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Studies on Growth and Yield of Maize as Influenced by Drip Fertigation

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Abstract

A field experiment was conducted during *Kharif* 2015 at Zonal Agricultural Research Station, V.C. Farm, Mandya, Southern Dry Zone of Karnataka to study the growth and yield of maize as influenced by drip fertigation. The experiment was laid out in randomized complete block design with three replications and eleven treatments comprising two levels of irrigation and four levels of fertilizers, absolute control, package of practice and paired row of spacing 45 x 75 cm. Highest plant height, number of leaves per plant, leaf area and total dry matter production was observed in the treatment irrigation @ 100 per cent CPE + DF 125 per cent RDF (206.10 cm, 13.19 plant $^{-1}$, 5701.78 cm^2, 360.00 g plant^{-1}, respectively) followed by irrigation @ 100 per cent CPE + DF 100 per cent RDF (203.90 cm, 12.98 plant $^{-1}$, 5695.11 cm^2, 350.67 g plant^{-1}, respectively) and absolute control (173.28 cm, 9.40 plant $^{-1}$, 3572.51 cm^2, 260.67 g plant^{-1}, respectively). Irrigation @ 100 per cent CPE + DF 125 per cent RDF was found higher kernel yield (7763 kg ha^{-1}) this might be due to more cob weight (160.16 g), higher cob length (16.12 cm), more rows per cob (17.56) and higher kernels per cob (527.65). Lowest was in absolute control (1531 kg ha^{-1}).

Maize (*Zea mays* L.) is becoming very popular cereal crop in India, because of the increasing market price and high production potential of hybrids in both irrigated as well as rainfed conditions. In India, about 50 to 55 per cent of the total maize production is consumed as food, 30 to 35 per cent goes for poultry, piggery and fish meal industry and 10 to 12 per cent to wet milling industry (Arun Kumar *et al*., 2007).It occupies an area of 9.4 m.ha in India with a production of 23 mt. (Anon., 2014). In Karnataka maize is grown in an area of 1.28 m.ha with a productivity of 3018 kg ha^{-1} (Anon., 2012). For increasing the profitability of maize, farmers are cultivating the crop intensively with the large use of chemical fertilizers, pesticides, weedicides, *etc*. Maize crop has better yield response to chemical or inorganic fertilizers. Hence, heavy doses of these fertilizers are applied. Though these practices help in temporary increasing of crop production; deterioration of natural resources (*viz*., land, water and air) is also another side of such high input intensive cultivation has been associated with decline in soil physical and chemical properties and crop yield (Paul Hepperly *et al.,* 2009).

Improper management of water has contributed extensively to the current water scarcity and pollution problems in many parts of the world, and also a serious challenge to future food security and environmental safety. This issue requires an integrated approach to soil-water-plant nutrient management at the plant rooting zone. One of these technologies is fertigation, which is the direct application of water and nutrients to plants through a drip irrigation system. Keeping in this view, an experiment was conducted to study the growth and yield of maize as influenced by drip fertigation.

Material and Methods

A Field experiment was conducted during *Kharif* 2015 at Zonal Agricultural Research Station, V.C.Farm, Mandya, Southern Dry Zone (Zone-6) of Karnataka. The experimental site is located between 12º 51' and Latitude and 77º 35' E Longitude at an altitude of 930 m above mean sea level (MSL). The soil was sandy loam with organic carbon content of 4.1 g kg^{-1}. The initial nitrogen, phosphorus and potassium status of the soil were 250.30, 26.50 and 175.69 kg per ha, respectively. The soil pH was 6.5 with an EC of 0.32 dSm^{-1}. The experiment was laid out in randomized complete block design with eleven treatments and three replications.

The drip line was passed in between paired row, which includes 18 emitters in each row at a distance of 30 cm with a total of 180 emitters per plot. This system included pump, filter units, fertigation tank, ventury, main line and sub line for each replication and a lateral for each plot.The calculated quantity of phosphorus was applied to all the treatments through single super phosphate by soil application, whereas, nitrogen and potassium were supplied through drip in equal splits (starting from 12th days after sowing up to silking stage) using water soluble urea and muriate of potash, respectively. The quantity of water to be irrigated was calculated based on daily pan evaporation and irrigated four days once.

The growth parameters like plant height, number of leaves, leaf areaand totaldry matter recorded at harvest and yield parameters like cob length, cob weight, number of kernel row per cob, number of kernels per cob, kernel and stover yield was recorded.

Results and Discussion

Growth parameters of maize at various growth stages as influenced by levels of irrigation and drip fertigation : Highest plant height, number of leaves per plant, leaf area and total dry matter production was observed in the treatment irrigation @ 100 per cent CPE + DF 125 per cent RDF (T_8) (206.10 cm, 13.19, 5701.78 cm^2, 360.00 g $plant^{-1}$, respectively) followed by T_9: irrigation @ 100 per cent CPE + DF 100 per cent RDF (203.90 cm, 12.98, 5695.11 cm^2, 350.67 g $plant^{-1}$, respectively) and absolute control (173.28 cm, 9.40, 3572.51 cm^2, 260.67 g $plant^{-1}$, respectively) (Table I).The higher growth parameters at all the crop growth stages and at harvest might be attributed toavailability of nutrients in root zone of plants, where plants were able to utilize all the nutrients and varying levels of nutrient management obviously results in to greater variation in growth patterns of maize leading to different levels of yield (Abbas Soleimanifard *et al.,* 2011).

Irrigation is one of the most important input influencing the plant growth and yield of maize. Water is the major constituent of physiologically active tissue. It is the solvent in which salts, sugars and other solute

Table I

Growth parameters of maize at various growth stages as influenced by levels of irrigation and drip fertigation

Treatment	Plant height (cm)	Number of leaves $plant^{-1}$	Leaf area (cm^2)	Total dry matter (g plant-1)
T_1: Absolute control	173.28	9.40	3572.51	260.67
T_2: Paired row (RDF+ FYM+ $ZnSO_4$ soil application)	196.25	11.45	5258.63	343.33
T_3: UAS Package (spacing 30/60 +RDF+FYM+ $ZnSO_4$)	200.32	10.40	5012.25	321.92
T_4: Irrigation @ 75 % CPE + DF 125 % RDF	202.14	12.30	5601.96	348.33
T_5: Irrigation @ 75 % CPE + DF 100 % RDF	197.28	11.50	5428.74	344.33
T_6: Irrigation @ 75 % CPE + DF 75 % RDF	195.9	10.90	5096.11	325.67
T_7: Irrigation @ 75 % CPE + DF 50 % RDF	179.10	9.89	4555.29	310.69
T_8: Irrigation @ 100 % CPE + DF 125 % RDF	206.10	13.19	5701.78	360.00
T_9: Irrigation @ 100 % CPE + DF 100 % RDF	203.90	12.98	5695.11	350.67
T_{10}: Irrigation @ 100 % CPE + DF 75 % RDF	200.10	11.89	5601.50	346.33
T_{11}: Irrigation @ 100 % CPE + DF 50 % RDF	177.24	10.20	4656.00	313.62
S.Em.±	5.68	0.48	256.67	9.00
C.D. (p=0.05)	17.08	1.55	762.60	26.55

Note : CPE: Cumulative pan evaporation DF: Drip fertigation RDF: Recommended dose of fertilizers move from cell to cell and organ to organ. It is essential for maintenance of the turgidity, necessary for cell enlargement and growth. Thus, highest growth parameters were attributed to the timely application of water to the root zone of the crop, which in turn increased the physiological activity of the cells (Sefer Bozkurti *et al.,* 2011).

Fertigation resulted in continuous supply of nutrients besides maintaining optimum water availability which lead to higher uptake of nutrients (203.91, 52.10 and 173.37 kg ha^{-1}) which in turn recorded higher growth parameters. Similar results have been reported by Abdesh *et al.* (2006), Hokam *et al*. (2011) and Richa Khanna (2013) in maize.

The economic yield is a fraction of the total biological yield of the crop (Donald, 1962). Total dry matter production may reflect on the economic yield in view of the fact that, vegetative part of the plant serves as the source and the kernels as sink. Accumulation of dry matter (resultant of leaf area duration and crop growth rate during the crop cycle) and its distribution to yield attributes during reproductive stage (translocation from source to sink) determines the yield of a crop.

*Maize yield as influenced by levels of irrigation and drip fertigation :*Irrigation @ 100 per cent CPE + DF 125 per cent RDF was found higher kernel yield (7763 kg ha^{-1}) this might be due to more cob weight (160.16 g), higher cob length (16.12 cm), more rows per cob (17.56) and higher kernels per cob (527.65) and lowest yield was recorded in absolute control (1531 kg ha^{-1}) (Table II & III). Application of water in accordance with plant need (100% CPE) to the root zone with required quantity and irrigation intervals through drip in combination with water soluble fertilizers favored higher uptake of nutrients which contributed better growth and yield parameters and yield of maize.The similar trends were also observed for stover yield. This higher yield parameters due to sufficient supply of nutrients to the root zone of the crop and less moisture stress leads better transfer of photosynthates from source to the sink (Abd El-Rehman, 2009) and Richa Khanna (2013).

Kernel yield recorded with irrigation @ 100 per cent CPE + DF 100 per cent RDF (7619 kg ha^{-1}) was

TABLE II

Yield parameters of maize as influenced by levels of irrigation and drip fertigation

Treatment	Cob lenght (cm)	Rows per cob	Kernels per cob	Test Weight (g)	Cob Weight (g)
T_1: Absolute control	10.95	12.01	390.10	25.01	101.18
T_2: Paired row (RDF+ FYM+ $ZnSO_4$ soil application)	14.14	15.13	455.40	26.95	130.46
T_3: UAS Package (spacing 30/60 +RDF+FYM+ $ZnSO_4$)	12.85	14.15	433.00	26.13	126.01
T_4: Irrigation @ 75 % CPE + DF 125 % RDF	15.50	16.67	488.16	28.10	147.87
T_5: Irrigation @ 75 % CPE + DF 100 % RDF	14.91	15.51	460.98	27.28	136.38
T_6: Irrigation @ 75 % CPE + DF 75 % RDF	13.50	14.45	445.40	26.42	128.91
T_7: Irrigation @ 75 % CPE + DF 50 % RDF	12.10	13.54	432.25	25.12	115.80
T_8: Irrigation @ 100 % CPE + DF 125 % RDF	16.12	17.56	527.65	28.80	160.16
T_9: Irrigation @ 100 % CPE + DF 100 % RDF	15.90	17.00	509.25	28.60	155.24
T_{10}: Irrigation @ 100 % CPE + DF 75 % RDF	15.23	16.10	470.38	27.81	139.19
T_{11}: Irrigation @ 100 % CPE + DF 50 % RDF	12.52	13.94	440.10	25.53	120.06
S.Em±	0.86	0.97	27.55	1.44	7.91
CD at 5 %	2.67	2.81	80.43	NS	24.07

Note: CPE: Cumulative pan evaporation **DF:** Drip fertigation **RDF:** Recommended dose of fertilizers

TABLE III

Maize yield as influenced by levels of irrigation and drip fertigation

Treatment	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1: Absolute control	1531	1627
T_2: Paired row (RDF+ FYM+ $ZnSO_4$ soil application)	5902	6125
T_3: UAS Package (spacing 30/60 +RDF+FYM+ $ZnSO_4$)	5649	5824
T_4: Irrigation @ 75 % CPE + DF 125 % RDF	7383	7792
T_5: Irrigation @ 75 % CPE + DF 100 % RDF	7278	7521
T_6: Irrigation @ 75 % CPE + DF 75 % RDF	5839	6015
T_7: Irrigation @ 75 % CPE + DF 50 % RDF	3863	4158
T_8: Irrigation @ 100 % CPE + DF 125 % RDF	7763	8159
T_9: Irrigation @ 100 % CPE + DF 100 % RDF	7619	7938
T_{10}: Irrigation @ 100 % CPE + DF 75 % RDF	7351	7650
T_{11}: Irrigation @ 100 % CPE + DF 50 % RDF	4104	4427
S.Em±	247.5	213.6
CD at 5 %	751.3	656.4

Note : CPE:Cumulative pan evaporation, DF : Drip fertigation, RDF: Recommended dose of fertilizers

found on par with the T_8, but significantly over paired row (RDF+ FYM+ $ZnSO_4$ soil application) (5902 kg ha^{-1}) and UAS package (spacing 30/60 +RDF+FYM+ $ZnSO_4$) (5649 kg ha^{-1}) treatments. The growth parameters *viz*., plant height, number of leaves and leaf area were found higher in treatments, received fertilizers than absolute control resulted in production of higher photosynthates that contributes for higher yield. Balanced and optimum dose of macro and micronutrients, which might have improved soil condition, root proliferation and source to sink relationship. Similar results on maize yield were observed by Arun Kumar *et al.* (2007).

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