Inter Faculty Department of Irrigation Water Management
Post Graduate Institute
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)

Preamble

The Inter-Faculty Department of Irrigation Water Management was started with the aid of United States Agency for International Development (USAID) through Water Resources Management and Training Project (WRM & TP), Central Water Commission, New Delhi in 1985-86. The Government of Maharashtra accorded the administrative approval for development of separate curricula in Irrigation Water Management (IWM) in integrated manner. The USAID assistance ceased in September, 1992 and there after the Department is running under non-plan scheme of State Government at the Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri.

The Department is entrusted with responsibilities of teaching, research and extension education in the field of Irrigation Water Management for the jurisdiction of Western Maharashtra.

Mandate

1. To offer courses in Irrigation Water Management for Post Graduate degree programme leading to M.Sc. (Agri.) IWM and Ph.D. (Agri.) IWM.
2. To conduct research in Irrigation Water Management
3. To undertake adaptive research for achieving increased water use efficiency and agricultural productivity
4. To promote technology transfer by disseminating the knowledge of water and land management to farmers

Thrust Areas

The department is working on following thrust areas for generation of its domain knowledge

1 Apportioning fertilizer dose according to the need of crop through micro-irrigation

2 Assessment of clogging of the emitters with different quality of saline water

3 Use of saline water, sewage water and other effluents through micro-irrigation systems

4 Evaluation of sprinkler and micro-irrigation methods on farmers fields

5 Scheduling of irrigation with micro-irrigation and sprinkler method for different crops

6 Development of planting techniques for economic adoption of micro-irrigation

7 Cropping sequence studies in drip irrigation

8 Economics of different micro and sprinkler irrigated crops

9 Adoption of advanced packages of practices on farmers' field

Faculty

S. N.	Name	Designation	Specialization	Contact (Mobile No. & Email)
1	Dr. M. S. Mane	Professor & Head	Irrigation Water Management	09423295619 mahanandmane@rediffmail.com
2.	Dr. V. P. Patil	Associate Professor of Mathematics	Mathematics	09420639636 vikram.patil1967@gmail.com
3	Dr. D. D. Khedkar	Assistant Professor of Irrigation & Drainage Engg.	Irrigation Water Management	09822584985 devidadkhedkar@gmail.com
4	Dr. K. D. Kale	Assistant Prof. of Soil Science & Agril. Chemistry	Soil Science & Agril. Chemistry	09850558598 kd_kale@rediffmail.com

Academic Programmes

Sr. No.	Programmes	Intake Capacity
1	Master's Programme in Irrigation Water Management	09
2	Doctoral Programme in Irrigation Water Management	02

Inter-Faculty Department of Irrigation Water Management is offering M. Sc. and Ph. D. degree programme in discipline of Irrigation Water Management

Details of Course Work Proposed for M. Sc. / Ph. D. Degree Programme

Field of Master/ Doctoral degree	Proposed Credits	Minimum Credit	
		M. Sc.	Ph.D.
Major Courses	15	20	15
Minor Courses	08	09	08
Supporting Courses	05	05	05
Seminar	02	01	02
Total	30	35	30
Non-Credit Compulsory Courses	06	06	06

Details of course work proposed per Semester for M.Sc. Degree Programme:

Semester	Courses	Course No.	Course Title	Credits
Semester-I	Major	IWM -511	Water Resources, Planning and Management	2+1=3
		IWM -512	Soil Water Plant Environmental Relationship	2+1=3
		IWM-513	Agro-meteorological Applications in IWM	2+1=3
	Minor	IWM- 514	Cropping systems and Sustainable Agriculture	1+1=2
		IWM -516	Social Issues in Water Resources Management	1+1=2
	Supporting	IWM-525	Applied Mathematics for IWM	1+1=2
	Seminar	-	-	-
			Total course Credit	**9+6=15**
	Non-Credit Compulsory Courses	PGS- 501	Library and Information Services	0+1=1
		PGS- 504	Basic Concepts in Laboratory Techniques	0+1=1
	Research	-	-	
			Grand Total	**9+6=15**

Semester-II	Major	IWM -521	Crop Water Requirements and Irrigation Scheduling	**2+1=3**
		IWM - 522	Farm Irrigation Systems and Design	2+1=3
		IWM - 523	Soil and Water Quality for Irrigation	2+1=3
	Minor	IWM- 524	Application of Remote Sensing & GIS in Agriculture	2+1=3

	Supporting	IWM - 532	Computer Application in Irrigation Water Management	1+1=2
		Stat- 512	Experimental design	2+1=3
	Seminar	-	-	-
			Total Course Credit	**11+6=17**
	Non-Credit Compulsory Courses	PGS-502	Technical Writing and Communication Skills	0+1=1
		PGS-503	Intellectual Property and its Management in Agriculture	1+0=1
	Research	-	-	
			Grand Total	**20+12=32**
Semester-III	Major	IWM-531	Economic Issues in Water Resources Management	1+1=2
	Minor	IWM -517	Watershed Development and Management	2+1=3
	Supporting	-	-	-
	Seminar	-	-	-
			Total course Credit	**3+2=05**
	Non-Credit Compulsory Courses	PGS-505	Agricultural Research, Research Ethics and Rural Development Programme	1+0=1
		PGS-506	Disaster Management	1+0=1
	Research	-	-	15
			Grand Total	**23+14=37**
Semester-IV	Major	-	-	-
	Minor	-	-	-
	Supporting	-	-	-
	Seminar	IWM-591	Seminar - I	0 + 1=1
			Total course Credit	**0+1=01**
	Non-Credit Compulsory Courses	-	-	-
		-	-	-
	Research	-	-	-
			Grand Total	**23+15=38**

Details of course work proposed per Semester for Ph.D. Degree Programme:

Semester	Courses	Course No.	Course Title	Credits
Semester-I	Major	IWM - 611	Advances in Farm Irrigation System Design	2+1=3
		IWM - 612	Drought Climatology	2+1=3
		IWM - 613	Advances in Soil Physics	2+1=3
	Minor	IWM - 614	Watershed Management and Modeling	2+1=3
		IWM - 615	On Farm Water Management	1+1=2
	Supporting	-	-	-

	Seminar	-	-	-
			Total course Credit	**9+5=14**
	Non-Credit Compulsory Courses	-	-	-
		-	-	-
	Research	-	-	
			Grand Total	**9+5=14**
Semester	**Courses**	**Course No.**	**Course Title**	**Credits**
Semester-II	Major	IWM - 621	Diagnostic analysis & performance evaluation of irrigation projects	2+1=3
	Minor	IWM - 625	Soil, Water and Air pollution	2+1=3
	Supporting	SOIS - 602	Advances in Soil Fertility	2+0=2
	Seminar	-	-	-
			Total Course Credit	**5+3=08**
	Non-Credit Compulsory Courses	-	-	-
		-	-	-
	Research	-	-	
			Grand Total	**14+8=22**
Semester-III	Major	IWM - 631	Management of Saline, Sodic and Acidic Soils	2+1=3
	Minor	-	-	-
	Supporting	IWM- 635	Remote Sensing and GIS Application in Agriculture	2+1=3
	Seminar	IWM- 691	Doctoral Seminar - I	0+1=1
			Total Course Credit	**4+3=07**
	Non-Credit Compulsory Courses	-	-	-
		-	-	-
	Research	-	-	
			Grand Total	**18+11=29**
Semester-IV	Major	-	-	-
	Minor	-	-	-
	Supporting	-	-	-
	Seminar	IWM- 692	Doctoral seminar - II	0 + 1=1
	Total Course Credit	**0+1=01**		
	Non-Credit Compulsory Courses	-	-	-
		-	-	-
	Research	-	-	-
			Grand Total	**18+12=30**

Laboratory and Infrastructure Facilities

1. Soil, Water and Plant Testing Laboratory

i) Flame photometer
ii) Spectronic -20 D^+
iii) pH meter
iv) Electrical conductivity meter
v) Automatic N analyzer
vi) Neutron moisture meter
vii) Pressure plate apparatus
viii) Automatic leaf area meter
ix) Electronic digital balance

State of the art facilities for soil & water quality analysis

2. ET monitoring station (Automatic weather station)

Make: ICT International, Australia
Salient features:
The Automatic weather station is equipped with a preconfigured set of sensors for Air Temperature, Relative Humidity, Barometric Pressure, Wind Speed, Wind Direction, Solar radiation, PAR and rainfall.

- Data display on data logger screen.
- The evapotranpiration reading is directly be measured
- Data can be transferred on computer through wireless modem

3. Handheld Laser Leaf Area Meter

Make: CID- bio science, USA
Salient features:

- Advanced laser technology to measure leaf area
- The high-resolution laser scanner, data logger, and display are all enclosed in a single, handheld unit.
- Non-destructive measurements
- No calibration required
- One-Touch Data: Simply sweep over a leaf to yield its measurement

o parameters: area, width, length, perimeter, shape factor, and aspect ratio

- Durable and lightweight
- Improved consistency of measurements

4. Soil and water potential system (Psychrometer)

Make: ICT International, Australia
Salient features:
1 Useful tool integrating all the ambient environmental parameters acting upon the plant such as solar radiation, temperature, humidity, wind speed and water availability into a single continuously measurable variable.



5. Automatic Fertigation Systems (FERTIJET)
Make: Galcon, Israel
Salient features:
Irrigation according to EC / pH control

- Ability to maintain the desired concentration of the fertilizer in the water regardless of preparation error, material, chemistry, construction etc.

- Injects liquid fertilizers in the drip irrigation system mainline. It has an Ec/pH monitor & electronic venturies, which are connected to controller.


6. Time domain reflectrometry (Soil moisture meter)

Make: ICT International, Australia

Salient features:

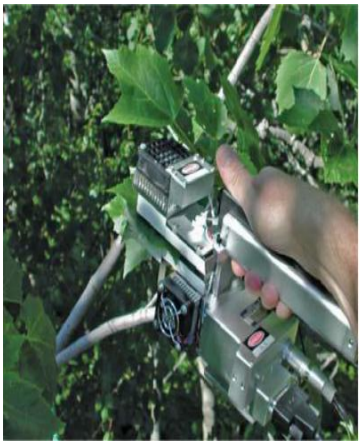
- Working on standing wave principle, highly accurate technique to measure the moisture content of soil and other media.
- Logging instrument for the measurement of volumetric moisture content and soil water potential.
- Fully self-contained unit requiring power input from a solar panel or 12V power supply.
- Communication is via a USB port or wireless connectivity.
- Not affected by external influences such as temperature, salinity and toxins.

7. Portable photosynthesis system (LI-6400XT)

Make: ICT International, Australia

Salient features:

- Allows complete control over environmental variables of interest.
- Networking capability via connectivity, providing a data output, file-sharing, and training possibilities.
- Equipped with leaf chambers and light sources, a leaf chamber fluorometer, and soil CO_2 flux chamber that are interchangeable.



Infrastructural Facilities:

1. Water Management Laboratory
2. Soil - Water - Plant Analysis Laboratory
3. Micro- Irrigation Methods Cafeteria
4. Research Farm 3.50 ha.
5. Water Measuring Devices
6. Automatic Weather Station

Research Farm:

Total Area of Instructional Farm = 3.50 ha.
All the research experiments are conducted on the instructional farm of the Department. Students' research experiments are also conducted on this farm. The research mainly involves irrigation scheduling and fertigation scheduling for important crops in the western Maharashtra

Onion seed production with drip fertigation

Soybean production with supplemental surface irrigation at critical growth stages

Tomato production with drip fertigation

Recording Photosynthesis of cotton with Infra Red Gas Analyser

Experiments as per Strategic Research Plan

Sr. No.	Theme/project	Duration	Centre
A.	**Rain Water Management**		
1	Deciding alternate protective irrigation strategies for rainfed farming in western Maharashtra.	2013-2016 (Short term)	IFD-IWM
2	Yield of soybean as influenced by application of irrigation at critical growth stages.	2014-2017 (Short term)	IFD-IWM
B	**Canal Water Management**		
1	GIS- GPS based soil fertility map, generate database of soil physical properties and assessment of well water quality in Mula command area in Rahuri tehsil.	2014-2025 (Long term)	AICRP on WM
C	**Pressurized Irrigation & Fertigation Management**		
1	Yield and economics of brinjal as influenced by application of water-soluble fertilizers through drip.	2012-2014 (Short term)	IFD-IWM
2	Influence of water application uniformity through microsprinkler for potato.	2013-2015 (Short term)	IFD-IWM
3	Studies on effect of different layouts, spacing, and irrigation systems on potato	2012-2014 (Short term)	IFD-IWM
4	Optimizing water productivity in sugarcane under subsurface drip irrigation system and mulching.	2014-2020 (Long term)	IFD-IWM
5	Effect of deficit irrigation scheduling on growth, yield and water productivity of drip irrigated onion (Allium cepa L.)	2014-2020 (Long term)	IFD-IWM
6	Effect of fertigation application timing on growth and yield of Chilli and nutrient mobility in Inceptisol	2014-2016 (Short term)	IFD-IWM

7	Mobility and availability of nutrients and Yield of Tomato as influenced by fertigation schedule and planting method in Inceptisol	2014-2020 (Long term)	IFD-IWM
8	Standardization of fertigation schedule for BT Cotton (extended period) under drip irrigation.	2014-2016 (Short term)	IFD-IWM
9	Effect of various row spacing of pre seasonal sugarcane (CoM-265) under drip irrigation method in relation to mechanical harvesting.	2012-2015 (Short term)	AICRP on WM
10	Effect of fertigation and irrigation regimes on soil properties and quality of turmeric	2012-2015 (Short term)	AICRP on WM
11	Effect of integrated nutrient management under different irrigation methods on soil health yield and storability of rabi onion.	2012-2015 (Short term)	AICRP on WM
12	Effect of different irrigation scheduling and irrigation interval through drip on chickpea.	2013-2016 (Short term)	Pulse improvement project
13	Improving use efficiency of inputs (Water and nutrient)	2013-2016 (Short term)	AICRP on cotton
D	**Crop Sequences Management under Pressurized Irrigation**		
1	Efficacy of automized ferti-irrigation for Chilli–paddy crop sequence.	2014-2020 (Long term)	IFD-IWM
2	Efficacy of automized ferti-irrigation for maize-potato-groundnut crop sequence.	2012-2014 (Short term)	IFD-IWM
3	Development of deficit irrigation practices under drip for marigold- rabi sorghum crop sequence for varied planting techniques.	2014-2016 (Short term)	AICRP on WM
4	Response irrigation regimes and fertigation levels in summer chilli-water melon crop sequence with mulch	2014-2016 (Short term)	AICRP on WM
E	**Water Stress Management**		
1	Studies on deficit irrigation scheduling through drip on sugarcane	2014-2020 (Long term)	IFD-IWM
2	Deciding supplementary irrigation strategy for cotton under rainfed conditions.	2014-2020 (Long term)	IFD-IWM
3	Identification of critical stage of water requirement in sweet orange	2012-2015 (Short term)	AICRP on Citrus
4	Identification of critical stage of water requirement in acid lime	2012-2015 (Short term)	AICRP on Citrus
5	Standardization of stage wise water requirement in sweet orange	2012-2015 (Short term)	AICRP on Citrus
6	Standardization of stage wise water requirement in acid lime	2012-2015 (Short term)	AICRP on Citrus
F	**Basic Studies Related to Moisture and Nutrient Dynamics under Drip Fertigation**		
1	Moisture and nutrient dynamics in soil as influenced by fertigation	2014-2020 (Long term)	IFD-IWM

2	Estimation of consumptive use of water by maize and rabi onion through lysimetric technique	2014-2020 (Long term)	AICRP on WM
3	Effect of nitrogen splitting and foliar spray using surface and drip irrigation method for yield maximization in Bt cotton under command areas. technique (AICRP on WM)	2013-2015 (Short term)	AICRP on WM
4	Effect of consortium of endophytic nitrogen fixing bacteria on yield and quality of seasonal sugarcane under drip irrigation.	2014-2020 (Long term)	AICRP on WM
G	**Action & Adaptive Research in Command Area**		
1	Effect of irrigation interval as per critical growth stages on yield of wheat.	2014-2020 (Long term)	IFD-IWM
2	Effect of irrigation scheduling as per critical growth stages on yield of chick pea.	2014-2020 (Long term)	IFD-IWM
3	Effect of mulch on yield of summer groundnut.	2014-2020 (Long term)	IFD-IWM
4	Effect of alternate furrow irrigation on water use and productivity of sugarcane.	2014-2020 (Long term)	IFD-IWM
5	Yield targeting of wheat through soil test crop response approach	2014-2020 (Long term)	IFD-IWM
6	Comparative performance of different irrigation methods on yield of sugarcane.	2014-2020 (Long term)	IFD-IWM
7	Comparative performance of different irritation methods on yield of groundnut.	2014-2020 (Long term)	IFD-IWM
8	Performance of different soybean varieties under irrigated conditions.	2014-2020 (Long term)	IFD-IWM

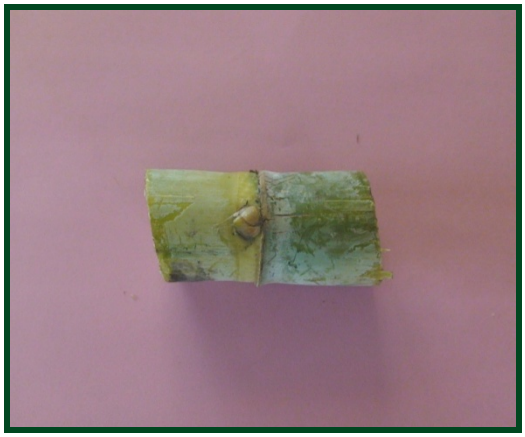
Research Recommendations

Water Management Technologies for Sugarcane

1. Sugarcane cultivation at 5 feet single row spacing under drip irrigation with 85% of crop evapotranspiration (ETc) water applied at every alternate day is recommended for obtaining higher yields, efficient water use and higher returns in medium black soils of Maharashtra.

2. On the basis of better cane and sugar productivity and for higher net returns and B:C ratio with considerable water saving, use of overhead sprinkler and raingun irrigation system for *Suru* sugarcane is recommended in addition to drip irrigation system in medium clay soils.


3. For maximum water saving maximum water use efficiency and net income in deep clay soils of semi arid climatic conditions, planting of single eye bud of *Suru* sugarcane under drip method of irrigation at 150 x 30 cm row spacing is recommended




4. Application of 80% recommended dose of fertilizer in water soluble form in 26 weekly splits as per following schedule through drip with 100% of ETc water applied on every alternate day is recommended for improved productivity, efficient use of water and nutrient and for higher economical returns from *Suru* sugarcane cultivated in medium deep black soils.

Weeks	Nitrogen, Kg/ha	Phosphorus, Kg/ha	Potassium, Kg/ha
1-4 weeks	30	09	09
5-9 weeks	70	32	14
10-20 weeks	100	51	32
21-26 weeks	--	--	37
Total	**200**	**92**	**92**

5. In Deccan canal track of western Maharashtra in medium deep black soils, for obtaining higher cane and sugar yield, water use efficiency and monetary returns from *Suru* sugarcane under limited water availability conditions (8-10 irrigation are available), irrigation scheduling at 125 mm CPE (January to August at an interval of 22-27 days and September at an interval of 45-47 days) with 8 cm depth of irrigation by surface irrigation method and application of sugarcane trash mulch at the rate of 6 t/ha (30 cm chopped sugarcane trash after 45 DAP) is recommended.


6. In *suru* sugarcane for higher monetary returns, water productivity and improved water use efficiency, sugarcane + onion intercropping system under overhead sprinkler and micro sprinkler and sugarcane + cucumber or sugarcane + water melon under drip irrigation and surface method of irrigation are recommended.


7. The adoption of drip irrigation technology for sugarcane cultivation under Farmers Participatory Action Research Program in Western Maharashtra resulted in increase in 25.38% yield, 50.19% water saving and increased economic returns of 33.5% (Rs. 70615 per ha). Hence, large scale adoption of drip irrigation in sugarcane is recommended.

Water Management Technologies for Cotton

1. Cultivation of BT cotton using 0.75 – 1.50 x 0.75 m paired row planting and fertigation with 75% of recommended dose of water soluble fertilizers in thirteen weekly splits as per enclosed schedule is recommended in medium deep black soils for improved seed cotton productivity, better water and nutrient use and enhanced economical benefits.

Days after planting	Nitrogen (N) Kg/ha	Phosphorus (P) Kg/ha	Potassium (K) Kg/ha
10-30 (3 weekly splits)	18	09	05
31-65 (5 weekly splits)	36	22	18
66-100(5 weekly splits)	36	14	22
Total	**90**	**45**	**45**

2. Drip fertigation at 80% recommended dose (96: 48: 48 kg/ha) of water soluble fertilizers in 14 weekly splits as per following schedule is recommended for higher yield, efficient water and nutrient use for Bt Cotton in medium deep black soils of Maharashtra.

Fertilizer Schedule: Percent nutrients to be applied in 14 weekly splits

Days after planting	N		P		K	
	%	(kg/ha)	%	(kg/ha)	%	(kg/ha)
1-21 (3 weeks)	30	28.8	22	10.6	10	**04.8**
22-63 (6 weeks)	25	24.0	40	19.2	30	**14.4**
67-80 (2 weeks)	28	26.9	30	14.4	22	**10.6**
81-101 (3 weeks)	17	16.3	08	03.8	38	**18.2**
Total	**100**	**96**	**100**	**48**	**100**	**48**

3. The 60 % of crop evapotranspiration (ETc) water throughout the crop growth period is recommended to minimize the reduction in irrigated cotton yield under water scarcity conditions in medium deep soils of western Maharashtra. The boll development stage (85-150 days) is found as most sensitive stage and water stress during this stage should be avoided.

Water Management Technologies for Vegetables

1. Planting of *Rabi* potato at 60 X 20 cm spacing on ridges and furrows adopting drip method of irrigation with lateral at 120 cm spacing and 100 % ETc water at alternate day is recommended in medium deep soils of Maharashtra for better yield, quality, efficient water use and higher economical returns.

2. Water application at 100% ETc at 3-4 days interval along with recommended dose (120:80:120 NPK Kg/ha.) in form of water soluble fertilizer through micro sprinkler with 80% overlapping is recommended for optimum tuber yields and economic returns from potato cultivation.

3. Under semi arid climatic conditions in medium deep Vertisols, for higher productivity of *Rabi* potato with maximum returns and efficient utilization of water, the potato be grown under overhead sprinkler irrigation and 30 mm depth of water be applied 25 mm CPE 5-8 days interval). Application of 120:60:120 kg N P_2O_5 and K_2O per ha is recommended.

4. Among all the irrigation methods, planting of potato under overhead sprinkler method of irrigation with 3.53 cm depth of irrigation at 25 mm CPE is recommended for increasing productivity, net income, B:C ratio and quality of potato. For obtaining yield of potato under sprinkler, micro sprinkle, drip and surface methods of irrigation application 40.07 cm, 40.07 cm 20.12 cm and 33.44 cm of irrigation water is recommended respectively.

5. Irrigation at 100 % crop evapotranspiration (ETc) through micro sprinkler twice in a week (3-4 days interval) is recommended for higher yield and efficient water use for cabbage cultivated on medium black soil.

6. Application of 80 % recommended dose of fertilizers (240:120:120, N:P:K Kg/ha) in water soluble form in 14 equal weekly splits through drip is recommended for improved yield and quality of fruits, better water and nutrient use and enhanced economical returns from hybrid tomato cultivated in medium deep black soils in western Maharashtra.

7. Drip method of irrigation with 100 % ETc at alternate day with fertigation of 100% recommended dose (150:75:75 NPK kg / ha) of water soluble fertilizers in 21 weekly splits as per following schedule is recommended for higher yield, efficient water and nutrient use for *Rabi* brinjal in medium deep soils.

Fertilizer Schedule: Per cent nutrients to be applied in 21 equal weekly splits.

Weeks after planting	N		P_2O_5		K_2O	
	%	(kg/ha)	%	(kg/ha)	%	(kg/ha)
1-4 weeks	30	45.0	30	22.5	10	7.5
5-7 weeks	15	22.5	30	22.5	20	15.0
8-11 weeks	15	22.5	20	15.0	20	15.0
12-21 weeks	40	60.0	20	15.0	50	37.5

8. Drip irrigation at 40 % of crop evapotranspiration (ETc) during initial stage (0-20 days) and 80 % of ETc in remaining period is recommended to minimize the reduction in *Rabi* onion yield under water scarcity conditions of western Maharashtra.

9. Application of 60 % recommended fertilizer dose (100:50:50 N P K kg/ha) in water soluble form in 10 equal weekly splits starting from transplanting through micro sprinkler is recommended for higher yield, efficient use of water and nutrients for onion on medium deep black soil.

10. The improved ‘water and nutrient management’ technology for onion seed production is recommended to obtain better growth, yield, efficient water & nutrient use and higher monetary returns.

Improved technology:

- Application of water at 90 % of crop evapotranspiration (ETc) at every alternate day through drip.
- Fertigation dose of 120:60:60 N, P and K kg/ha using water soluble fertilizers in 10 equal weekly splits from planting.

11. Application of water at 75 % of evapotranspiration at 3 days interval through drip is recommended for higher yield, economical returns and efficient water use for onion seed cultivated in medium black soil.

12. For western Maharashtra in medium deep soil for obtaining higher tuber yield and higher monetary returns, sprinkler method of irrigation at 25 mm CPE (Oct-6 days, Nov.-7 days, Dec.-9 days, Jan-8 days, Feb-6 days and march 4 days) with 2.5 cm depth of irrigation is recommended during *Rabi* season for sweet potato with 15 % saving of water over surface irrigation.

Advanced Water Management Technologies for Cropping Sequences

1. The brinjal-chilli crop sequence is recommended under drip system of irrigation as an alternate crop for sole sugarcane for considering the higher yield, water use efficiency and monetary returns.

2. In medium black soils for obtaining higher yield water saving water use efficiency and monetary return from onion soybean sequence, planting of Rabi onion on ridges and furrows (two rows of onion on ones side of ridge at a distance of 15 x 7.5 cm with drip irrigation (90 cm distance between two laterals and 60 cm between two drippers) and fertilized with 75 % N through inorganic(90 kg N +60 Kg P_2O_5 +60 Kg K_2O/ha) + 25 % N through organics (!5 kg N trough FYM + 7.5 Kg through vermin compost + 7.5 Kg through Neem cake / ha) followed by *Kharif* soybean with no fertilizer is recommended.

3. Sowing of *Kharif* maize followed by *Rabi* potato and summer groundnut in sequence at 60x20 cm, 45x20 cm and 22.5 x 15cm, respectively on BBF (90 cm top and 120 cm base) with single lateral per bed and 100% ETc water at alternate day and recommended dose of water soluble fertilizers through drip for higher yields, monetary returns and efficient water and nutrient use is recommended on medium deep soils of Western Maharashtra.

4. Sowing of *Kharif* Bt. Cotton followed by *Rabi* wheat in sequence at 75-150x 75 cm paired row and 15x15 cm (6 lines/bed) on BBF (90 cm top and 120cm base), respectively with single lateral per bed and 100% ETc water at an alternate day and recommended dose of water soluble fertilizers through drip for higher yields, monetary returns and efficient water and nutrient use is recommended on medium deep soils of Western Maharashtra.

Water Management Technologies for Fruit Crops

1. Application of 80% ETc irrigation water at 5 days irrigation interval is recommended for improved yield and quality of fruits, efficient water use and enhanced economical returns from pomegranate cultivated in light medium soils.

2. Application of 80% recommended dose (500: 200: 200, NPK, gm/plant) of water soluble fertilizers in 22 weekly splits as per following schedule is recommended for improved yield and quality of fruits, efficient water and nutrient use and enhanced economical returns from pomegranate cultivated in light medium soils.

Fertilizer schedule: Proportion of nutrients to be applied in 22 weekly splits

Days after Bahar Initiation	% N	% P	% K
1-35 (5)	20	28	16
36-106 (10)	28	40	20
107-142 (5)	20	12	24
143-157 (2)	12	-	20
Total	**80**	**80**	**80**


3. In western Maharashtra with medium deep black soil for obtaining higher fruit yield of sweet orange, it is recommended to with held irrigation upto 205 mm CPE.


4. Application of irrigation at 90 % ER and fertigation with 80 % of recommended dose of N and K (640 g N and 480 g K/plant/year) in eight equal split through drip and 20 kg FYM + 15 kg Neem cake + 300 g P/plant/year through soil is recommended for better growth, yield of quality fruits with saving of irrigation and nutrients for *Ambia bahar* of sweet orange planted in medium black soils of western Maharashtra.

5. Application of irrigation at 80 % ER and fertigation with 80 % of recommended dose of N and K (480 g N and 480 g K/plant/year) in eight equal split through drip and 15 kg FYM + 15 kg Neem cake + 300 g P/plant/year through soil is recommended for better growth, yield of quality fruits with saving of irrigation and nutrients in acid lime planted in medium deep black soils of western Maharashtra.

6. Fertigation at 80% of recommended dose (200:40:200 N P K g/plant) of water soluble fertilizers in 18 fortnightly splits as per following schedule is recommended for higher yield, efficient use of water and nutrients for banana in deep black soil.

Month	Nitrogen, %	Phosphorus, %	Potassium, %
First 2 month (4 splits)	15	30	10
3-4 months (4 splits)	40	50	20
5-6 months (4 splits)	25	20	25
7-8 months (4 splits)	20	-	30
9 months (2 splits)	-	-	15

7. Planting of banana spaced at 1.5 m x 1.5 m with separate lateral for each row and one dripper per plant be done under drip irrigation. For higher productivity of banana, fertilizer dose of 100:40:200 g N P_2O_5 and K_2O per plant; of which N(urea), through drip in 32 weekly splits (15%, 40 %, 25 % and 20 % for every two months in succession from planting, respectively and P (SSP) and K (MOP) as a basal dose be applied.

Water Management Technologies for Cereals and Oilseeds

1. Drip irrigation with 100 % ETc water at every alternate day is recommended for higher productivity and efficient water use of maize cultivated in medium deep soils of Maharashtra**.**

Sr. No.	Months	Water requirement, lpd per emitter	Water requirement, lit per alternate day per emitter
1	June	1.56	3.12
2	July	1.61	3.22
3	August	1.83	3.66
4	September	1.85	3.7
5	October	1.56	3.12

2. Drip fertigation with 80 % recommended dose (96: 48: 32 NPK kg / ha) of water soluble fertilizers in 12 weekly splits as per following schedule is recommended for kharif maize in medium deep soils of Maharashtra.

Fertilizer Schedule: Per cent nutrients to be applied in 12 weekly splits

Weeks after sowing	Nitrogen (N)		Phosphorus (P_2O_5)		Potassium (K_2O)	
	%	Kg/ha	%	Kg/ha	%	Kg/ha
1-3 weeks	30	29	25	12	25	8
4-6 weeks	40	38	35	17	40	13
7-9 weeks	20	19	20	10	20	6
10-12 weeks	10	10	20	9	15	5
Total	**100**	**96**	**100**	**48**	**100**	**32**

3. Application of recommended dose (120:60:40 NPK kg /ha) in water soluble form through drip in 12 weekly splits as per given schedule alongwith 3 foliar sprays of 2 % urea phosphate at 30, 45 and 60 DAP is recommended for higher yield, efficient water and nutrient use for wheat in medium deep black soils.

Fertilizer Schedule: Per cent nutrients to be applied in 12 weekly splits

Days after planting	N		P		K	
	%	(kg/ha)	%	(kg/ha)	%	(kg/ha)
1-21 (3 equal weekly splits)	25	30.0	15	9.0	24	9.6
22-42 (3 equal weekly splits)	47	56.4	20	12.0	48	19.2
43-63 (3 equal weekly splits)	20	24.0	35	21.0	16	6.4
64-84 (3 equal weekly splits)	08	9.6	30	18.0	12	4.8
Total	**100**	**120**	**100**	**60**	**100**	**40**


4. Drip irrigation with 100% ETc water at alternate day with fertigation of recommended dose (120:60:60 NPK kg/ha) in the form of water soluble fertilizers in 12 weweekly splits as per following schedule is recommended for higher productivity, net returns, efficient water and nutrient use for direct seeded paddy on BBF in medium deep soils of Western Maharashtra.


5. Drip fertigation with recommended dose (25:50: 25 NPK, kg / ha) of water soluble fertilizers in 12 weekly splits as per following schedule along with three foliar sprays of 2% Urea phosphate (17:44) at 30, 45 and 60 days after sowing is recommended for higher yield and monetary returns, efficient water and nutrient use for summer groundnut in medium deep soils of scarcity zone of Maharashtra.

Fertilizer Schedule: Per cent nutrients to be applied in 12 weekly splits

Weeks after planting	**Nitrogen (N)**		**Phosphorus (P_2O_5)**		**Potassium (K_2O)**	
	%	Kg/ha	%	Kg/ha	%	**Kg/ha**
1-3 weeks	25	6.25	20	10	10	2.5
4-7 weeks	30	7.50	30	15	20	5
8-10 weeks	30	7.50	30	15	40	10
11-12 weeks	15	3.75	20	10	30	7.5
Total	**100**	**25**	**100**	**50**	**100**	**25**

6. Drip irrigation with 100 % ETc water at alternate day is recommended for higher productivity and efficient water use for summer groundnut cultivated in medium deep soils of Maharashtra.

Sr. No.	Months	Water requirement, lpd per emitter	Water requirement, lit per alternate day per emitter
1	February	1.10	2.19
2	March	2.29	4.58
3	April	3.75	7.50
4	May	4.25	8.50
5	June	2.22	4.44

7. Application of 80% of ETc water through drip at alternate day and 100% of RDF through water soluble fertilizers in 9 equal splits at weekly interval is recommended for better growth, yield, efficient water and nutrient use and for economical returns from summer groundnut in medium deep soils of assured rainfall zone of North Maharashtra.

8. In absence of rainfall sowing of *Kharif* soybean in the second fortnight of June with presowing irrigation, afterwards on availability of one irrigation it should be applied at the time of flowering (40-45 DAS) and on availability of two irrigations it should be applied at flowering and grain filling stage (60-65 DAS) for higher yields is recommended in medium deep soils of Maharashtra.

Characterization of Pressurized Irrigation Systems

1. In case of microsprinkler irrigation method, uniform distribution of water was observed with stake height of 30 cm. hence it is recommended to have the stake height for microsprinkler upto 30 cm.


2. For medium to heavy textured soil, mathematical equation developed taking into consideration basic rate of infiltration emitter discharge rate and volume of water applied through drip is recommended for estimation for maximum lateral and vertical movement of water for deciding drip lateral layout of a particular planting technique.

Equation for maximum lateral movement:

$$W = 0.34\, q^{-0.09}\, x\, v^{0.30}\, x\, t^{-0.10}$$

Equation for maximum vertical movement:

$$Z = 0.63\, q^{0.08}\, x\, v^{0.19}\, x\, t^{0.20}$$

Where, W = maximum lateral movement , m;

Z = maximum vertical movement , m;

q = emitter discharge, lph;

v = volume of water added, lit;

i = basic rate of infiltration, cm/hr.

Other Irrigation Technologies

1. The computer program "Phule SPRINK-UC" developed at Mahatma Phule Krishi Vidyapeeth is recommended to compute uniformity coefficient and average precipitation rate for any desired spacing from a single observation pattern of sprinkler irrigation system.

2. It is recommended to consider a distance a 600 m to estimate the groundwater potential around the percolation tanks constructed in hard rock region of western Maharashtra.

Extension Activities

- The department has made a significant contribution in increasing awareness of adoption of micro-irrigation methods for agricultural crops at state as well as National levels through various extension means.
- Organized National and State level seminars/workshops on drip, sprinkler irrigation and adaptive research.
- Conducted training programmes especially on drip and sprinkler irrigation for Officers of State Department of Agriculture, CADA Officers, Assistant professors from SAUs and ICAR institutes and MAIDC engineers.
- Participated in television and Radio programmes, farmers' rallies, extension publications etc.

- Involvement in State Level Committee on "Drip and Sprinkler Irrigation" as a member of committee since 1986-87, for policy decisions in adoption of micro irrigation by farmers in Maharashtra.

- Conducted farmers rallies for adoption of improved package of practices under adaptive research programme.

- Adaptive Research Project in Irrigated Areas

- Farmers Participatory action Research Programme

Linkages

State:

1. Department of Agriculture, Water Conservation and Irrigation Government of Maharashtra
2. Water and Land Management Institute, Aurangabad
3. Dr. PDKV., Akola, Dr. VSMKV, Parbhani and Dr. BSKKV, Dapoli
4. Directorate of Irrigation Research & Development, M.S. , Pune
5. Maharashtra Agro-Industries Development Corporation(MAIDC), Mumbai
6. National Bank for Agril. and Rural Development(NABARD), Mumbai

National:

1. Central Water Commission (CWC), New Delhi.
2. Indian Council of Agricultural Research (ICAR), New Delhi.
3. Indian Society of Water Management (ISWAM), New Delhi.
4. State Agricultural Universities in India.

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