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Influence of deficit irrigation schedules on nutrient uptake of maize hybrid under drip system

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Abstract
A field experiment was conducted during summer 2017 on sandy clay loam soil at irrigated upland farms of Tamil Nadu Agricultural University, Coimbatore to study the effect of deficit irrigation practices through drip system on nutrient uptake of maize crop. In the present study, PRD and deficit irrigation (DI) concepts (creation of soil moisture gradient) were implemented through alternate deficit irrigation (ADI) at two levels of irrigation having full and partial application at 60, 80 per cent, and four critical stage based PE as well as ET_c based levels using drip system, comprised of seven irrigation levels. Higher growth and grain yield (75711 kg ha^{-1}) was recorded with plots irrigated with CDI at IW/CPE of 0.75 due to superior growth and higher nutient uptake. Application of 80 and 60 per cent ET_c as ADI produced next better yield and uptake among the deficit practices which was on par with a regulated deficit irrigation of 80 per cent as PE based approach.

Keywords: maize, deficit irrigation, NPK uptake and yield

Introduction

Water is one of the most precious and heavily scrutinized natural resource worldwide. Particularly in arid regions and in parts of the world that have limited water resources improving agricultural water use efficiency is vitally important. Innovative irrigation solutions must address the water scarcity problems affecting arid countries. Advanced irrigation technologies, such as drip and sprinkler irrigation, are more efficient than traditional surface methods to achieve higher crop and water productivity (Sivanappan, 1998) [13].

Deficit (or regulated deficit) irrigation is one way of maximizing the water use efficiency (WUE) for higher yield per unit of irrigation water applied. The goal of deficit irrigation (DI) is to increase crop WUE by reducing the amount of water at irrigation or by reducing the number of irrigation events (Kirda, 2002) [8]. Under DI, crops are deliberately exposed to water stress, which may consequently lead to yield reduction (Prichard *et al.*, 2004) [11]. Drip irrigation has been practiced for many years for its effectiveness in reducing soil surface evaporation, increasing the crop yield and WUE (Sivanappan, 2004) [14]. Now it has been widely used in horticultural and wide-spaced agricultural crops to tackle the problem of water scarcity. In addition to DI, Partial Root zone Drying (PRD) is also a promising practice for inducing stress tolerance in some agricultural and horticultural crops (Gencoglan *et al.*, 2005) [6]. The DI and PRD systems require high management skills. Micro-irrigation technology facilitates the application of DI and PRD.

Maize is a heavy feeder. Among the plant nutrients, nitrogen is the most important element for plant growth and development. High yielding maize hybrids, with very high biomass production, extracts higher amounts of mineral nutrients from the soil than by other major cereals like rice or wheat. It requires high quantities of nitrogen during the period of efficient utilization, particularly at 25 days after sowing and pre-tasseling (40 days after sowing) stages for higher productivity (Bravo *et al.*, 1995) [1]. Keeping all this in view, this research was undertaken to study the uptake of NPK under various levels of deficit irrigation as implemented through drip system.

Materials and Methods

Field experiment was conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, to study the effect of varying deficit irrigation regimes in maize under drip irrigation system during summer, 2017. The experimental soil was texturally classified as sandy clay having 25.2 per cent field capacity, 12.5 per cent permanent wilting point and has 1.36 (g cc^{-1}) bulk density. Soil has pH value of 7.95, organic carbon content of 0.36 per cent and EC of 1.55 dsm^{-1}. The available status of nitrogen in the soil was low (264 kg ha^{-1}), with medium phosphorus (18.5 kg ha^{-1}) and high in potassium (378 kg ha^{-1}). The experiment was laid out in a randomized block design and the treatments were replicated thrice. Treatments comprised of seven irrigation levels through drip (Table 1). Drip irrigation system was operated once in three days and irrigation was applied as per the treatments based on PE and ET_c levels.

Table 1: Treatment details

T_1 – Conventional Irrigation at IW/CPE of 0.75
T_2 – Irrigation at 80 % PE
T_3 – Irrigation at 80 % ETc
T_4 – Irrigation at 60 % PE
T_5 – Irrigation at 60 % ETc
T_6 – 80 and 60% PE as ADI [ADI – Alternate Deficit Irrigation]
T_7 – 80 and 60% ETc as ADI

The experimental field was thoroughly ploughed. Beds were formed in the dimensions of 120 cm width, 30 cm furrow and 15 cm height. Buffer channels were formed to control the lateral seepage of water from one plot to another. The plot size was 7.2 × 4.5 m, accommodating six rows of crop. Maize hybrid COHM-6, was used for the experimental study. Seeds were hand-dibbled at the rate of one per hole. Paired row spacing of 120 + 30 × 60 cm was followed. Sowing irrigation was uniformly given to all treatments.

Water requirement (Litres per day or Lpd) or ETc= CPE × Kp× Kc× Wp× S,

$PE = CPE \times K_p$

Where, ETc= crop evapotranspiration,
CPE = cumulative pan evaporation (mm),
Kp= pan factor (0.8) (Vijayalakshmi, 2003),
Kc= crop coefficient,
Wp= wetting area percentage (80%) (Veeraputhiran, 2000),
S = Crop spacing (0.60 × 0.25 m for maize).

Irrigation water was pumped from the water source and conveyed to the main line of 63-mm outer diameter (OD) polyvinyl chloride (PVC) pipes after filtering through sand filter. In the main line, venturi was installed for fertigation. From the main, sub-mains of 40 mm OD PVC pipes were drawn, and from the sub-main, laterals of 12-mm low linear density polyethylene (LLDPE) pipes were installed at an interval of 1.2 m. Each lateral was provided with individual tap control for imposing respective irrigation schedules. Along the laterals, inline drippers with a discharge capacity of 4 L hr^{-1} were spaced at 0.4 m. Single lateral was used for a paired row of maize. Sub-mains and laterals were closed at the end with end cap. After installation, trial run was conducted to assess mean dripper discharge and uniformity coefficient. This was taken into account while fixing the irrigation water application time. During the irrigation period an average of 90–95% uniformity was observed. The recommended dose of fertilizer was applied as N: P_2O_5:K_2O @ 250:75:75 kg ha^{-1}. All the package of practices was carried out as per recommendation of CPG (2012) [2].

All the relevant biometric observations on growth parameters were recorded at periodic interval of the crop growth stages *viz.*, 30, 60 DAS and at harvest stage. The yield and yield attributes of maize were recorded as per the procedure. The plant samples were collected for estimating DMP at harvest stages were used for nutrient analysis. The oven dried samples were powdered and utilized for estimating the uptake of N, P and K of crop as per standard procedure. The uptake values obtained as percentage in the analysis were computed to kg ha^{-1} by multiplying with corresponding total dry matter production. Data of each character collected were statistically analyzed using standard procedure of variance analysis.

Results and Discussion

The results obtained from the present study as well as discussions have been summarized under following heads:

Growth attributes

At harvest, taller plants with more leaves and thick stems was recorded from plots irrigated with 80 and 60 per cent ET_c as alternate deficit irrigation (ADI), which was comparable with regulated deficit of 80 per cent PE (Table 2). It is due to optimal availability of soil water throughout the cropping period, which vigorously induced the vegetative development of the plants. The higher availability seems to have promoted development of morphological structure by virtue of multiplication of cell division and expansion (Kang *et al*., 2000; El-Hendawy *et al*., 2008) [7, 3]. Dry matter accumulation was highly correlated with soil moisture and increased as crop grew. It was mainly due to seasonal rainfall contribution, in all the treatments, which encouraged the plant growth and kept then stress free. Pandey *et al.* (2002) [9] and Farre and Faci, 2009) also expressed similar views in these lines.

Yield attributes and yield

Water stress significantly affected the yield components and most affected was kernel number and weight (Garrity *et al.*, 1983) [5]. However, application of alternate deficit irrigation as 80 and 60 per cent ET_c based produced heavier cobs with more grains row^{-1} of longer corn embedded with more grain rows $corn^{-1}$, which is comparable with application 80 per cent PE as regulated deficits (Table 2). The mobilization of carbohydrate reserve in the stem and leaf sheath is a key factor for grain filling and contribution to grain weight (Zhang *et al.*, 1998) [16]. This process was affected due to severe water stress and resulted in low grain weight. The results of this study also indicated that the lowest grain weight was obtained under severe water stressed treatments *ie*. 60 per cent PE based irrigation.

ADI treatments maintained grain yield as that of conventional drip irrigation at IW/CPE of 0.75 and the reduction was very little compared to the same. This is mainly due to favourable soil moisture during the growth period and better root development under alternate wetting and drying practice. Moreover, better root development under ADI may be attributed to good soil aeration and increase in microbial activity than other treatments. Payero *et al*. (2006) [10] found good linear relationships between yield and irrigation water applied in maize subjected to deficit irrigation treatments.

Nutrient uptake

Deficit irrigation imposed through drip system had significant effect on N, P and K uptake at different growth stages of maize (Fig 1). In general, uptake was found to be maximum at harvest for all nutrients. The higher NPK uptake compared to other treatments was observed under CDI at IW/CPE of 0.75. This might be due to availability of favorable soil moisture throughout the crop growth which promote plant growth positively and consequently accumulation of more DM and nutrients. This was found to be in agreement with Yazar *et al*. (2002) [15] and Sampathkumar (2003) [12]. Full irrigation

registered higher values for NPK uptake due to maximum production of dry matter, with better root development.
Under severe stress (60 percent irrigation based on PE approach), P and K uptake reduced. Simulation of alternate wetting and drying through ADI improved the root proliferation and enhanced the nutrient uptake by the crop, whereas severe stress damaged the root system and reduced the absorptivity to nutrients.

Table 2: Effect of deficit irrigation practices on growth and yield attributes with grain yield of maize hybrid.

Treatment	Plant height (cm)	DMP (kg ha^{-1})	Rows per cob (No.)	Grains per row (No.)	Cob weight (g)	Grain yield (kg ha^{-1})
T_1 – CDI at IW/CPE of 0.75	282.4	17728	14.0	37.6	127.6	7571
T_2 – Irrigation at 80 % PE	276.0	16780	12.8	35.2	117.4	7093
T_3 – Irrigation at 80 % ET_c	246.4	13820	11.6	30.0	106.4	5952
T_4 – Irrigation at 60 % PE	238.2	15336	12.4	32.0	102.6	5573
T_5 – Irrigation at 60 % ET_c	226.2	11732	10.2	25.5	99.4	4290
T_6 – 80 and 60% PE as ADI	266.4	15887	12.6	34.6	113.9	6860
T_7 – 80 and 60% ET_c as ADI	272.6	17085	13.2	36.6	119.5	7233
SEd	19.9	576	0.9	2.6	8.7	119
CD (P=0.05)	43.4	1256	2.1	5.7	18.9	260

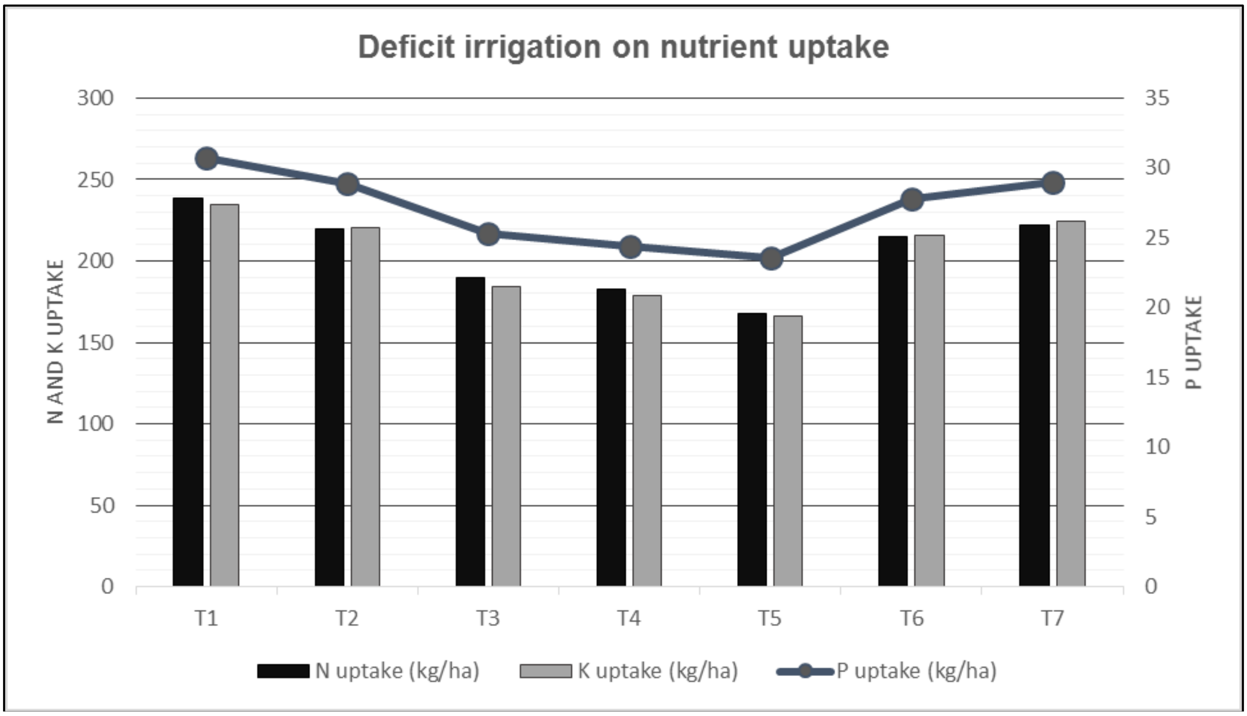

Fig 1: Effect of deficit irrigation practices on Nutrient uptake (kg/ha) of maize hybrid

Conclusion

Deficit irrigation practices significantly influenced the uptake of N, P and K at all the stages of the crop and the increment was progressed as crop age was increased and attained maximum values at harvest. Full watered plants registered higher values followed by alternate deficit irrigation practices and regulated deficit of 80 per cent PE. But, it was on par with each other. Lower values for nutrient uptake was recorded under severely stressed treatment. Thus, it was proved that amount of water can quantify the uptake of nutrients.

References

1. Bravo BE, Ureta AE, Ashley RA. Alternative nitrogen fertility levels and profitability in sweet corn production. J Sustain. Agric. 1995; 5:95-104.
2. Crop production guide (CPG). Published by DEE. TNAU offset press. Coimbatore, 2012.
3. El-Hendawy SE, El-Lattief, Mohamed EAA, Ahmed S, Schmidhalter U. Irrigation rate and plant density effects on yield and water use efficiency of drip-irrigated corn. Agric. Water Mange. 2008; 95:836-844.
4. Farre I, Faci JM. Deficit irrigation in maize for reducing agricultural water use. J Exp. Bot., 2008; 58:147-159.
5. Garrity DP, Suvllian CY, Darrell GW. Moisture deficits and Grain sorghum performance: Drought Stress conditioning. Agron J. 1983; 75:997-1004.
6. Gencoglan C, Gencoglan S, Kirnak H, Akbay C, Boz I. Deficit irrigation analysis of cotton under Harran conditions, Proc. Of the 4th GAP (Southeastern Anotolia Project) Agricultural Congress, September 21-23. Turkey, 2005.
7. Kang S, Liang Z, Pan Y, Peize S, Zhang J. Alternate furrow irrigation for maize production in arid area. Agric. Water Manage. 2000; 45:267-274.
8. Kirda C. Deficit irrigation scheduling based on plant growth stages showing water stress tolerance. In Deficit Irrigation Practice, 1–3 (Ed C. Kirda), Water Reports 22. Rome, Italy: FAO, 2002.
9. Pandey RK, Maranville JW, Admou A. Deficit irrigation and nitrogen effects of maize in a Sahelian environment I. Grain yield and yield components. Agric. Water Manage. 2002; 46:1-13.
10. Payero JO, Melvin SR, Irmak S, Tarkalson D. Yield response of corn to deficit irrigation in a semi-arid climate. Agric. Water Manage. 2006; 84:101-112.
11. Prichard T, Hanson B, Schwankl L, Verdegaal P, Smith R. Deficit Irrigation of Quality of Wine Grapes Using

Micro-Irrigation Techniques. Davis, CA: University of California Co-operative Extension, Department of Land, Air and Water Resources, University of California, 2004, 5.

12. Sampathkumar T. Evaluation of drip and surface irrigation methods with rice straw mulching in cotton. M.Sc. thesis submitted to the Department of Agronomy, Agricultural College and Research Institute, TNAU, Madurai, Tamil Nadu India, 2003.
13. Sivanappan RK. Status, scope and future prospects of micro-irrigation in India. In: Proceedings of a workshop on micro irrigation and sprinkler Irrigation Systems, 28-30th April, 1998, New Delhi, India, 1998, 1-7.
14. Sivanappan K. Irrigation and rainwater management for improving water use efficacy and production in cotton crop. Proceedings of International Symposium on Strategies for Sustainable Cotton Production – A Global Vision, 23–25 November, UAS, Dharwad, Karnataka, India, 2004.
15. Yazar A, Sezen SM, Sesveren S. LEPA and trickle irrigation of cotton in the south east Anatolia project (GAP) area in Turkey. Agric., Water Manage. 2002; 54:189-203.
16. Zhang FL, Wang ZM, Zhao M, Wang SA, Zhao JR, Guo JL. Studies on regulating model of maize kernel abortion. Journal of Maize Scienecs. 1998; 6:49-51.