EFFICACY OF HYDROGELS UNDER SENSOR BASED IRRIGATIONONSOILNUTRIENTSTATUSOF TREEMULBERRY

ABSTRACT

A field experiment was carried out to study the efficacy of hydrogels under sensor-basedirrigation on soil nutrient status of tree mulberry during 2022-23. The experiment was laid outin Randomized Complete Block Design (RCBD) with nine treatment combinations and threereplications, observations were recorded at 30th, 45thand 60th Days after Pruning (DAP) andpooled data of five crops were analyzed. The hydrogels were applied during beginning of firstcrop. Main plot included two different types of hydrogels *viz.*, Pusa hydrogel (T_1- Pusahydrogel @ 1 kg/ac, T_2- Pusa hydrogel @ 2 kg/ac, T_3- Pusa hydrogel @ 3 kg/ac and T_4- Pusahydrogel @ 4 kg/ac) and Zeba hydrogel (T_5- Zeba hydrogel @ 3 kg/ac, T_6- Zeba hydrogel @4kg/ac,T_7-Zebahydrogel@5kg/ac,andT_8-Zebahydrogel@6kg/ac)andT_9-controlwithoutanyhydrogel.Amonghydrogels,Zebahydrogel @5&6kg/ac(T_7andT_8)exhibitedidealpH(6.73), EC (0.27 d Sm^{-1}) and OC (0.43 %). The major nutrients *viz* Nitrogen, Phosphorus andPotassium(282.03,40.78and231.35kg/ha)andsecondarynutrients*viz*Calcium,Magnesiuman d Sulphur (2.87 c. mol/kg, 2.32 c. mol/kg and 7.68 mg/kg) has recorded significantly on theapplication of Zeba hydrogel @ 6kg/ac. The micronutrient content was significantly higher insoil collected from T_8which received Zeba hydrogel @ 6kg/ac with Zn, Fe, Cu and Mn of2.50,20.97, 3.80 and 23.78 mg/kg respectively,

Keywords:TreeMulberry,SensorbasedIrrigation,Hydrogels,Soil nutrientstatus.

INTRODUCTION

Mulberryfoliageisthesolefoodforthesilkworm(*Bombyxmori*,L.)isaperennialcropwhichcanbemaintainedformanyyearsandfollowingtherecommendedpackageofpracticesand water management are the imperial factors for producing quality leaf. The quality ofmulberryleavesiscriticaltothe sericulture industry'sperformanceasitdeterminestheeconomics. Moisture content in mulberry leaves improves ingestion, digestion and also theconversion of nutrients in silkworm, and provide the maximum output. Water content inmulberryleavesisconsideredasoneofthecriteriainestimatingtheleafquality.Theimprovement of leaf quality and the productivity of leaves is immediately required for thesustainabilityof cocoon crops (Seenappaand Devakumar,2015).

In Karnataka, about 95.0 percent of the mulberry gardens are under the irrigatedcondition, even though borewell water is a common source of irrigation, its availability isgettingscarcedaybydayduetoquickgroundwaterdepletionwhichoftenleadstothedifficultytoirrigatetheirmulberrygardensaccordingtotherequirements(Rashmi *et al.,* 2009).Waterinthesoil-plantsystemisanecessarymediumforthedistributionofnutrientsthroughtheplant,worksasasolventforbiochemicalreactions,representsasamediumofdistributionforsolutesandhelpsintemperatureregulation as well asasourceof hydrogenin photosynthesis(Anon., 2018).

Among all the agronomic inputs, irrigation water has highest impact on mulberry leafquantityandquality.Insensor-baseddripirrigationsystem,waterisappliedatfrequentintervalsover the soil to irrigate a limited area around the plant. Soil moisture sensors can be connectedto the existing irrigation system controller (Suma 2022). The sensor measures the soil moisture content in thetargeted root zone before scheduled irrigation event and bypasses the cycle if the soil moistureis above the specific threshold. Hanson and Orloff (2002), examined that when the sensors areintherootzoneatvariouspointstheyaidindeterminingtheacceptabilityofirrigationandactual depthof irrigation to begiven.

Mulberryrequiresabout1.5-2.0acreinchesofwaterperirrigationatanintervalof6-12daysdependinguponthetypeofsoilandseasons.Abouteightnumberofirrigationsarerequired per crop of 65-70 days' duration to achieve the maximum leaf yield. Thus countingtheannual requirementofirrigationwaterforfivecropsisabout 75acreinchesof waterequalto1875mmrainfalldistributedequally@36mmperweekor5-6mmperday.But80percent of average annual rainfall of 1,160 mm is received in 4-5 months in our country (Lal, 2001;Guptaand Deshpande, 2004).

Hydrogels are also called as hydrophilic gels or super absorbent polymers and they arecategorized into different groups, such as naturally occurring, semi-synthetic or synthetic. Mostofthesepolymerscanretain332-465timesofwatertoitsweightandreleasethemslowlyduringstress under soil (Dehkordi, 2016). Hydrogels are subjected to swelling due to its hydrophilicnature on coming in contact with water and release nearly 95 per cent of stored water availablefor crop absorption. The process of retaining water and releasing the same by super absorbentgels may last for two to five years depending on the soil environment and cultivation process.However, ultimately in due course of time, they breaks down into CO_2, water, ammonia andpotassium ions without any residue, thus making it environment friendly (Trenkel, 1997).Hydrogels also act as soil ameliorant or conditioner by improving porosity, bulk density, soilpermeability,compaction, infiltration rate,*etc*.

When the superabsorbent hydrogel polymers are incorporated in moist soil, it becomesswollenafterabsorbingandstoringalargequantityofwaterandnutrientswithinashortperiod, andallowstheabsorbedwaterandnutrientswithinitslowlytothesoil,mitigatingthewaterandnutrient requirements of the plant especially when the drought stress condition around the rootzone periphery prevails. The peculiar water-nutrient reservoir and lending characteristics of thehydrogelpolymersforthesoil-plantsystemhavebeenwidelyappliedintheagriculturaldomainforsubstantial waterandnutrientsaving andecological restoration(Li*etal.*, 2013).

MATERIALANDMETHODS

Theexperimentwasconductedduring2022-23inwell-establishedV1treemulberrygardenatIFSdemonstrationplot,All India Coordinated Research Project -AgroforestryUnit,UniversityofAgriculturalSciences,GandhiKrishiVigyanKendra,Bengaluru.Thefieldislocatedatalatitudeof12°58′N,andlongitudeof77°35′Eastandatanaltitudeof930mabove meansealevelintheEasternDryZone(Zone-5)ofKarnataka.Forallotherperennialcrops,therecommendeddosageofPusa hydrogel is 1-2.5 kg per acre (acrehttps://vikaspedia.in/agriculture/crop-production/advanced-technologies/applications-of-super-absorbent-polymers-in-agriculture)and Zebahydrogel is 5 kg per (https://www.uplltd.com/in/crop-protection/water-conservation/zeba).Basedonthat,theexperimentwasestablishedwithninetreatmentcombinations *viz.*,Pusahydrogel(T_1-Pusahydrogel@1kg/ac,T_2-Pusahydrogel@2kg/ac,T_3-Pusahydrogel@3kg/acandT_4-Pusahydrogel@4kg/ac)andZebahydrogel(T_5-

Zebahydrogel@3kg/ac, T_6-Zebahydrogel@ 4kg/ac,T_7-Zebahydrogel@5kg/acandT_8-Zebahydrogel@6kg/ac)andT_9-controlwithouthydrogel,werelaidoutinRCBDdesignwiththreereplications.

Hydrogels are applied at the root zone of the tree mulberry immediately after pruning.Irrigation is applied at 50 per cent DASM (Depletion of available soil moisture). All the otherpractices of mulberry cultivation followed as per standard package of practices (Dandin andGiridhar,2014).Observations recordedat regular intervalstill 60th day afterpruning.

Soil moisture content in the soil wasmeasured by using soil moisture indicator,moistureprobemeterandsinglepointsensors.Singlepointsensorswereplacedat15cmdepthtoensureenoughwaterforcropgrowth.TheseweretconnectedtotheIoTbasedfieldcontrollerinturntothegatewaythroughwirelessconnectioninordertostorethedataincloudstomonitorthewaterstored in thesoil outsidethe area(Li *et al.*, 2020).

Soil moisture indicator was developed by Sugarcane Breeding Institute, Coimbatorewhichworksonprincipleofresistancebut,thedepictionwillbeintheformofcolourasgivenin Table 1(https://sugarcane.icar.gov.in/index.php/soil-moisture-indicator/).

Table1:Indicatorreadingsandsoilmoisturestatus

Colourof LED	Soilmoisture percentage	Soilmoisture status	Inference
Blue	75-100%	Amplemoisture	Noneedofirrigation
Green	50%	Sufficientmoisture	Immediateirrigationnot required
Yellow	25%	Lowmoisture	Irrigationadvisable
Red	<25%	Verylowmoisture	Immediateirrigationnecessary

The data on growth parameters at 30th, 45th and 60th DAP of mulberry crop were recorded ineachtreatmentonrandomlyselectedfiveplantsfromeachnetplotandmeanvaluewasworkedout.Theexperimentaldatacollectedongrowthcomponentsofplantweresubjectedto Fisher'smethodofAnalysisof Variance(ANOVA) as outlinedby Panseand Sukhatme(1967).

Estimationofchemicalpropertiesofsoil

Thechemicalpropertiesinsoilandplantweredeterminedbyfollowingthestandardprocedureas follows

List 1. Chemicalpropertiesinsoilandplant

Parameters	Methods	References

Soilanalysis		
pH(1:2.5)	Potentiometricmethod	Jackson(1973)
EC (dS m^{-1})	Conductometricmethod	Jackson(1973)
Organiccarbon(%)	Wetoxidation method	Walkley andBlack(1934)
AvailableN(kgha^{-1})	Alkaline permanganatemethod	Subbiahand Asija(1956)
AvailableP_2O_5(kgha^{-1})	Olsen'sMethod	Jackson(1973)
AvailableK_2O(kgha^{-1})	FlamephotometerMethod	Jackson(1973)
ExchangeableCa(c.mol/kg)	VersanatetitrationMethod	Jackson(1973)
ExchangeableMg(c.mol/kg)	VersanatetitrationMethod	Jackson(1973)
AvailableS(mg kg^{-1})	TurbidometricMethod	Black(1965)
DTPA extractable Fe, Mn,Znand Cu (mg kg^{-1})	Atomic absorptionspectro photometry	LindsayandNorwell(1978)

SoilpHandElectricalconductivity

Soil pH was estimated in 1:2.5 soil water-suspension, using pH meter (Jackson, 1973).Theclearsupernatantofthesoilwatersuspensionwasremovedandthe Electricalconductivity (EC)was measured usingconductivity bridge(Jackson,1973).

Soil organiccarbon

Thewetoxidationprocesswasusedtoestimatesoilorganiccarbon(WalkleyandBlack,1934).

Availablenitrogen

Soil of 5 g was distilled with 25 ml of 0.1N $KMnO_4$ and 25 ml of 2.5 per cent NaOH.Duringdistillationtheammoniareleasedwastrappedin4percentboricacidcontainingmixed indicatorandtitratedagainststandardH_2SO_4andtheavailablenitrogenwasexpressedinkg/ha(Subbaiahand Asija, 1956).

Availablephosphorus

The available phosphorus present in the soil was extracted with Olsen's reagent. Theextractedphosphoruscontentwasthenestimatedby Ascorbicacidreducedbluecolormethod.Th eintensity ofbluecolorwasread in spectrophotometer (Jackson,1973).

Availablepotassium

The available potassium in the soil was extracted with neutral normal ammoniumacetatesolutionandwasestimatedusingflamephotometerasdescribedby(Jackson,197 3).

Secondarynutrients

Calciumandmagnesiumweredeterminedbythe EDTAtitrationorVersonate-titrationmethod (Jackson 1973). Sulphur content in the di acid digested sample was estimated byturbidometricmethod asoutlined by Black (1965).

DTPAextractablemicronutrients

ThecontentofZn,Fe,Cu,andMndeterminedbyusingatomicabsorptionspectrophotometer with appropriatehallowcathodelamps(Lindseyand Norwell,1978).

<u>RESULTS AND DISCUSSION</u>

SoilpH

SoilpHwasmeasuredintreemulberrygardenafterthecompletionofexperiment. Therewas no significant difference among the treatments. However, lower pH (6.72) was observedin T_7andT_8amongthetreatmentwhichreceivedZebahydrogel@5&6kg/ac,followedbyT_6 (6.73) and highest pH (7.80) was recorded in control plot (T_9) (Table 2).Trung *et al*. (2009)foundthatpHwasunchangedincompostedpinebarkamendedwithPAG,butwasreducedbyU FRF (urea-formaldehyde resin foam) alone and UFRF plus PAG (Artificial polyacrylamidegel).The addition of FYM and integrated use of FYM with chemical fertilizers resulted insignificantly higher organic carbon accumulation over inorganic fertilizers alone after harvestofmaizein an alfisols (Kumari *etal.*, 2013),whichcould becorelated tothepresent findings.

SoilEC(dSm^{-1})

Significantly higher EC (0.27 dS m^{-1}) was observed in T_8 (Zeba hydrogel @ 6kg/ac)andT_7(Zebahydrogel@kg/ac),whereas,thevaluewasalsoonparwiththatofT_6(0.26dSm^{-1}), T_4 (0.26 d Sm^{-1}) and T_5 (0.25 dS m^{-1}). The lowest EC (0.25dS m^{-1}) was found in Control(T_9) (Table 2).The increase in EC (d Sm^{-1}) might be due to increased amount of K applicationwhichmighthaveaccountedformoreK$^+$ionsinsolution.Theincreaseinelectricalconductivity of soil with the increase in N and K fertigation levels was reported also by Gohaand Malkout (1992). Khanday and Ali (2012), revealed that amongst interactions S1F1 (floodirrigation + soil application of the 100 % NPK) and S2F1 (drip irrigation + soil application of100 % NPK) resulted in the highestpH in surface and sub-surface soils, respectively. S2F4(drip irrigation + soil application of 150% NPK) and S1F6 (flood irrigation + biofertilizer andFYM)resultedinthehighestECin0-15and15-30cm. AsimilareffectonCECinthe surfaceand sub-surface soil was shown by S2F4 (drip irrigation + soil application of 150% NPK) andS3F4(dripFertigation with150%NPK+FYM)respectively.Herealsotheavailabilityofmoremoisture in several treatments resulted in good EC, which means usage of hydrogels havesucceededin maintaining good EC at the applied soil.

Organiccarbon (%)

Organic carbon content in soil at the completion of the experiment in tree mulberrygarden was significantly higher in $T_8$and T_7(0.43 %) which received Zeba hydrogel @ 5 & 6kg/ac. However, significantly lower organic carbon (0.42 %) content was found in control(T_1)(Table 2). The addition of FYM and its integrated usage with chemical fertilizers haveresulted in significantly higher organic carbon accumulation over inorganic fertilizers aloneafterharvestofmaizeinanalfisolswasreportedbyKumari*etal*.,(2013).Also,theresultswereon par with findingsof Pandey and Awasthi (2014) and they reported highest organic contentwith the application of RDF (120:60:40 NPK kg ha^{-1}) + FYM 10 t ha^{-1} in maize. The presentresults also expressed the similar trend. Organic carbon content of soil after harvest of pearlmilletincreasedsignificantlywith100%RDF+Azotobacter+PSBor50%RDF+5tFYM+Azotobacter+PSB(Jakhar*etal*.,2018).

Table2:Efficacyofhydrogelsundersensor-basedirrigationonsoilproperties

Treatments	pH	EC (dsm^{-1})	OC(%)

BeforeExperiment	6.80	0.25	0.42
T_1	6.78	0.25	0.42
T_2	6.76	0.25	0.42
T_3	6.75	0.25	0.42
T_4	6.73	0.26	0.43
T_5	6.73	0.25	0.42
T_6	6.73	0.26	0.43
T_7	6.72	0.27	0.43
T_8	6.72	0.27	0.43
T_9	6.80	0.25	0.42
Ftest	NS	NS	NS
S Em±	0.03	0.05	0.02
CD@5%	-	-	-
CV%	3.02	4.44	4.68

Primarynutrient(N,P,K)contentinsoilaftertheexperiment

After applied with different levels of hydrogels and completion of the experimentsignificantlyhighersoilnitrogen(282.03kg/ha)contentwasfoundinT_8whichreceived Zebahydrogel @ 6 kg/ac which was on par with that of T_7 (Zeba hydrogel @ 5 kg/ac) (281.92kg/ha) and T_6 (Zeba hydrogel @ 4 kg/ac) (280.70 kg/ha), whereas, lowest nitrogen (278.87kg/ha)wasfoundincontrol(T_9)(Table3).Significantlyhighersoilphosphorus(40.78kg/ha)content was found in T_8 (Zeba hydrogel @ 6 kg/ac) which was on par with that of T_7 (Zebahydrogel@5kg/ac)(39.74kg/ha),T_6 (Zebahydrogel@4kg/ac)(38.32kg/ha)andT_4(Pusahydrogel@4kg/ac)(38.24kg/ha).Whereas,lowestsoilphosphorus(37.02kg/ha)wasfoundin control (T_9). Significantly higher soil potassium (231.35 kg/ha) content was found in T_8(Zeba hydrogel @ 6 kg/ac) which was on par with that of T_7 (Zeba hydrogel @ 5 kg/ac)(230.98 kg/ha), T_6 (Zeba hydrogel @ 4 kg/ac) (230.49 kg/ha) and T_4 (Pusa hydrogel @ 4kg/ac) (230.11 kg/ha). Whereas, lowest soil phosphorus (227.04 kg/ha) was found in controlplot (T_9) which was on par with that of T_1 (Pusa hydrogel @ 1 kg/ac) (227.16 kg/ha) and T_2(Pusahydrogel@2kg/ac)(227.80kg/ha).El-HadyandEl-Dewiny,(2006)statedthatsoil conditioningcanimprovetheretentivityofNPKandkeeptheminavailableformsforgrowingplants. Liu*etal*.(2007)expressedthatsuperabsorbentslowreleasenitrogenfertilizer(SSRNF) exhibits good slow release properties and also possess excellent soil moisturepreservation capacity, which could effectively improve the utilization of fertilizer and waterresources in *Pinus pinaster*. Karimi *et al*. (2008) observed that by using Igita, a Japan-madesuper absorbent, nutrient (NPK) uptake was increased by plants and also the possession oftheseelementsinclay,loamyandsandysoilwasintheamountsof0.05,0.1and0.3percent,respectively.Incorn,Seyed*etal*.(2010)reportedthatpotassiumwasincreasedby21percentand17.6percent bytheapplicationof35percentmanurewith65percentofsuperabsorbentpolymer and 65 per cent manure with 35 per cent super absorbent polymer, respectivelycompared to control, which supports the present investigation. In *Pennisetum glaucum*, Leila*et al*.(2012) reported applicationof zeoliteincreasedthe nitrogencontent significantly(0.05 %) as compare to control (0.042 %) by preventing from its leaching. Dabhi *et al.* (2013)reportedthatsuperabsorbentpolymersinfluencedoptimumuseoffertilizersincashcropsin arid and semi-arid regions. The soil organic C, available N, P and K were significantlyinfluencedduetodifferenttreatments.Thefavourablesoilconditionsmighthavehelpedinthemineralization of soil N leading to its higher build-up in different treatments. An increase inavailablePmightbeduetoreleaseoforganicacids*viz*.maleicandcitricacidondecompositionoforganicmanureswhichhelpsinsolubilizationofunavailableP.Anincreasein available Kdue to the addition of organic manures may be ascribed to the reduction of Kfixation and release of K due to interaction of organic matter with clays, besides the direct Kaddition to the soil (Hazarika and Boris, 2019). Incorporation of FYM along with fertilizersenhanced the available N content in post-harvest soil as compared to control. Increase inavailable N may be attributed to mineralization of FYM (Chandel *et al.*, 2014), which wasalsoconfirmedinthepresentstudy.Thepolymerfunctionsinabsorptiondesorptioncyclesofwater and nutrients. Application of zeba gel @ 37.5 kg ha-1 in tomato was resulted inenhancingnutrientNPKuseefficiency(70.2,11.8and76.1%respectively).Duetohydrogelapplication the nutrient and water holding capacity of soils and growing media is kept inoptimal conditions (Jeevan *et al.*, 2023). The trend of the present results follows in similarway.

Table 3: Efficacy of hydrogels under sensor-based irrigation on major nutrient status inpost-harvestsoil

Treatments	Nitrogen(kg/ha)	Phosphorus(kg/ha)	Potassium(kg/ha)

BeforeExperiment	276.36	36.26	225.35
T_1	278.07	37.09	227.16
T_2	278.62	37.33	227.80
T_3	279.14	37.91	228.54
T_4	280.38	38.24	230.11
T_5	279.54	38.12	228.96
T_6	280.70	38.32	230.49
T_7	281.92	39.74	230.98
T_8	282.03	40.78	231.35
T_9	278.87	37.02	227.04
Ftest	**NS**	*	**NS**
S.Em±	2.72	0.07	1.19
CD@5%	-	0.20	-
CV%	2.17	5.79	1.16

Secondarynutrient(Ca,MgandS)contentinsoilaftertheexperiment

Themaximumcalcium(2.87c.mol/kg)contentwasrecordedinT_8(Zebahydrogel@6 kg/ac) among all the treatments and the value is on par with T_7 (Zeba hydrogel @ 5 kg/ac)(2.82 c. mol/kg), T_6 (Zeba hydrogel @ 4 kg/ac) (2.70 c. mol/kg) and T_4 (Pusa hydrogel @ 4kg/ac) (2.67 c. mol/kg). Whereas, lowest soil calcium (2.38 c. mol/kg) was found in control(T_9) which was on par with that of T_1 (Pusa hydrogel @ 1 kg/ac) (2.45 %) and T_2 (Pusahydrogel @ 2 kg/ac) (2.50 c. mol/kg). Significantly higher magnesium (2.32 c. mol/kg)content was observed in the T_8 which received Zeba hydrogel @ 6 kg/ac after 60 days afterpruning of tree mulberry followed by T_7, T_6, T_4 and T_5 (2.30, 2.26, 2.23 and 2.18 c. mol/kg,respectively).However,lowestsoilmagnesium(1.75c.mol/kg)wasfoundincontrolplot

(T_9) which was on par with that of T_1 (Pusa hydrogel @ 1 kg/ac) (1.77 %) and T_2(Pusahydrogel @ 2 kg/ac) (1.97 %). The Sulphur (7.68 mg/kg) content was significantly abundantin T_8 which received Zeba hydrogel @ 6 kg/ac after 60 days after pruning of tree mulberrygarden.Whereas, less Sulphur(6.06 mg/kg)content was foundin control (T_9)(Table 4).

The increase in exchangeable Ca and Mg content of soil might be due to release ofthese nutrients from added organic sources which was confirmed even by Sanjivkumar(2014).

Table4:Efficacyofhydrogelsundersensor-basedirrigationonsecondarynutrientstatusin post-harvestsoil

Treatments	Calcium(c.mol/kg)	Magnesium (c.mol/kg)	Sulphur (mg/kg)
BeforeExperiment	2.30	1.71	6.03
T_1	2.45	1.77	6.11
T_2	2.50	1.97	6.16
T_3	2.56	2.06	6.20
T_4	2.67	2.23	6.84
T_5	2.62	2.18	6.59
T_6	2.70	2.26	7.09
T_7	2.82	2.30	7.15
T_8	2.87	2.32	7.68
T_9	2.38	1.75	6.06
Ftest	*	*	*
S.Em±	0.03	0.06	0.18
CD@5%	0.11	0.09	0.54
CV%	3.30	7.15	6.32

Micronutrient(Zn,Fe,CuandMn)contentinsoilaftertheexperiment

Among all the treatments, the micronutrient content was significantly higher in soilcollected from T_8 which received Zeba hydrogel @ 6kg/ac with Zn, Fe, Cu and Mn of 2.50mg/kg,20.97mg/kg,3.80mg/kgand23.78mg/kg,respectively,followedbyT_7(2.21mg/kg,20.88mg/kg,3.74mg/kgand22.62mg/kg),T_6(1.96mg/kg,20.55mg/kg,3.61mg/kgand 21.85mg/kg),T_4(1.77mg/kg,20.25mg/kg,3.56mg/kgand21.26mg/kg)andT_5(1.68mg/kg, 19.04mg/kg,3.45mg/kgand21.09mg/kg).Whereas,lowestZn,Fe,CuandMncontentwasobserved (1.46 mg/kg, 18.39 mg/kg, 3.28 mg/kg and 20.16 mg/kg) in control (T_9) which wason par with that of T_1 (1.52 mg/kg, 18.22 mg/kg, 3.35 mg/kg and 20.12 mg/kg) and T_2 (1.58mg/kg,18.66mg/kg,3.39mg/kgand20.64mg/kg)on60daysafterpruning(Table5).Ahmed*et al*. (2015) reported that addition of more concentration of hydrogels raises CEC, andthereby increases the retention of soil nutrients which corroborates even the present study.The dissolved fertilizer diffuses from the hydrogel network and releases slowly into the soilby the dynamic exchange of free water between swollen hydrogel and soil. The rate offertilizer release increases with the increase in swelling. Eventually when the hydrogelswelling reaches equilibrium the fertilizer release rate also becomes constant (Olad et al.,2018), which could be the reason for more quantum of micronutrients compared to control.Also the highest copper, boron, iron and manganese content was observed in the treatmenthaving FYM @ 10 t ha^{-1} + 100% RDF followed by treatment receiving FYM @ 10 t ha^{-1} +50%RDF(Prashaanth *etal*., 2019).

Table 5: Efficacy of hydrogels under sensor-based irrigation on micro nutrient status inpost-harvestsoil

Treatments	Zn(mg/kg)	Fe(mg/kg)	Cu (mg/kg)	Mn(mg/kg)
BeforeExperiment	1.42	18.25	3.25	20.12
T_1	1.52	18.42	3.35	20.23
T_2	1.58	18.66	3.39	20.64
T_3	1.63	18.90	3.43	20.80
T_4	1.77	20.25	3.56	21.26

T_5	1.68	19.04	3.45	21.09
T_6	1.96	20.55	3.61	21.85
T_7	2.21	20.88	3.74	22.62
T_8	2.50	20.97	3.80	23.78
T_9	1.46	18.39	3.28	20.16
Ftest	*	*	NS	*
S. Em±	0.07	0.45	0.33	0.60
CD@5%	0.20	1.30	-	0.85
CV%	8.87	5.14	12.03	6.35

CONCLUSION

It can be concluded that climate change affected the distribution of rainfall affecting the plantgrowth due to unavailability of moisture and nutrients during critical stages, especially in dryland areas. That demands to cultivate crops with good agricultural practices. Application ofhydrogel enhances maximum water holding capacity, prevent runoff and evaporation loss ofwater from the soil. Besides, loss of nutrient through leaching and volatilization can bepreventedwhich in termplants arebenefitedfor their growth and development.

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