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Response of Irrigation and Fertigation Management on Growth and Yield of Maize

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A B S T R A C T

A field experiment was carried out at AICRP on Irrigation Water Management, V.N.M.K.V., Parbhani during *kharif* season of 2015-16 on clayey soil. The experiment was laid in split plot design with twelve treatments consisting of three combinations of irrigation as main plot and four combinations of fertigation as sub plot treatments replicated thrice. Treatments consist of Main plot treatments - Irrigation Levels viz., 0.6 x P.E through drip, 0.8 x P.E through drip, 1.0 x P.E through drip and Subplot treatments: - Fertigation Levels Viz., 100 % RDF through Fertigation, 75 % RDF through Fertigation, 50 % RDF through Fertigation, 100%RDF as soil application. Growth parameters like plant height (cm), dry matter production (g), number of grains per cob, cob weight per plant, grain weight per plant, and number of grain row per cob were significantly higher with irrigation at 1.0 PE (I_1) over the 0.6 PE (I_3) and comparable with 0.8 PE (I_2) at all observations. Application of fertilizer @ 100% RDF through drip (F_1) recorded significantly highest growth parameters like plant height (cm), and dry matter production (g), number of grains per cob, cob weight per plant, grain weight per plant, number of grain row per cob over the application of fertilizer with 100% RDF through soil (F_4) and 50% RDF through drip (F_3), respectively but it was on par with 75% RDF through drip (F_2). Significantly lowest growth parameters were recorded at 50% RDF through drip (F_3) and were at par with 100% RDF through drip (F_4).

Introduction

Maize (*Zea mays L.*) also called corn, is one of the most crucial and strategic crop in the world. Its origin is in Mexico (Central America) and it is also called as queen of cereals due to its great importance in human, animal diet and high yielding ability. It efficiently utilizes solar energy and has immense potential for higher yield, and called as "Miracle Crop". It is the crop of the future as mentioned by the Father of Green Revolution, Renounced Nobel Laureate Dr. Norman E. Borlaug. Maize plays a vital role in ensuring food security as well as nutritional security through quality protein (Rawool, 2004). It is ranked third after wheat and rice in area and production but in productivity, it surpasses all cereals. Among the maize producing countries in 2014, USA has the largest area and production (314 million tonnes) followed by China, Brazil, Ukraine, India, Argentina, Mexico etc. Worldwide production of maize is 785 million tonnes, of which USA produces 42% Asia produces 28.5% and Africa contributing 6.4%. Maize accounts 22 and 25% of world cereal area and production, respectively (Anonymous, 2015). In India, area and production of maize is about 9.43 million hectares, 24.35 million tones, respectively, having average productivity of about 2337 kg/ha (www.indiastat.com/maize). It ranked next to rice, wheat and sorghum in respect of area and production. Though it is consumed all over the country but it is a staple food of people in hilly and sub mountain area of North India. It is extensively grown in Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh etc. (Dayannad and Jain, 1994). In Maharashtra, the area and production of maize is about 0.58 million hectares and 1.15 million tonnes production with the productivity of 2066 kg/ha (Anonymous, 2014). It is well known that maize is a heavy feeder crop and it gives response to fertilization, especially where soils are generally low in native fertility. It is generally observed that maize fails to produce worthwhile grain yield in plots without fertilizer application (Kumar, 1993). Soil fertility is a major constraint for its productivity, low organic matter content coupled with low and imbalance application of nutrients limits its full potential yield and is the main yield barrier (Bellakki *et al.,* 1999, Kalane 1998). Considering the commercial demand of maize its productivity needs to be increased. This can be easily possible through manipulation of major input factor like irrigation and fertigation. However, the work on these aspects in maize is very meager, particularly in post rainy season. Therefore, the importance of these aspects in maize production, an experiment was planned on Studies on irrigation and fertigation management in post *Kharif* maize.

Materials and Methods

A field experiment was conducted during *kharif* season of 2015-16 at AICRP on Irrigation Water Management, V.N.M.K.V., Parbhani with objectives to study the performance of maize under irrigation levels in post *kharif* season, to determine optimum fertigation levels for maize in post *kharif* season and to study the interaction effect of irrigation and fertigation levels on maize in post *kharif* season. The topography of field was fairly uniform and leveled.

The soil was clayey in texture, medium in total nitrogen and available phosphorus, high in potassium and slightly alkaline in reaction Sowing was done by dibbling method on September 9, 2015. The experiment was laid out in split plot design with twelve treatments consisting of three combinations of irrigation as main plot and four combinations of fertigation as sub plot treatments replicated thrice. The layout consisted of thirty three plots with gross plot size of 6.0 m x 5.0 m and net plot size of 3.6 m x 4.4 m.

Results and Discussion

Effect of irrigation levels

Growth attributes

Data on growth attributes during present investigation (Table 1) revealed that irrigation scheduled at 1.0 PE (I_1) recorded maximum plant height, and dry matter per plant at all observation dates. This was followed by irrigation at 0.8 (I_2) and irrigation at 0.6 (I_3), respectively for all growth attributes at all crop growth stages this trend in growth attributes showed that maize responded linearly with increasing irrigation levels from 0.6 PE to 1.0 PE this also indicated that there is higher water requirement for maize to obtain better growth of the crop. Better growth attributes with increased irrigation level also reported by Bharti *et al.,* (1997), Abdullah *et al.,* (2001), Bharti *et al.,* (2007), Patil *et al.,* (2008) and Basva *et al.,* (2012).

Better growth of maize under drip might be attributed to better moisture availability, soil aeration and also crop did not experience stress during the crop growth period at 1.0 PE irrigation schedule this ultimately reflected better physiological activity in plant and there by increased plant height, and dry matter production per plant. Similarly findings were reported by Thorat and Ramteke (1991) and Leta Tulu (1998).

Yield attributes

Data pertaining to yield attributes indicated that yield attributing characters *viz*., number of cobs per plant, average weight of cob, number of grain per cob and number of grain per row per cob, weight of grain per plant were significantly influenced by different treatments of irrigation (Table 1 and 2).

Amongst irrigation levels, 1.0 PE (I_1) recorded significantly higher values of above referred yield attributing characters over 0.6 PE (I_3) and was comparable with 0.8 PE (I_2). This might be due to the water stress under low PE which resulted in poor plant growth due to restriction imposed on nutrient translocation, photosynthesis and metabolic activities of plant system.

All these above referred yield attributes were decreased with subsequent decrease in the level of irrigation. These findings are in close conformity with those of Khan *et al.*, (1996), Tyagi *et al.*, (1998) and Bharti *et al.*, (2007).

Grain yield and fodder yield

Irrigation levels significantly influenced the grain yield of maize. Drip irrigation at 1.0 PE. (I_1) registered significantly higher grain yield of maize than 0.6 PE (I_3) and was at par with 0.8 PE (I_2) (Table 3). This might be attributed to better growth and yield attributes under 1.0 PE (I_1) compared to irrigation at lower PE values. Significantly higher grain yield, fodder yield and biological yield was observed with irrigation at 1.0 PE (I_1) than irrigation at 0.6 PE (I_3), however, it was found comparable with 0.8 PE (I_2).

Harvesting index showed little variation among irrigation levels, 1.0 PE (I_1) was numerically higher than rest of treatments followed by 0.8 PE (I_2) and 0.6 PE (I_3), respectively. This indicated little effect on sink-source relation due to fertigation levels.

Effect of fertigation levels

Growth attributes

Data on growth attributes at all observations indicated that 100 % RDF through drip showed maximum plant height, and dry matter per plant than rest of the fertigation levels *viz*., 75% RDF through drip (F_2), 100% RDF through soil (F_4) and 50% RDF through drip (F_3), respectively. This might be attributed to better availability of nutrient under application of water soluble fertilizer which resulted in better or on par growth attributes with low fertigation levels i.e. 50% RDF and 75% RDF through drip over 100% RDF through soil. Similar results were found by Sampatkumar and Pandian (2010) and Muthukrishnan *et al.*, (2011)

Yield attributes

Yield attributing characters of maize *viz*., number of cobs per plant, average weight of cob, number of grain per cob and number of grain row per cob, weight of grain per plant were differed statistically due to various fertigation levels (Table 3). 100% RDF through drip (F_1) recorded significantly higher values of all above referred yield attributes over 100% RDF through soil application (F_4) and 50% RDF through fertigation (F_3), respectively.

Table.1 Growth and yield attributes as influenced by different treatments

Treatment	plant height (cm), At harvest	dry matter production (g/plant) At harvest	No of cob/plant	Cob weight/plant (gm)	Husk Weight/plant (gm)	Spindle weight/plant^{-1} (gm)[1]
IRRIGATION LEVELS						
I_1 at 1.0 PE	205.24	259.79	1.30	233.58	14.82	21.06
I_2 at 0.8PE	191.02	242.23	1.22	218.10	13.84	19.67
I_3 at 0.6PE	178.83	227.02	1.15	205.34	13.03	18.52
S.E ±	4.18	5.14	0.03	4.49	0.29	0.41
C.D at 5%	16.40	20.19	0.10	17.64	1.12	1.59
FERTIGATION LEVELS						
F_1 at 100% RDF Through drip	207.51	262.73	1.32	235.71	14.96	21.26
F_2 at 75% RDF Through drip	199.63	252.82	1.27	227.61	14.44	20.53
F_3 at 50% RDF Through drip	174.31	221.39	1.12	200.45	12.72	18.08
F_4 at 100% RDF Through soil	185.34	235.12	1.18	212.26	13.47	19.14
S.E ±	5.95	7.40	0.04	6.32	0.40	0.57
C.D at 5%	17.68	21.99	0.11	18.78	1.19	1.69
Interaction (I x F)						
S.E ±	10.30	12.82	0.06	10.95	0.70	0.99
C.D at 5%	NS	NS	NS	NS	NS	NS
GM	191.70	243.02	1.22	219.01	13.90	19.75

Table.2 Growth and yield attributes as influenced by different treatments

Treatment	No of grain/cob	No of grain row/cob	Grain weight/plant (gm)	1000 grain weight (gm)
IRRIGATION LEVELS				
I_1 at 1.0 PE	483.70	14.06	186.77	322.58
I_2 at 0.8PE	451.64	13.13	174.39	306.49
I_3 at 0.6PE	425.22	12.36	164.19	302.26
S.E ±	9.31	0.27	3.59	9.70
C.D at 5%	36.54	1.06	14.11	NS
FERTIGATION LEVELS				
F_1 at 100% RDF Through drip	488.11	14.19	188.47	319.48
F_2 at 75% RDF Through drip	471.34	13.70	182.00	309.32
F_3 at 50% RDF Through drip	415.09	12.06	160.28	301.41
F_4 at 100% RDF Through soil	439.55	12.77	169.72	311.57
S.E ±	13.09	0.38	5.05	11.18
C.D at 5%	38.89	1.13	15.02	NS
Interaction (I x F)				
S.E ±	22.67	0.66	8.75	19.36
C.D at 5%	NS	NS	NS	NS
GM	453.52	13.18	175.12	310.44

Table.3 Mean grain, spindle, husk, fodder, biological yield (kg/ha) and harvest index of maize as influenced by various levels of irrigation and fertigation

Treatment	**Grain yield (kg/ha)**	**Husk weight (kg/ha)**	**Sp Spindle weight (kg/ha)**	**Fodder yield (kg/ha)**	**Biological yield (kg/ha)**	**Harvest index**
IRRIGATION LEVELS						
I_1 at 1.0 PE	8845.43	742.32	1100.62	12511.31	23199.69	38.12
I_2 at 0.8PE	8259.16	693.12	1027.67	11815.16	21795.13	37.89
I_3 at 0.6PE	7775.89	652.56	967.54	11213.07	20609.07	37.71
S.E ±	170.19	14.28	21.18	245.87	451.52	-
C.D at 5%	668.15	56.07	83.14	965.25	1772.59	-
FERTIGATION LEVELS						
F_1 at 100% RDF Through drip	8926.05	749.09	1110.66	12653.56	23436.50	38.08
F_2 at 75% RDF Through drip	8619.30	723.34	1072.49	12251.64	22624.75	38.09
F_3 at 50% RDF Through drip	7590.70	637.02	944.50	10928.25	20145.35	37.66
F_4 at 100% RDF Through soil	8037.92	674.55	1000.15	11552.61	21265.23	37.78
S.E ±	239.37	20.09	29.78	341.98	627.28	-
C.D at 5%	711.22	59.69	88.50	1016.12	1863.81	-
Interaction (I x F)						
S.E ±	414.60	34.79	51.59	592.33	1086.48	-
C.D at 5%	NS	NS	NS	NS	NS	-
GM	8293.49	696.00	1031.95	11846.52	21867.96	37.90

However, the treatment 100% RDF through fertigation (F_1) was at par with 75% RDF through fertigation (F_2) for all yield attributes. The lowest values of yield attributes were observed with 50% RDF through drip (F_3) and were at par with 100% RDF through soil application (F_4). This effect was obviously due to high efficiency and easy availability of plant nutrients through the water soluble fertilizers. As availability of source in respect of maize increased with the increase in level of fertigation, the production in sink in the crop also followed same trend. These results are in conformity with those obtained by Hassanein *et al.,* (2006)

Significantly higher grain yield, fodder yield and biological yield was observed with 100% RDF through drip (F_1) than 100% RDF through soil (F_4) and 50% RDF through drip (F_3), however, it was found comparable with 75% RDF through drip (F_2).

Harvest index showed little variation among fertigation levels, 75% RDF through drip (F_2) was numerically higher than rest of treatments followed by 100% RDF through drip (F_1), 100% RDF through soil (F_4) and 50% RDF through drip (F_3), respectively. This indicated little effect on sink-source relation due to fertigation levels.

Interaction effect

Interaction effect due to different irrigation and fertigation levels were non-significant for all growth attributes, yield attributes, grain yield, fodder yield and biological yield.

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