with a spacing of 30/90 × 20 cm) produced the lowest stover yield. It was due to increased leaf area index and leaf area duration at harvest (Vijay Kumar Choudhary *et al.*, 2006).

Table 1. Yield and economics of maize as influenced by different IW:CPE ratios and crop geometry under subsurface drip irrigation

Treatment	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
IW:CPE ratio (I)						
0.6	2615	4079	39.2	45921	16575	1.57
0.8	4658	6489	41.6	81021	51601	2.76
1.0	4919	6753	42.0	85459	55963	2.90
SEm±	87	140	0.6	1500	4915	0.08
C.D. (P=0.05)	343	551	2.3	5892	6950	0.33
Crop geometry (G)						
60 × 15 cm	3483	6079	36.0	61814	31709	2.07
30/90 × 15 cm	3553	6023	36.8	62875	33207	2.10
60 × 20 cm	4575	5501	45.2	78711	49594	2.70
30/90 × 20 cm	4644	5491	45.7	79801	51008	2.76
SEm±	26	18	1.1	410	1073	0.03
C.D. (P=0.05)	78	56	3.4	1219	1517	0.08
Interaction						
C.D. (P=0.05)	Significant	Significant	Non significant	Significant	Significant	Significant

Table 2. Grain yield (kg ha^{-1}) of maize as influenced by different IW: CPE ratios and crop geometry under subsurface drip irrigation

Treatments	IW:CPE ratio (I)			
Crop geometry (G)	**0.6**	**0.8**	**1.0**	**Mean**
60 × 15 cm	2264.2	3967.8	4218.3	3483.4
30/90 × 15 cm	2329.8	4032.1	4297.8	3553.2
60 × 20 cm	2897.6	5287.9	5541.5	4575.7
30/90 × 20 cm	2968.9	5345.2	5618.9	4644.3
Mean	2615.1	4658.3	4919.1	

	SEm±	CD (P=0.05)
I	87.41	343.2
G	26.33	78.2
I at G	95.93	361.1
G at I	45.62	135.5

Table 3. Stover yield (kg ha^{-1}) of maize as influenced by different IW: CPE ratios and crop geometry under subsurface drip irrigation

Treatments	IW:CPE ratio (I)			
Crop geometry (G)	**0.6**	**0.8**	**1.0**	**Mean**
60 × 15 cm	4518	6704	7015	6079
30/90 × 15 cm	4487	6676	6907	6023
60 × 20 cm	3685	6302	6515	5501
30/90 × 20 cm	3625	6275	6574	5491
Mean	4079	6489	6753	

	SEm±	CD (P=0.05)
I	140.4	551.3
G	18.9	56.2
I at G	143.3	557.0
G at I	32.8	97.2

Economics

The highest gross and net returns with hihger benefit -cost ratio were realized with IW: CPE ratio of 1.0, which was however comparable with IW: CPE ratio of 0.8 but significantly higher than with IW: CPE ratio of 0.6. Crop geometry practice of 30/90 × 20 cm produced the highest gross and net returns and B:C ratio, which was at par with 60 × 20 cm. Plant spacing of 60 × 15 cm has resulted in the lowest gross and net returns and B:C ratio under subsurface drip irrigation in sandy clay loam soils.

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