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Effects of Sub Surface Drip Fertigation on Yield Attributes and Yield of Zero Tillage Maize

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Abstract A field experiment was carried out for two consecutive years (2012-13 and 2013-14) on sandy loam soils of Jain Hi-tech Agri institute, Jalgaon, Maharashtra with the objective to study the response of zero tillage to subsurface drip fertigation. The experiment was laid out in split-plot design with four replications. The yield attributes viz. Cob length, Number of kernels per cob, Kernel weight per cob, Test weight, kernel and straw yield, of zero till maize increased with increase in irrigation schedule from 75% Epan to 150% Epan irrigation schedule in drip irrigation. Increase in the level of N application from 120 to 240 kg N ha^{-1} resulted in the increase of all the yield attributes, kernel and stover yield were higher with the irrigation schedule of 150% Epan and nitrogen dose of 240 kg N ha^{-1} applied through fertigation.

Keywords Zero tillage maize, Sub surface drip, Fertigation.

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Introduction

Maize is the third most important cereal crop next to rice and wheat in the world. In India, maie is grown in an area of 8.26 m ha with a production of 16.72 m t with a productivity of 2024 kg ha^{-1}. In Andhra Pradesh, it is grown in an area of 0.783 m ha with a production and productivity of 2.762 m t and 3527 kg ha^{-1} respectively [1]. Judicious use of irrigation water coupled with efficient nutrient management is more important to enhance total food grain production. During vegetative growth, plants have a high demand for nitrogen that is required for efficient root system, leaf and stem development and dry matter production. Nitrogen is the main plant nutrient that limits plant growth and affects yield and quality of the kernel. Escalating prices of nitrogen fertilizers coupled with reduction in subsidy on fertilizers have forced crop growers to use fertilizers efficiently. Better plant nutrient management is necessary for achieving self-reliance in agriculture [2].

Fertigation is the precies application of water soluble fertilizers (Nitrogen) through drip irrigation. It is an efficient and economically viable method of

Table 1. Cob length (cm) of zero tillage maize as influenced by irrigation schedule and N level through sub surface drip fertigation.

	2012-13 Nitrogen level (kg ha^{-1})					2013-14 Nitrogen level (kg ha^{-1})				
Irrigation schedule	120	160	200	240	Mean	120	160	200	240	Mean
I_1 : 75% Epan	17.9	18.3	18.7	19.4	18.6	16.8	17.1	17.3	17.6	17.2
I_2 : 100% Epan	18.6	18.9	19.3	19.7	19.1	17.5	17.3	17.4	17.9	17.5
I_3 : 125% Epan	18.6	19.3	19.7	20.0	19.4	18.0	18.3	18.4	18.5	18.3
I_4 : 150% Epan	19.9	19.7	20.0	20.4	19.8	18.3	18.4	18.5	18.9	18.5
Mean	18.6	19.0	19.4	19.9		17.6	17.8	17.9	18.2	
		SEm±	CD (p=0.05)	CV %			SEm±	CD (p=0.05)	CV %	
I		0.1	0.2	1.1			0.1	0.4	3.0	
N		0.1	0.4	2.9			0.2	0.7	5.4	
I × N										
N at same level of I		18.3	NS				17.1	NS		
I at Same or different level of N		18.9	NS				17.3	NS		
Check : Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}				19.5						18.4

providing soluble plant nutrients directly to the active plant root zone [3]. The increase in area under micro-irrigation in different crops provides an excellent opportunity to explore fertigation technique that provides complete and balanced plant nutrient management and have the potential to improve plant growth and maximum yield with less/equal quantity of nitrogen. Though many studies were reported on effect of drip irrigation and N fertigation levels on grain maize, only few have been reported on maize with drip irrigation and N fertigation.

Materials and Methods

A field experiment was carried out for two consecutive years (2012-13 snd 2013-14) at sandy loam soils of Jain Hi-tech Agri institute, Jalgaon, Maharashtra with the objective to study the response of zero tillage to subsurface drip fertigation. The experimental soil was sandy loam soils which had pH of 7.3 and soil was low in organic carbon (0.37%), available nitrogen (184.4 kg ha^{-1}), available phosphorus (11 kg ha^{-1}) and available potassium (257.3 kg ha^{-1}) experiment was ladi out in split-plot design with four replications. Four irrigation schedules were taken in main plots and four nitrogen levels in sub plots in drip system irrigation treatments included I_1 : SDI at 75% Epan, I_2 : SDI at 100% Epan, I_3 : SDI at 125% Epan and I_4 : SDI at 150% Epan with four nitrogen levels i.e., N_1 :120; N_2 ; 160; N_3 : 240 kg ha^{-1} in fertigation. In maize crop, the check tested was surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}. The cultivars used for the study 'Dekalb' (Private hybrid) in maize. The growth parameters viz. plant height, drymatter accumulation and kernel yield, of zero till maize increased with increase in irrigation schedule from 75% Epan to 150% Epan irrigation schedule in drip irrigation. Increase in the level of N application from 120 to 240 kg N ha^{-1} resulted in the increase of all the growth parameters, kernel yield were higher with the irrigation schedule of 150% Epan and nitrogen dose of 240 kg N ha^{-1} applied through fertigation. N was supplied as per the treatments through fertigation commencing from 10 days after sowing upto 80 days after sowing using water soluble fertilizers (Urea) through a ventury fitted to the drip system at weekly interval. For check treatment, N was applied in three equal splits as basal, at knee high and tasseling stages. P_2O_5 was supplied @ 60 kg ha^{-1} as mono ammonium phosphate (MAP) during first fertigation uniformly to all the treatments. For check it was applied as single super phosphate as basal dose. Uniform dose of K_2O @ 50 kg ha^{-1} was applied for all the treatments including checks as basal through MOP.

Table 2. Number of kernels per cob of zero tillage maize as influenced by irrigation schedule and N level through sub surface drip fertigation.

Irrigation schedule	2012-13 Nitrogen level (kg ha^{-1}) 120	160	200	240	Mean	2013-14 Nitrogen level (kg ha^{-1}) 120	160	200	240	Mean
I_1 : 75% Epan	236.3	241.4	243.2	245.9	241.7	199.9	208.8	213.7	226.4	212.2
I_2 : 100% Epan	237.4	242.2	249.2	250.7	244.9	213.8	219.6	223.9	230.2	221.9
I_3 : 125% Epan	241.8	243.4	258.1	265.7	252.2	224.9	232.3	242.0	245.0	236.0
I_4 : 150% Epan	246.4	254.9	261.0	268.0	257.6	236.5	243.1	244.2	248.3	243.0
Mean	240.5	245.5	252.9	257.6	249.1	218.8	225.9	230.9	237.5	228.3
		SEm±	CD (p=0.05)	CV %			SEm±	CD (p=0.05)	CV %	
I		3.9	12.6	6.3			3.3	10.4	5.7	
N		3.4	9.7	5.4			2.9	8.4	5.1	
I × N										
N at same level of I		6.8	NS				17.6	NS		
I at Same or different level of N		7.1	NS				18.1	NS		
Check : Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}				254						233

Results and Discussion

Cob length increased with increased irrigation regimes during both the years of study. In the first year of study all the irrigation levels differed significantly with one on other. There was a gradual and significant increase in cob length with each increment in irrigation levels (Table 1). Longer cobs (19.8 cm) were seen with irrigation schedule of 150% Epan and dwarfer cobs (18.6 cm) were registered with 75% Epan scheduled irrigation treatments. During second year of study also the longer cobs (18.5 cm) and shorter cobs (17.2 cm) were observed with irrigation schedule of 150% Epan and 75% Epan. However the treatments in pairs of 75%–100% Epan and 125%–150% Epan were on a par. Longer cobs were recorded high-

Table 3. Test weight (g) of zero tillage maize at maturity as influenced by irrigation schedule and N level through sub surface drip fertigation.

Irrigation schedule	2012 Nitrogen level (kg ha^{-1}) 120	160	200	240	Mean	2013 Nitrogen level (kg ha^{-1}) 120	160	200	240	Mean
I_1 : 75% Epan	23.7	24.1	24.6	24.6	24.3	23.0	23.4	23.9	23.9	23.6
I_2 : 100% Epan	24.3	25.0	25.8	26.3	25.3	23.6	24.3	25.1	25.6	24.6
I_3 : 125% Epan	25.5	26.2	26.7	27.3	26.4	24.8	25.5	26.0	27.1	25.8
I_4 : 150% Epan	26.0	26.6	26.8	28.1	26.9	25.3	26.1	26.4	28.0	26.4
Mean	24.9	25.5	26.0	26.6		24.2	24.8	25.3	26.1	
		SEm±	CD (p=0.05)	CV %			SEm±	CD (p=0.05)	CV %	
I		0.3	1.0	5.0			0.3	1.0	4.9	
N		0.3	0.8	4.3			0.2	0.7	3.9	
I × N										
N at same level of I		0.6	NS				0.5	NS		
I at Same or different level of N		0.6	NS				0.5	NS		
Check : Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}				25.9						25.4

Table 4. Kernel yield (kg ha^{-1}) of zero tillage maize at maturity as influenced by irrigation schedule and N level through sub surface drip fertigation.

	2012 Nitrogen level (kg ha^{-1})					2013 Nitrogen level (kg ha^{-1})				
Irrigation schedule	120	160	200	240	Mean	120	160	200	240	Mean
I_1 : 75% Epan	8253	9047	9330	9980	9152	7867	8124	8533	8793	8329
I_2 : 100% Epan	8698	9478	9811	10350	9584	8443	9246	9739	9931	9340
I_3 : 125% Epan	8950	9714	10485	11124	10068	9530	9809	10212	10690	10060
I_4 : 150% Epan	9599	10976	11753	11942	11067	10326.3	11234	11620	12256	11359
Mean	8875	9804	10344	10849		9042	9603	10026	10418	
		SEm±	CD (p=0.05)	CV %			SEm±	CD (p=0.05)	CV %	
I		258	826	10			258	758	10	
N		255	731	10			255	698	10	
I × N										
N at same level of I		510	NS				487	NS		
I at Same or different level of N		511	NS				484	NS		
Check : Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}				8910						8052

est with Sub surface irrigation plots might be due to more vigorous and luxuriant vegetative growth, which in-turn favored better partitioning of assimilates from source to sink [4].

Significantly longer cobs (19.9 cm and 18.2 cm) were recorded with the fertigation level at of 240 kg N ha^{-1} compared to 120 kg N ha^{-1} (18.6 cm and 17.6 cm) and it was on a par with 160 kg N ha^{-1} (17.9 cm) during 2013-14. During 2012-13 the cob length was significantly superior to one another. N application increases the potential sink capacity and sink growth rate [5].

Number of kernels cob^{-1} significantly increased with increasing irrigation schedule, the highest number of kernels cob^{-1} were recorded with 150% Epan (257.6) and was superior to 75%Epan (241.7), but on a par with 125% Epan (252.2). Similar trend was followed in 2013-14 also. Increased number of kernels at higher irrigation schedules was also reported by Zaidi et al. [6]. Kernel number cob^{-1} was also enhanced gradually with increase in N dose from 120 to 240 kg N ha^{-1} (Table 2). During first year, kernel number cob^{-1} with 240 kg N ha^{-1} (257.6) was significantly superior to that of 120 kg N ha^{-1} (240.5) but was on a par with that of 200 kg N ha^{-1} (252.9). However during second year, fertigation at 240 kg N ha^{-1} recorded significantly higher number of kernels per cob (237.5) over 200, 160 and 100 kg N ha^{-1}. Nitrogen stress at lowest doses during flowering stage might have resulted in kernel and ear abortion and stress during grain filling accelerates leaf senescence reduce photosynthesis and kernel development [7].

The varying irrigation levels showed significant effect on 100 kernel weight of zero tillage maize. Significantly higher kernel weight was observed with the 150% Epan (26.9 and 26.4 g) which was on par with 125% Epan (26.4 and 25.8 g) during both the years of study and these two differed significantly from remaining irrigation levels. Least test weight was recorded in 75% Epan (24.3 and 23.6 g) during both the years of experimentation. Surface irrigation at IW/CPE ratio 1.2 recorded similar test weight compared to 100% Epan during 2012-13 and 125% Epan during 2013-14.

The increase in the level of nitrogen from 120 to 240 kg ha^{-1} significantly influenced the 100 kernel weight. Application of nitrogen at 240 kg ha^{-1} recorded the maximum weight (26.6 and 26.1 g) followed by 200 kg N ha^{-1} but both were at par and significantly differed from remaining doses (Table 3). Least kernel weight was recorded at 120 kg N ha^{-1} (24.9 and 24.8 g) during both years of study. These results are in agreement with [8].

Kernel yield increased with increasing Nitrogen fertigation level. Among the four nitrogen levels studied, higher kernel yield was recorded at 240 kg N ha^{-1} (10849 and 11359 kg ha^{-1}) and was superior to that of fertigation with 120 kg N ha^{-1} (8875 and 9042 kg ha^{-1}) during first year and at par with 200 kg N ha^{-1} during second year (Table 4). Application of 160 kg was again superior to 120 kg N ha^{-1} during both the years. Nitrogen fertigation with more readily available form at more frequent intervals might have resulted in higher availability of nitrogen in the soil solution which led to higher growth, uptake and better translocation of assimilates from source to sink thus in turn might have increased the yield [9].

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