Biological Forum – An International Journal **14(1): 725-729(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Maize based Intercropping Systems under Drip Irrigation on Productivity of Summer Maize

Navin Kumar C.[1*], S. Panneer Selvam[2], S.P. Ramanathan[3], M. K. Kalarani[4], G. Nagarajan[5] and S. Duraisamy[6]

[1]Ph.D. Scholar, Agro Climate Research Centre,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.
[2]Director, Water technology Centre,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.
[3]Professor and Head, Agro Climate Research Centre,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.
[4]Professor and Head,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.
Department of Plant Physiology,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.
[5]Professor and Head, Soil and Water Conservation Engineering,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.
[3]Professor and Head, Department of Physical Sciences,
Tamil Nadu Agricultural University, Coimbatore, (Tamil Nadu), India.

(Corresponding author: Navin Kumar C.)*
(Received 28 October 2021, Accepted 31 December, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Field experiment on irrigation and quality characters of maize was conducted during *summer* 2021. The field was laid out with Factorial Randomized Block Design (FRBD) with as inter cropping of pulses were assigned as a main factor (A) *viz.*, lablab, green gram, black gram, cowpea and maize. Irrigation a sub factor (B) with 75% PE, 100% PE, 125% PE along with flooding as check irrigation. Normal irrigation practices were followed for flooding and volume of water was quantified using parshall flume. Irrigation was given once in three days interval from 1st day to 75 days after sowing. Yield was positively responded based on the amount of irrigation given at various stages during the crop growth. Lesser irrigation and higher the amount of irrigation than the normal had lesser yield on maize compared to other irrigation as a treatments. Maize + Black gram cropping system recorded the highest number of grains per row (34.1) and least number of grains per row was recorded in Maize + Cowpea cropping system. Higher number of rows per cob (13.1) values were recorded with Maize + Lablab cropping system, which is on par with Maize + Black gram (12.9). The implementation of innovative irrigation water management systems may help to mitigate the negative effects of climate change. Our hypothesis was that traditional drip system could be converted to an innovative water management system based on precision irrigation techniques and evaporative cooling application to improve crop physiological status and yield of maize in western region of Tamil Nadu.

Keywords: Potential evapo-transpiration. Yield, Yield attributes, Irrigation Quantity.

INTRODUCTION

Over 170 nations are currently producing nearly 1147.7 million MT of maize on an area of 193.7 million ha, with an average productivity of 5.75 t/ha (FAOSTAT, 2020). Maize is the foremost food crop grown all over the world with leading producer of USA, Mexico (366.28 tones) followed by China (257.330 tones) and Brazil (94.500) (Statista, 2019). In 1950-51, India produced 1.73 million metric tonnes of maize, which has climbed to 27.8 million metric tonnes in 2018-19, an almost 16-fold increase in production (IIMR, 2020). During this time, the average productivity increased by 5.42 times, from 547 kg/ha to 2965 kg/ha, although the area nearly tripled. In India, Madhya Pradesh (15% in its total production) is the leading state for maize production (Siddavatam and Vijendra 2021). 60-75 % of maize grown during *Rabi* and remaining 30-35% is grown in *Kharif* (Singh *et al*., 2012). Rainfall and effective rainfall (rainfall available for crop growth) are the major factor for maize production (Ines and Hansen 2006). Irreversible changes in the human activities (burning of fossil fuel, deforestation, mining in industrial sector *etc*.,) causes change in climate and climate variability (Nda *et al.,* 2018). Prolonged changes in natural habitat by humans cause increase in temperature, decrease of ground water, and decline in food crop production (Sivaramanan, 2015). This adverse effect of climate change on climate variability causes reduction in duration, intensity and quantum of rainfall. Decline of ground water resulting in unavailability of water of irrigation based on future climate (Taylor, 2013). Water is a key input in agricultural productivity and contributes to food security. Irrigated agriculture accounts for 20% of all farmed land and 40% of all food produced globally (Hanjra and Qureshi, 2010). Irrigated agriculture is at least twice as productive per unit of land as rainfed agriculture, way that allows for more crop diversification and output intensification (Mishra *et al.*, 2021). There are different of irrigation were followed *viz.*, surface, localized, sprinkler, center pivot, lateral move, sub surface, manual irrigation. Based on future climatic scenario, considering the past water experiences the cultivation of agricultural crops is difficult though, the crop grown under rainfed condition (Fader *et al.*, 2010). Drip irrigation is the best successful method for cultivation of food crops and other flower and fruits crop grown under agriculture. Cultivation of maize under drip irrigation saves water up to 70% of normal irrigation (flooded irrigation) (Zhang, 2017). Maize is one of the indicator plants for not only the nutrient deficiency but also for the quantity of water applied through irrigation. Increase in the amount of irrigation, resulting in reduction in cob size and no of grains per row (Farré, and Faci, 2009). Grain yield loss is significantly larger for the time period 2051–2080 than for the time period 2021–2050 under irrigated conditions compared to the baseline yield, whereas grain yield increased in both the time periods 2021–2050 and 2051–2080 under rainfed conditions, indicating that increased rainfall mitigated the negative effect of the temperature on crop yield (Kobuliev *et al.*, 2021).

MATERIAL AND METHODS

Field experiment was conducted at Tamil Nadu agricultural university, eastern block farm (field no. 75) in Coimbatore. The farm is located in Western agro-climatic zone of Tamil Nadu located at 11º North latitude and 77º East longitude, at an elevation of 426.72 meters above mean sea level (MSL). Using a cultivator and a rotavator, the field was ploughed with fine tilth. The tractor-drawn implement made the wide bed furrow (BBF) with a 90 cm bed and 30 cm furrow size. Drip was installed in the field with a 16 mm lateral diameter, 1.2 m lateral spacing, 0.4 m emitter distance, and a 4 lph emitter capacity. Different inter crops were cultivated between the rows of maize, including lab lab Co (Gb) 14, black gramme (Co-7), green gramme (Co-7), and cowpea Co (CP) 7. Pulses are grown with a 30 × 10 cm inter row spacing and maize with 60 × 25 cm intra row spacing. The experiment was carried out using the Factorial Randomised Block Design (FRBD) method. The intercropping system was used as the first factor (A), while other irrigation treatments, such as Drip irrigation (DI) at 125% PE, DI at 100% PE, DI at 75 % PE, and normal furrow irrigation, were used as the second factor (B) with three replications. The average mean data on Number of grains per row, Number of grains per cob, number of rows per cob, Cob length and girth (cm) was calculated and statistically analyzed.

RESULT AND DISCUSSION

Yield attributes of maize is shown in Table 1. Yield attributes (Grain yield (kg ha^{-1}), number of grains per row, number of grains per cob, number of rows per cob, Cob length and girth) had significant relationship on irrigation levels. Among the treatments, Maize + Black gram cropping system recorded the highest number of grains per row (34.1) and least number of grains per row was recorded in Maize + Cowpea cropping system. With respect to irrigation levels, 100 % PE had maximum number of grains per row with 34.2 number of grains and minimum number was noted in flooding conditions. With the treatment combinations, 100% PE with Maize + Black gram registered higher number of grains per row (38.9). This may be due to the excess irrigation and lowest requirement of irrigation on pan evaporation *i.e.*, 75 % PE affected the number of grains per row under stressed condition (Sandhu *et al.*, 2019). These indicate that stress have significantly influenced the expression of the parameters among the maize genotypes (Mittal *et al.*, 2021). During *Summer* 2021, Drip irrigation levels as well as intercrops significantly influenced the number of grains per cob of maize. Maize + Black gram cropping system, recorded a higher number of grains per cob (471.6). With irrigation levels, 125 % PE registered highest number of grains per cob (448.5) and 75% PE had lowest number of grains per cob with 388.9. Interaction effect on cropping system and influence significantly on number of grains per cob. 125% PE with Maize + Black gram registered higher number of grains per cob (583.1) and lower number of grains per cob was noted in maize as a sole crop under surface irrigation (Wang *et al.*, 2021). Number of rows per cob of maize varied significantly for intercrops and irrigation levels. Higher number of rows per cob (13.1) values were recorded with Maize + Lablab cropping system, which is on par with Maize + Black gram (12.9). Irrigation levels doesn't influence significantly. Regarding the interaction effect on intercropping system and irrigation levels, higher values (13.9) were observed under Maize + Lab Lab intercropping system with 100% PE is at par with 75%, 100%, 125% PE on Maize + Black gram cropping system. Remaining all other treatment combinations, registered lower values of number of rows per cob. Intercropping maize with lab lab primes in higher number of cobs per plant, number of seeds per cob, 100 seed mass and grain production than simultaneous maize/lablab intercropping, according to Ngwira *et al.* (2012). The decrease in growth, yield and quality characters under water stress is a common phenomenon (Singh and Rajpoot, 2021). During *Summer* 2021, the Cob length (Fig. 1.) was found to be higher when the maize cropped with Maize + Lab Lab (19 cm) which is on par with Maize + Black gram cropping system (18.7 cm). Among the irrigation levels, 100% PE on cob length (18.2 cm) on par with 125% (17.7 cm) PE. Between the treatment effects, 100% PE on Maize + Black gram cropping system was found to be higher (22.2 cm) and on par with 75% PE on Maize + Lablab (21.2 cm). Remaining all other treatment combinations, recorded the lowest values. Better translocation of assimilates from source to sink was achieved with the recommended amount of nutrients delivered at regular intervals with a favourable moisture state under drip irrigation. This might be the reason for increased yield in maize intercropped black gram. This was in line with Ramah (2008); Fanish (2013) findings.

Cob girth (Fig. 2) varied significantly with higher girth of maize cob under Maize + Black gram intercropping system (14.3 cm), which is on par with Maize + Lab Lab (13.5 cm). Among irrigation levels, 125% PE had higher girth on maize cob (12.6cm) is on par with 75% and 125% PE. Lower girth was recorded on surface irrigation. Between the interaction effects, 75% PE on Maize + Black gram registered higher values (15.5 cm) and remaining all other treatment combinations had lower values and doesn't influence on cob girth of maize. This could be because to the increased yield obtained in the 75 percent PE irrigation regimen, resulting in a better profit when compared to other treatments. Ibrahim *et al.* (2016) reported similar findings.

Grain yield (kg ha^{-1}) was significantly influenced by intercrops and irrigation levels (Fig. 3). Higher grain yield was obtained in maize intercropped with black gram of 6890 kg ha^{-1}. Between the irrigation levels, the maximum production was found in 100% PE levels (6503.8 kg ha^{-1}) which is at par with 75 % PE with 6312.3 kg ha^{-1}. Flooded conditions recorded the lowest yield with irrespective to intercropping systems. Among interaction effect, maize intercropped with green gram at 75% PE irrigation levels had maximum grain yield of 7894.7 kg ha^{-1} and lesser yield was obtained in all other treatment combinations.

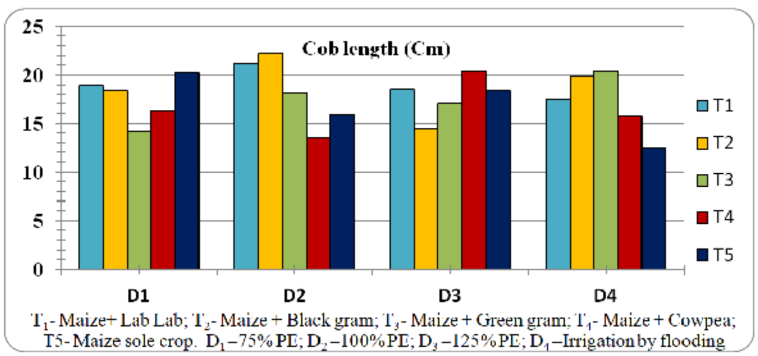


Fig. 1. Yield attributes on maize based intercropping system and irrigation levels on cob length of maize (cm).

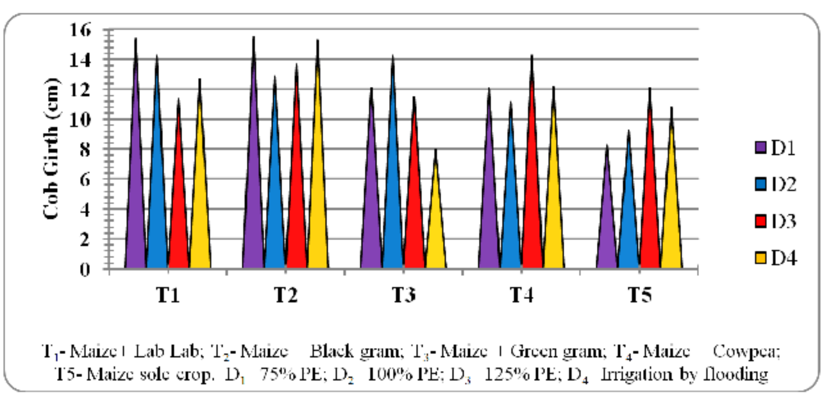
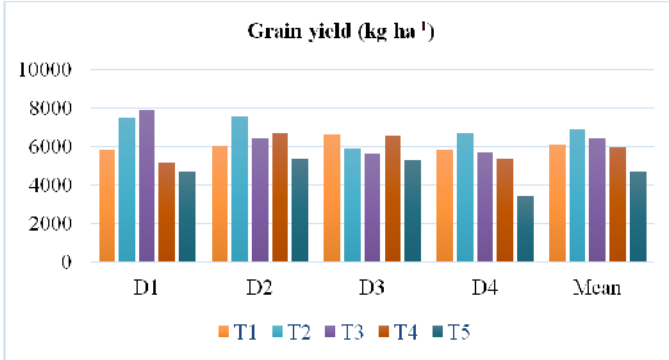


Fig. 2. Yield attributes on maize based intercropping system and irrigation levels on cob girth of maize (cm).



T_1- Maize+ Lab Lab; T_2- Maize + Black gram; T_3- Maize + Green gram; T_4- Maize + Cowpea;
T5- Maize sole crop. D_1 –75% PE; D_2 –100% PE; D_3 –125% PE; D_4 –Irrigation by flooding

Fig. 3. Yield on maize based intercropping system under drip irrigation (kg ha^{-1})

Table 1: Effect of maize based intercropping system on yield attributes of maize during *Summer* 2021.

	Number of grains per row					Number of grains per cob					Number of rows per cob				
Treatments	**D_1**	**D_2**	**D_3**	**D_4**	**Mean**	**D_1**	**D_2**	**D_3**	**D_4**	**Mean**	**D_1**	**D_2**	**D_3**	**D_4**	**Mean**
T_1	33.2	35.3	35.2	31.5	**33.8**	398.0	423.7	492.7	456.4	**442.7**	12.9	13.9	12.8	12.8	**13.1**
T_2	30.7	38.9	34.1	32.8	**34.1**	304.4	469.8	583.1	529.2	**471.6**	13.4	13.3	13.5	11.4	**12.9**
T_3	35.0	33.4	31.7	31.2	**32.8**	419.7	409.6	405.5	434.2	**417.3**	13.3	13.3	12.4	11.0	**12.5**
T_4	33.4	29.2	28.9	28.2	**29.9**	433.6	380.2	312.5	308.2	**358.6**	12.1	13.3	12.1	11.2	**12.2**
T_5	28.4	28.2	27.6	18.2	**25.6**	343.0	366.5	294.8	236.7	**310.3**	12.4	12.3	12.0	11.3	**12.0**
Mean	**33.1**	**34.2**	**32.5**	**30.9**		**388.9**	**420.8**	**448.5**	**432.0**		**12.9**	**13.4**	**12.7**	**11.6**	
	T	**D**	**TXD**			**T**	**D**	**TXD**			**T**	**D**	**TXD**		
SEd	0.4	0.3	0.7			4.6	4.1	9.3			0.2	0.2	0.3		
CD	0.7	0.7	1.5			9.4	8.4	18.8			0.3	NS	0.7		

T1- Maize + Lab Lab; T2- Maize + Black gram; T3- Maize + Green gram; T4- Maize + Cowpea; T5- Maize sole crop.
D_1 –75% PE; D_2 –100% PE; D_3 –125% PE; D_4 –Irrigation by flooding. NS- Non-Significant; DAS- Days after sowing

CONCLUSION

The present study concluded that irrigation under flooded condition doesn't give the potential yield attributes of maize. Maize intercropped with pulses under drip irrigation gives better yield attributes and drip irrigation is the best suitable tool for cultivation of maize under future climatic scenarios.

FUTURE SCOPE

The emerging threat to global agricultural sustainability necessitates a paradigm shift in irrigation practise; the rapid increase in global population and the corresponding demand for extra water by water users forces the agricultural sector to use irrigation water more efficiently. This entails implementing an irrigation water management strategy that can help achieve the goal of producing more crops per drop of water, such as the use of a drip irrigation system and the use of deficit irrigation scheduling, among other.

Acknowledgement. This work is supported by the Agro Climate Research Centre and Water Technology Centre of Tamil Nadu Agricultural University, Coimbatore.

Conflict of Interest. The results furnished in this paper were from our own research and there were no conflicts from other research scholars or scientists.

REFERENCES

Fader, M., Rost, S., Müller, C., Bondeau, A. and Gerten, D. (2010). Virtual water content of temperate cereals and maize: Present and potential future patterns. *Journal of Hydrology*, *384*(3-4): 218-231.

Fanish, A. S. (2013). Water productivity and profitability of maize under drip fertigation in intensive maize based intercropping system. *International Journal of Agricultural Sciences*, *3*(5): 538-543.

FAOSTAT, (2020) FAO Statistics, Food and Agriculture Organization of the United Nations, Rome, http://faostat.fao.org/, Accessed 17-May-2020.

Farré, I. and Faci, J. M. (2009). Deficit irrigation in maize for reducing agricultural water use in a Mediterranean environment. *Agricultural water management*, *96*(3): 383-394.

Hanjra, M. A. and Qureshi, M. E. (2010). Global water crisis and future food security in an era of climate change. *Food policy*, *35*(5): 365-377.

Ibrahim, M. M., El-Baroudy, A. A. and Taha, A. M. (2016). Irrigation and fertigation scheduling under drip irrigation for maize crop in sandy soil. *International agrophysics*, *30*(1).

IIMR, (2020). Indian institute of maize research, Indian council of agricultural research. Accessed 08 December2021.Available:https://iimr.icar.gov.in/india maze-scenario/

Ines, A. V., and Hansen, J. W. (2006). Bias correction of daily GCM rainfall for crop simulation studies. *Agricultural and forest meteorology*, *138*(1-4): 44-53.

Kobuliev, M., Liu, T., Kobuliev, Z., Chen, X., Gulakhmadov, A. and Bao, A. (2021). Effect of future climate change on the water footprint of major crops in southern Tajikistan. *Regional Sustainability*, *2*(1): 60-72.

Mishra, A., Ketelaar, J. W., Uphoff, N., and Whitten, M. (2021). Food security and climate-smart agriculture in the lower Mekong basin of Southeast Asia: evaluating impacts of system of rice intensification with special reference to rainfed agriculture. *International Journal of Agricultural Sustainability*, *19*(2): 152-174.

Mittal, G. K., Singh, B., Mahatma, M. K. and Gupta, A. K. (2021). Morpho-physiological Changes in Maize Genotype under Water Stress Condition at Pre and Post Flowering Stages. *Biological Forum – An International Journal*, *13*(4): 326-331.

Nda, M., Adnan, M. S., Ahmad, K. A., Usman, N., Razi, M. A. M. and Daud, Z. (2018). A review on the causes, effects and mitigation of climate changes on the environmental aspects. *International Journal of Integrated Engineering*, *10*(4).

Ngwira, A. R., Aune, J. B., and Kwinda, S. (2012). On-farm evaluation of yield and economic benefit of short-term maize legume intercropping systems under conservation agriculture in Malawi. *Field Crops Research*, *132*, 149-157.

Ramah, K. (2008). Study on drip fertigation in maize (*Zea mays* L.) based cropping system (Doctoral dissertation, Tamil Nadu Agricultural University Coimbatore).

Sandhu, O. S., Gupta, R. K., Thind, H. S., Jat, M. L. and Sidhu, H. S. (2019). Drip irrigation and nitrogen management for improving crop yields, nitrogen use efficiency and water productivity of maize-wheat system on permanent beds in north-west India. *Agricultural Water Management*, *219*, 19-26.

Siddavatam, R. P. and Vijendra, C. (2021). Risk Analysis of Spot and Futures Prices of Maize in India. *IUP Journal of Financial Risk Management*, *18*(2).

Singh, B. and Rajpoot, V. (2021). Assessment of Genetic Variability for Different Parameters in Fenugreek under Moisture Regime. *Biological Forum – An International Journal*, *13*(3a): 232-237.

Singh, N., Rajendran, R. A., Shekhar, M., Jat, S. L., Kumar, R. and Kumar, R. S. (2012). Rabi maize opportunities and challenges.

Sivaramanan, S. (2015). Global Warming and Climate change, causes, impacts and mitigation. *Central Environmental Authority*, 2-4.

Statista, (2019). World corn production by country 2018/19.https://www.statista.comstatistics/254292/global-corn-production-by-country. Accessed,10-Sept.2019.

Wang, G. Y., Hu, Y. X., Liu, Y. X., Ahmad, S., and Zhou, X. B. (2021). Effects of supplement irrigation and nitrogen application levels on soil carbon–nitrogen content and yield of one-year double cropping maize in subtropical region. *Water, 13*(9), 1180.

Zhang, G., Liu, C., Xiao, C., Xie, R., Ming, B., Hou, P., and Li, S. (2017). Optimizing water use efficiency and economic return of super high yield spring maize under drip irrigation and plastic mulching in arid areas of China. *Field Crops.Research*,*211*,137-146.

How to cite this article: Navin Kumar C., S. Panneer Selvam, S.P. Ramanathan, M. K. Kalarani, G. Nagarajan and S. Duraisamy (2022). Maize based Intercropping Systems under Drip Irrigation on Productivity of *Summer* Maize. *Biological Forum – An International Journal*, *14*(1): 725-729.