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Effect of Precision Irrigation and Nutrient Management on Growth and Yield of Baby Corn (*Zea mays* L.)

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ABSTRACT: Water scarcity is becoming more and more serious globally as a result of climate change and population increase. This necessitates automation in the irrigation system for effective water resource utilisation, and most researchers are now focusing on irrigation system automation. Sensor-based automation in drip irrigation systems will be game changer technology for effectively utilising water resources. A field experiment on precision irrigation and nitrogen management on growth and yield of baby corn (*Zea mays* L.) was carried out during summer 2021 and 2022 at L Block, GKVK, Bengaluru. Three levels of irrigation as main plot treatment with five sub plots of nutrient management practices were laid out in a split plot design. The results revealed that IoT based drip irrigation at 50 per cent DASM along with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} recorded significantly higher plant height (177.1 cm), number of leaves (15.6 plant^{-1}), dry matter accumulation (164.5 g plant^{-1}), GreenSeeker value (0.78), SPAD value (61.3), Cob length (13.9 cm), cob girth (6.1 cm), cob weight (21.9 g cob^{-1}), cob yield (85.5 q ha^{-1}) and water use efficiency (31.8 kg ha-mm^{-1}) on pooled basis compared to all treatments. Surface irrigation with recommended dose of fertilizer recorded significantly lower plant height (123.7 cm), number of leaves (10.1 plant^{-1}), dry matter accumulation (110.0 g plant^{-1}), GreenSeeker value (0.56), SPAD value (42.7), Cob length (8.4 cm), cob girth (3.9 cm), cob weight (15.7 g cob^{-1}), cob yield (42.2 q ha^{-1}) and water use efficiency (11.9 kg ha-mm^{-1}). Sensor based irrigation and nitrogen management will save irrigation water, nutrients applied and enhance the yield.

Keywords: Sensor, Internet of Things, GreenSeeker, SPAD, Baby corn.

INTRODUCTION

Maize is the third most important cereal crop after rice and wheat, and it is an important cereal in the global agricultural economy. Maize comes in several varieties, including dent corn, sweet corn, pop corn, and baby corn. Growing maize for vegetable purposes, also known as baby corn, is a recent development for diversification in value addition and food processing industries (*Zea mays* L.). The dehusked young cob of maize harvested within 2-3 days of silk emergence is known as baby corn. It is an efficient converter of absorbed nutrients into food as a C4 plant. Baby corn is high in folate and vitamin B, and it also contains a variety of other nutrients (Singh *et al*., 2010). Water and nutrients play a critical role in growth and productivity of baby corn. The spatial and temporal variability of rainfall and groundwater depletion has posed a challenge to crop production sustainability (Patil *et al*., 2012; Sah *et al*., 2020). Water scarcity is becoming increasingly severe around the world as a result of climate change and population growth. Freshwater demand for domestic use is increasing at a faster rate, with agriculture accounting for approximately 91% of total demand (Kayatz *et al*., 2019).

To reduce water loss and increase water use efficiency, appropriate irrigation practices are required. Several management practices, particularly in summer-grown baby corn, have been tried in this context to manipulate soil moisture content and input use efficiency. Changes in irrigation levels have a significant impact on crop growth, phenological stages, cob length, cob girth, and baby corn yield (Sangakkara *et al*., 2010; Sah *et al*., 2020). Drip irrigation is used to maximize the use of water resources while increasing crop yield. It is clear that the groundwater level has gradually decreased over the last ten years. Automation in the drip irrigation system is required to efficiently use the available water resources. Researchers are now focusing on irrigation system automation. Sensor-based automation in drip irrigation systems will be game changer technology for effective water resource utilization.

With the advancement of sensor technology and network-based information technology, the Internet of Things (IoT) now plays a larger role in precision agriculture (Jino and Jackuline 2017; Barkunan *et al*., 2019). The system employs soil moisture sensors, which measure the exact moisture level in the soil and transmit the data to the solar-powered field controller at five-minute intervals. The message will be sent to the cloud analytics and data center by the field controller. The message will be processed and sent to the master control, where it will be turned on and the solenoid valve will open using battery power. The water flow will be measured using a water metre, and the moisture content will be determined using a field sensor. This solenoid value allows the system to use an appropriate amount of water, avoiding over/under irrigation.

Fertilizers play a critical role in increasing productivity across the baby corn spectrum (Abebe and Feyisa 2017). Efficient nitrogen (N) fertilization is critical for economically producing baby corn. Even when N supplies are abundant, crop N absorption varies between and within seasons, as well as between locations within the same field. The supply of nitrogen from soil to crop varies spatially, as does the crop's demand for nitrogen. As a result, the nutritional status of the crop is a good predictor of the required N rate application. The soil test crop response (STCR) approach considers a crop's nutrient requirements to produce unit yield, as well as the likely contribution from soil and fertilizer to determine how much fertilizer to add for a given yield level. Similarly, one such approach is site-specific nutrient management (SSNM), which focuses on balanced and crop-need-based nutrient application (Johnston *et al.,* 2009). It allows for the timely application of fertilizers at optimal rates to bridge the nutrient gap between nutrient needs of a high yielding crop and the nutrient supply from naturally occurring indigenous sources such as soil, crop residues, manures, and irrigation water.

Sensors are becoming more common in agricultural fields. It is possible to detect crop variability and make quick decisions in the field by using variable rate equipment or application. Precision agriculture technology advancements have resulted in the development of ground-based active remote sensors (or crop canopy sensors) that calculate NDVI readings. Green Seeker is an integrated optical sensing and application system that measures crop nitrogen status and applies crop nitrogen requirements in a variety of ways. A crop's yield potential is determined by a vegetative index known as NDVI (normalized difference vegetative index) and an environmental factor. These sensors detect N stress by measuring the visible and near-infrared (NIR) spectral response of plant canopies. Chlorophyll in the leaf's palisade layer absorbs 70 to 90% of all incident light in the red wavelength band. The reflection of the NIR electromagnetic spectrum (720-1300 nm) is dependent on mesophyll cells, which scatter and reflect up to 60% of all incident NIR radiation (Puneet, 2011). Nitrogen (N) is then recommended based on yield potential and crop receptivity to additional nitrogen.

Given the foregoing, the current study intends to investigate the effect of sensor-based irrigation and nitrogen management in baby corn.

MATERIAL AND METHODS

A field experiment on sensor based irrigation and nitrogen management in baby corn (*Zea mays* L.) was carried out during summer 2021 and 2022 at L block of Zonal Agricultural Research Station, Gandhi Krishi Vignana Kendra (GKVK), University of Agricultural Sciences (UAS), Bangalore. The site of experimentation was in Agro Climatic Zone V (Eastern Dry Zone) of Karnataka, located in 12º 51' N Latitude and 77º 35' E Longitude at an altitude of 930 m above mean sea level (MSL). The soil of the experimental site is red sandy loam with coarse sand (35.20 %), fine sand (38.70 %), Silt (7.60 %) and Clay (25.00 %) as soil components. The soil reaction in field was neutral (6.17) with an EC of 0.27 dS m^{-1}, medium in available nitrogen (245 kg ha^{-1}), available phosphorus (48 kg ha^{-1}) and available potassium (180 kg ha^{-1}). The experiment was laid out in split plot design. The treatment consists of three main plots and five sub plots. Main plots: I_1 - Surface Irrigation, I_2 – Yellow SMI based Drip irrigation, I_3–IoT based drip irrigation at 50 per cent DASM. Sub plots: N_1 – Recommended dose of nitrogen, N_2 – GreenSeeker based nitrogen at 25 kg ha^{-1}, N_3 - STCR based target yield of 10t ha^{-1} (2 split), N_4 - STCR based split application of N for target yield of 10 t ha^{-1}, N_5 - SSNM based split application of NPK for target yield of 10 t ha^{-1} (Table 1).

Table 1: Quantity of nitrogen, phosphorus and potassium calculated for Baby corn during summer 2021 and 2022.

Fertilizer levels	N (kg ha^{-1})			P_2O_5 (kg ha^{-1})			K_2O (kg ha^{-1})		
	2021	2022	Average	2021	2022	Average	2021	2022	Average
N_1	150	150	150	75	75	75	40	40	40
N_2	100	100	100	75	75	75	40	40	40
N_3	280	254	267	113	113	113	96	95	95.5
N_4	280	261	270	113	113	113	96	95	95.5
N_5	263	250	256	139	100	119	220	150	185

Before sowing, the land was prepared to a fine tilth. The furrows were opened with a furrow opener by adjusting the width to the required row spacing of 45 cm. The calculated amounts of nutrients were applied to the respective treatments. Sturdy and vigorous plant growth, conical shape baby, yellow in color, high standard and uniform cob, easy to harvest, high yielding hybrid G5417 baby corn suitable for all seasons was sown.

The irrigation was given based on the sensors data. For every treatment, water meter (hall effect sensor) was installed to measure the quantity of water flows. To measure the soil moisture instantly, resistance type single point sensors were installed in the field at a depth of 15 cm, in turn all these were connected to IoT based field controller and gateway. The drips were installed to the solenoid valve monitored system for automation. Upon reaching the soil moisture to prescribed level or depletion in soil, the message will be transmitted to the field controller for automated turning the valve to on and off. For measuring soil moisture content at regular interval, we used Soil Moisture Indicator (SMI) developed by Sugarcane Breeding Institute (ICAR-SBI), Coimbatore and soil moisture meter probe. The mode of operation is that the sensor rods of SMI need to be inserted into the soil to a required depth to assess the soil moisture, which indicates different moisture levels present in soil by glowing different colour LEDs *viz*. blue, green, yellow, red, respectively.

The amount of nutrient required to achieve target yield was calculated by using the formulae for different techniques. The chemical fertilizer required for STCR treatments were calculated using soil test crop response (STCR) equations developed by UAS, Bengaluru. The amount of fertilizer for site specific nutrient management treatment was calculated using SSNM equation. Based on crop removal pattern, nutrients were applied *i.e.* to produce one tonne of maize grain we need to apply 26.3 kg N, 13.9 kg P_2O_5 and 27.3 kg K_2O. Green seeker is an optical sensor that emits and measures reflected light at two different wave lengths *viz*., one in the visible spectrum (660 nm) and another one in the near-infrared spectrum (770 nm). Measured spectral reflectance is expressed as spectral vegetation indices such as NDVI. NDVI is an indicator of soil nitrogen and also nitrogen status of the crop canopy. NDVI values range from 0 to 1. If NDVI values are below 0.3 (15-30 DAS) applied 25 kg ha^{-1} nitrogen, if values are in between 0.3 to 0.5 (45-60 DAS) applied 25 kg ha^{-1} nitrogen, if it is not in the range no nitrogen was applied and values are more than 0.7 no need to apply additional nitrogen. Application of nitrogen was discontinued after the initiation of silking (Puneet *et al*, 2011; Prakasha *et al*., 2020). The growth observations were recorded at different growth stages. The baby were harvested 2 days after silking, when the silk started to turn pink.

RESULTS AND DISCUSSION

Growth attributes of baby corn. The data pertaining to plant height, number of leaves and total dry matter production of baby corn as influenced by sensor based irrigation and nitrogen management practices on pooled basis are presented in Table 2.

Table 2: Plant height (cm), number of leaves per plant and dry matter production of baby corn as influenced by sensor based irrigation and nitrogen management.

Treatments	Plant height (cm)	Number of leaves per plant	Dry matter accumulation (g $plant^{-1}$)
Main plot			
I_1: Surface irrigation	127.9	11.5	125.9
I_2: Yellow SMI based drip irrigation	140.9	12.7	141.6
I_3: IoT based drip Irrigation @ 50 % DASM	148.9	13.4	148.2
S.Em.±	3.43	0.18	3.42
CD at5%	13.43	0.69	13.39
Subplot			
N_1: RDN	128.4	11.3	119.3
N_2: GreenSeeker based N application	130.6	11.8	125.2
N_3: STCR based target yield of 10t ha^{-1}	133.3	12.1	137.4
N_4: STCR based split application of N for target yield of 10 t ha^{-1}	145.1	13.4	153.4
N_5: SSNM based split application of NPK for target yield of 10 t ha^{-1}	158.8	13.9	157.6
S.Em.±	3.1	0.24	2.82
CD at5%	8.96	0.69	8.22
Interaction			
I_1N_1	123.67	10.1	110.0
I_1N_2	124.85	11.5	110.5
I_1N_3	126.65	11.6	111.3
I_1N_4	130.35	12.1	147.5
I_1N_5	134.06	12.1	150.2
I_2N_1	129.88	11.7	121.0
I_2N_2	133.28	11.8	124.8
I_2N_3	134.93	12.3	150.4
I_2N_4	141.04	13.3	153.8
I_2N_5	165.27	14.2	158.0
I_3N_1	131.78	12.0	126.9
I_3N_2	133.79	12.1	140.3
I_3N_3	138.36	12.3	150.5
I_3N_4	163.63	14.8	158.9
I_3N_5	177.05	15.6	164.5
S.Em.±	5.86	0.41	5.55

CD at5%	15.52	1.19	14.24

IoT based drip irrigation at 50 per cent DASM recorded significantly higher plant height, number of leaves per plant and dry matter accumulation (150.3 cm, 13.4 plant^{-1}, 148.2 g plant^{-1}, respectively). Surface irrigation recorded significantly lower plant height, number of leaves per plant and dry matter accumulation (128.5 cm, 11.5 plant^{-1}, 125.9 g plant^{-1}, respectively). Significantly higher plant height, number of leaves per plant and dry matter accumulation was observed with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} (158.8 cm, 13.9 plant^{-1} and 157.6 g plant^{-1}, respectively). Application of recommended dose nitrogen recorded significantly lower plant height (128.7 cm,11.3 plant^{-1} and 119.3 g plant^{-1}, respectively).

Among the interactions IoT based drip irrigation at 50 per cent DASM along with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} recorded significantly higher plant height, number of leaves per plant and dry matter accumulation (177.1 cm,15.6 plant^{-1} and 164.5 g plant^{-1}, respectively). Significantly lower plant height was noticed in surface irrigation with RDN (123.7 cm, 10.1 plant^{-1} and 110.0 g plant^{-1}, respectively).

Sensor-based irrigation maintains adequate soil moisture in the crop root zone throughout the growth period, which results in higher nutrient uptake. The increased availability of nutrients helps in synthesis of amino acids, proteins and growth promoting substances, which will enhance meristematic activity and increase the cell division and elongation. The higher moisture regimes along with sufficient nutrients helps the crop to put higher plant height, number of nodes, internodal length, number of leaves, higher leaf area which intercepts higher solar radiation resulting in increased photosynthetic apparatus. The higher photosynthates produced will accumulate as total dry matter in various parts of the plant.

Higher plant height was observed under sensor based automated irrigation at 50 per cent DASM helped continuous availability of required moisture near the root zone which increase higher nutrient uptake resulting in greater cell division and elongation. The nutrient supplied by SSNM practice will make nutrient available for crop uptake at all stages of crop growth. The above results are in accordance with the findings of Chethan, (2015); Jasim Iqbal *et al*. (2016); Prakasha *et al*, (2020). In surface irrigation, maximum moisture availability will be at the time of irrigation followed by intermittent dryness which might have affected cell division and elongation. On the other hand, severe stress imposed at surface irrigation has reduced plant height at all growth stages. The above results are in corroborative with findings of Chigign (2011); Banerjee *et al*. (2014); Hokam *et al*. (2011); Desai and Mudalagiriyappa (2022).

Green Seeker and SPAD readings. The data on greenseeker as influenced by sensor based irrigation and nitrogen management practices in baby corn on pooled basis are presented in Fig. 1.

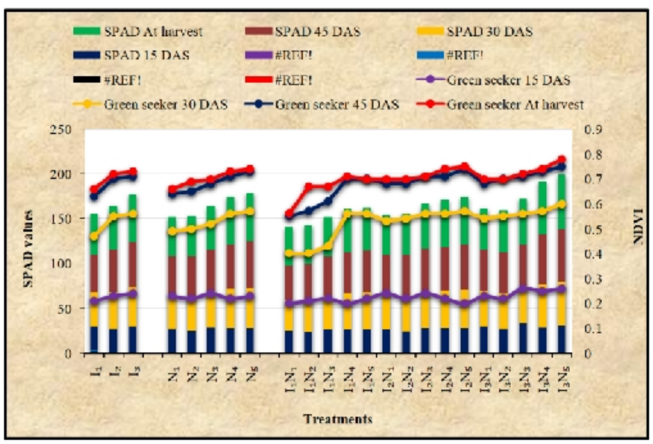

Fig. 1. Green seeker and SPAD values of baby corn at different growth stages as influenced by irrigation and nitrogen management.

IoT based drip irrigation at 50 per cent DASM recorded significantly higher greenseeker value and SPAD reading (0.73 and 52.9, respectively). Surface irrigation recorded significantly lower values (0.66 and 45.1, respectively). Significantly higher greenseeker value and SPAD reading were observed with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} (0.74 and 45.1, respectively). Application of recommended dose of nitrogen recorded significantly lower values (0.66 and 45.1, respectively). Among the interactions IoT based drip irrigation at 50 per cent DASM along with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} recorded significantly higher greenseeker value and SPAD reading (0.78 and 61.3, respectively). Surface irrigation with RDN recorded significantly lower values (0.56 and 42.7 respectively).

Sensor-based irrigation helps in consistent supply of moisture and increases the uptake of nitrogen, which results in higher growth parameters such as plant height, number of leaves and leaf area, which in turn increased canopy cover and ultimately biomass production. The higher the NDVI value, the higher the biomass production. The findings are consistent with the work of Kumar *et al.* (2014); Yinkun *et al*. (2014); Bijay *et al*. (2015); Prakasha and Mudalagiriyappa (2018); Desai and Mudalagiriyappa (2022). IoT based drip irrigation along with SSNM based target yield approach nutrient management recorded higher SPAD readings as moisture was adequate in these treatments throughout the growth period and there will be increased movement of water which increased the uptake of nutrients. The application of nitrogen at split doses will help for the increased uptake and translocation. The above results are in corroborating with the findings of Sadhana (2015); Chaithra (2020); Desai and Mudalagiriyappa (2022).

Yield parameters

Cob length, cob girth and fresh cob weight. The data pertaining to cob length and cob girth (cm) as influenced by sensor based irrigation and nitrogen management practices in baby corn on pooled basis are presented in Table 3.

IoT based drip irrigation at 50 per cent DASM recorded significantly higher fresh cob length, cob girth and cob weight (11.4 cm, 5.1 cm and 18.7 g cob^{-1}, of dehusked cob, respectively). Surface irrigation recorded significantly lower values (9.4 cm, 4.1 cm and 16.3 g cob^{-1}, of dehusked cob, respectively).

Table 3: Cob length, cob weight and cob weight of baby corn as influenced by sensor based irrigation and nitrogen management.

Treatments	Cob length (cm)	Cob girth (cm)	Cob weight (g cob^{-1})
Mainplot			
I_1: Surface irrigation	9.4	4.1	16.3
I_2: Yellow SMI based drip irrigation	10.6	4.6	17.9
I_3: IoT based drip Irrigation @ 50 % DASM	11.4	5.1	18.7
S.Em.±	0.27	0.12	0.35
CD at5%	1.07	0.46	1.36
Subplot			
N_1: RDN	9.3	4.1	16.1
N_2: GreenSeeker based N application	9.5	4.2	16.3
N_3: STCR based target yield of 10t ha^{-1}	10.0	4.4	16.8
N_4: STCR based split application of N for target yield of 10 t ha^{-1}	11.4	5.1	19.0
N_5: SSNM based split application of NPK for target yield of 10 t ha^{-1}	12.0	5.3	19.9
S.Em.±	0.21	0.10	0.43
CD at5%	0.62	0.28	1.25
Interaction			
I_1N_1	8.4	3.9	15.7
I_1N_2	8.9	4.0	15.9
I_1N_3	9.0	4.0	16.3
I_1N_4	10.2	4.4	16.6
I_1N_5	10.2	4.4	16.9
I_2N_1	9.6	4.0	16.6
I_2N_2	9.6	4.1	16.6
I_2N_3	10.6	4.6	16.3
I_2N_4	11.3	5.1	19.3
I_2N_5	11.8	5.4	20.9
I_3N_1	9.9	4.4	16.0
I_3N_2	10.0	4.4	16.6
I_3N_3	10.5	4.7	17.8
I_3N_4	12.8	5.7	21.1
I_3N_5	13.9	6.1	21.9
S.Em.±	0.43	0.19	0.75
CD at5%	1.07	0.49	2.17

Significantly higher fresh cob length, cob girth and cob weight was observed with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} (12 cm, 5.3 cm and 19.9 g cob^{-1}, of dehusked cob, respectively). Application of recommended dose of nitrogen recorded significantly lower values (9.3 cm and 4.1 cm and 16.1 g cob^{-1}, of dehusked cob, respectively), it was on par with green seeker based nitrogen application (9.5 cm, 4.2 cm and 16.3 g cob^{-1} dehusked cob, respectively).

Among the interactions IoT based drip irrigation at 50 per cent DASM along with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} recorded significantly higher fresh cob length, cob girth and cob weight (13.9 cm,6.1 cm and 21.9 g cob^{-1}, of dehusked cob, respectively). Surface irrigation with RDN recorded significantly lower values (8.4 cm, 3.9 cm and 15.7g cob^{-1}, of dehusked cob, respectively).

Fresh cob yield, fodder yield and harvest index. The data pertaining to fresh cob yield (q ha^{-1}), fodder yield (t ha^{-1}) and harvest index as influenced by sensor based irrigation and nitrogen management practices in baby corn are presented in Fig. 2.

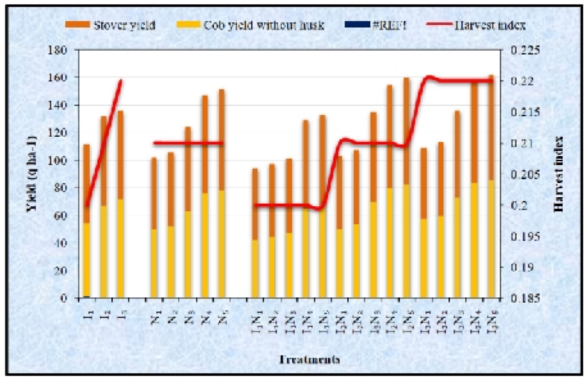

Fig. 2. Cob yield, fodder yield and harvest index of baby corn as influenced by irrigation and nutrient management.

IoT based drip irrigation at 50 per cent DASM recorded significantly higher fresh cob yield (71.7 q ha^{-1} of dehusked cob, respectively) and fodder yield (63.9 t ha^{-1}). Surface irrigation showed significantly lower yields (53 q ha^{-1} of dehusked cob, respectively) and (57.8 t ha^{-1}).

Significantly higher fresh cob yield and fodder yield was observed with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1}(78.3 q ha^{-1} of dehusked cob, respectively) and (73.2 t ha^{-1}) and was at par with STCR based split application of N for targeted yield of 10 t ha^{-1} (76 q ha^{-1} of dehusked cob, respectively) and (71.2 t ha^{-1}). Application of recommended dose of nitrogen shown significantly lower yields (49.8 q ha^{-1} of dehusked cob, respectively) and (51.9 t ha^{-1}) and was on par with green seeker based nitrogen application (52.3 q ha^{-1} of dehusked cob, respectively) and (53.5 t ha^{-1}).

IoT based drip irrigation at 50 per cent DASM along with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} recorded significantly higher fresh cob yield (and 85.5 q ha^{-1} of dehusked cob, respectively) and fodder yield (76.5 t ha^{-1}). Surface irrigation with RDN recorded significantly lower yields (42.2 q ha^{-1} of dehusked cob, respectively) and (51.9 t ha^{-1}).

There was no significant difference in the harvest index among the irrigation and nutrient management practices.

The growth parameters like plant height, leaf area and dry matter production have an positive impact on the yield attributing characters like number of cobs and fresh cob weight. The adequate amount of irrigation and nutrients supplied to the crop at all growth stages have helped to put forth increased growth and yield attributing characters (Desai and Mudalagiriyappa 2022). The husked and dehusked baby corn yield observed in sensor based automated drip irrigation at 50 per cent DASM. The increased availability of moisture throughout the crop growth period in turn have helped in increased uptake of nutrients and favored on yield contributing factors. Significantly higher cob weight and yield was attributed due to higher dry matter production. Increased cob weight and yield with SSNM approach was ascribed to the higher rate and balanced level of nutrient application (Jayaprakash *et al*., 2006; Umesh, 2008). Adequate amount of nitrogen increases the dry matter production ability of baby corn per unit area. Dry matter production at different growth stages of any crop is an important pre requisite for higher yields as it signifies photosynthetic ability of the crop (Asghar *et al*., 2011).

Water use and water use efficiency. The variation was observed in total water used (ha-cm) by baby corn due to sensor based irrigation management (Fig. 3). During 2021 and 2022, the total water used in IoT based drip irrigation at 50 per cent DASM (28.8 ha-cm and 29.0 ha-cm, respectively) with five days interval followed by Yellow SMI based drip irrigation (29.7 ha-cm and 30.0 ha-cm, respectively) with seven days interval. However higher water used was observed in surface irrigation (37.1 ha-cm and 38.2 ha-cm, respectively) with10 days interval.

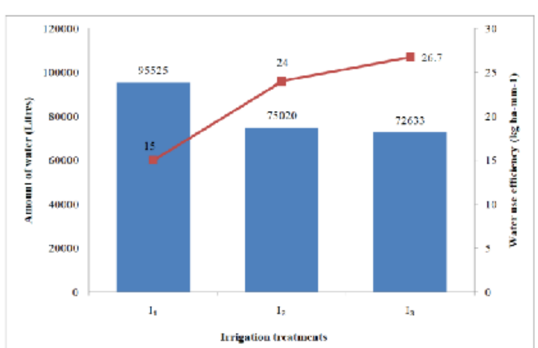

Fig. 3. Irrigation water used and irrigation water use efficiency of baby corn as influenced by irrigation and nutrient management.

Irrigation water use efficiency (kg ha-mm^{-1}) differed significantly due to sensor based irrigation and nutrient management (Fig. 3). Significantly higher Irrigation water use efficiency (26.7 kg ha-mm^{-1}) was observed in IoT based drip irrigation at 50 percent DASM and was followed by Yellow SMI based drip irrigation (24.0 kgha mm^{-1}). However, significantly lower IWUE recorded in surface irrigation (15 kg ha-mm^{-1}). Application of fertilizer using SSNM based NPK management for target yield of 10 t ha^{-1} recorded significantly higher irrigation water use efficiency (26.7 kg ha-mm^{-1}). Application of recommended dose of nitrogen recorded significantly lower irrigation water use efficiency (17.1 kg ha-mm^{-1}). Among the interaction between drip irrigation and nutrient management practices, IoT based drip irrigation at 50 percent DASM alongwith application of fertilizer using SSNM based NPK management for target yield of 10 t ha^{-1} recorded significantly higher irrigation water use efficiency (31.8kg ha-mm^{-1}). Surface irrigation with RDN recorded significantly lower irrigation water use efficiency (11.9 kg ha-mm^{-1}).

Higher irrigation water use efficiency with drip irrigation system was attributed to reduced water loss and efficient water use by the plants resulting in higher yield. Favourable effect of drip irrigation helps in maintaining of constants oil moisture potential (Shah and Das 2012). Lower water use efficiency of surface irrigation was attributed to more evaporation and percolation loss of soil moisture due to more exposed wetting surface upon irrigation apart from reduced grain yield as compared to sensor based drip irrigation at 50 per cent DASM. Similar findings were reported by Barkunan *et al*. (2019); Chaithra *et al*. (2021).

CONCLUSION AND FUTURE SCOPE

Irrigation with IoT based drip irrigation at 50 % DASM and yellow SMI based drip irrigation in baby corn helps to achieve yield of 7.17 and 6.70 t ha^{-1} with saving of water up to 31 and 27 per cent, respectively as compared to surface irrigation. Application of nutrients through SSNM based NPK management for target yield of 10 t ha^{-1} in baby corn helps to achieve dehusked cob yield of 7.83 t ha^{-1} by applying nutrient at split doses and STCR based split application of N for target yield of 10 t ha^{-1} will give on par yield (7.6 t ha^{-1}). IoT based drip irrigation at 50 per cent DASM along with application of fertilizer using SSNM based split application of NPK for targeted yield of 10 t ha^{-1} helps to achieve higher fresh cob yield (8.55 t ha^{-1} of dehusked cob, respectively) and fodder yield (76.5 t ha^{-1}).

Framers can use these Internets of things in scheduling the irrigation and can monitor their field from various places. Artificial intelligence application in agriculture will bring new revolution in efficient irrigation and save the water applied. The smart irrigation technologies will change the face of irrigation with increasing the irrigation efficiency and higher yield. Irrigation used in the agriculture will be cut down to higher level so that the extra water can be utilized to raise other additional crops in the field. The sensors will help to improve the resource use efficiency.

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Conflict of Interest. None.

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