

Fertigation Technology for Fruit Crops

Judicious use of irrigation water and fertilizers to prevent leaching, volatilization losses of nutrients, optimization and precise utilization of irrigation water near to root zone is required in the present scenario due to depletion and over-exploitation of natural resources. Punjab Agricultural University (PAU) has recommended drip fertigation schedule for kinnow, guava and strawberry to enhance fruit quality and production. Application of fertilizers with drip irrigation system saves about 20 % of fertilizers and 20-35% of irrigation water in different fruit crops. Sustainable production has been realized through the adaptation of drip and fertigation to fruit crops.

IN Punjab, fruits are cultivated on about 0.97 lakh ha with a production of 21.4 lakh MT. The maximum area under citrus crops accounts for about 55.5 % (0.53 lakh ha) of the total area under fruits in the state. Kinnow mandarin is the dominant fruit crop in the state and contributes about 87.3 % of the total area under citrus fruits. Guava ranks 2nd in area and production after citrus crop and is cultivated on 0.12 lakh ha with a production of 2.77 lakh MT. Citrus and guava crops are the leading fruit crops of the region contributing nearly 68.0 % of the total area. In Punjab, strawberries are cultivated in the Ludhiana, Gurdaspur, Ropar, Sri Muktsar Sahib, Patiala, Pathankot, Amritsar and Sangrur districts. The cultivation of strawberries is getting an impetus in North India due to the availability of day-neutral and high-yielding varieties, standardization of plasticulture, irrigation and fertigation schedule, post-harvest management, etc. The availability of fresh water for irrigation purposes is an issue of concern in achieving sustainable production. The water table in northern India is depleting at an alarming rate, particularly in Punjab and adjoining states due to the requirement of water for annual/perennial crops, livestock population, and wheat-rice cropping system. The study was conducted under Punjab conditions using drip irrigation and fertigation technology for various fruit crops with the objective to avoid excessive use of irrigation, fertilizers and to prevent leaching of nutrients. The available groundwater, particularly in the southwestern zone of Punjab, is brackish and not used for both fresh human consumption and irrigation purposes.

Fruit crops generally require irrigation throughout the year because water is used for vegetative growth and fruit development. Irrigation schedule depends on plant water requirements, which vary with age, phenological stages, crop load, soil type, atmospheric aridity and irrigation method. However, some critical periods for irrigation scheduling coincide with rapid vegetative, flowering, fruit set, fruit growth and maturation. Water stress during

critical stages causes an impact on the tree physiology. In bearing trees, fruit size and quality parameters are significantly improved with the adoption of drip and fertigation technologies. Fruit crops are perennial in nature and the use of poor-quality water has long-lasting detrimental effects. Excessive utilization of saline water causes the deposition of salts on soil surface, burning of leaf margins, dropping, drying of twigs and ultimately showing symptoms of sudden declining of trees. Micro-irrigation has gained wider acceptance in fruit cultivation owing to water scarcity and poor water-use efficiency under flood or basin irrigation. Drip irrigation also helps in utilizing poor-quality water under scarcity, poor rainfall and non-availability of irrigation water due to the closer of canals in the region. The application of soluble fertilizers through micro-irrigation systems (fertigation) helps in sustainable fruit production by optimizing both irrigation and nutrient requirements. With the application of fertilizers through drip systems, approximately 20 % less fertilizers are utilized.

Kinnow

Fruiting season of Kinnow crop is very long (approx. 10 months), and guava bears two crops (winter, rainy season in northern India) in a year. Nutrients should be applied to fruit crops to replenish the removal of nutrients by excessive crop load from the soil. Better irrigation technologies, such as micro-irrigation are required to decrease the 'water footprint' and enhance 'water productivity' owing to a decrease in the availability of fresh water for horticultural crops. To optimize the utilization of water and fertilizers, Punjab Agricultural University has standardized the monthly water requirements of Kinnow crop based on the age of the tree planted at 6 × 6 m spacing through drip system. The recommended irrigation and fertigation schedule for Severe water scarcity is noted in S-W districts of Punjab because of the *Bandi* of the canals from March to May. Hence, Kinnow trees can

occasionally be irrigated by mixing saline and freshwater (about EC of 2 mmhos/cm), exclusively through drip irrigation. Excessive irrigation in citrus orchards causes serious fungal diseases *such as Phytophthora*, foot, and root rot. Kinnow plants should not be subjected to water stress during February (before sprouting) and from April to June (after fruit set); otherwise, the intensity of flowers and fruit drop will be enhanced.

Application of irrigation water (litre/day/plant) in Kinnow tree through drip irrigation (monthly basis) (6 × 6 m)

Month	Age of plants (Years)				
	0-2	3-5	5-6	7-8	9 and above
January	3	6	9	12	15
February	6	12	18	24	30
March	9	18	27	36	45
April	13	25	39	52	65
May	16	32	48	64	80
June	17	34	51	68	85
July	13	26	39	52	65
August	12	24	36	48	60
September	11	22	33	44	55
October	8	16	24	36	48
November	5	10	15	20	25
December	3	6	9	12	15

Application of irrigation water (litre/day/plant) in Kinnow tree through drip irrigation (6 × 3 m)

Month	Age of tree (Years)				
	1	2	3	4	5
January	-	-	-	-	-
February	0.8	1.5	3.8	5.9	13.6
March	1.7	2.2	6.3	10.2	22.5
April	3.3	5.4	13.6	33.1	40.9
May	4.1	9.6	16.3	39.2	53.3
June	4.4	8.4	15.8	38.1	54.3
July	3.2	6.5	10.1	27.8	35.8
August	2.6	4.4	9.8	21.4	29.3
September	1.9	4.9	7.8	19.6	26.1
October	1.7	3.5	6.4	15.2	18.8
November	1.1	1.9	4.0	5.7	12.5
December	0.6	1.4	2.5	7.0	7.5

Application of Fertilizers: The application of N, P, K fertilizers (g/tree) for high-density Kinnow mandarin should be done in equal split doses at weekly intervals. About 15 fertilizer split doses are applied from February

Fertigation schedule for Kinnow (6 × 3 m)

Age of trees	February- April (15 splits)			July-Mid September (12 splits)		
	Urea	UP	MOP	Urea	UP	MOP
1	115	-	-	77	-	-
2	230	-	-	154	-	-
3	346	-	-	230	-	-
4	370	240	80	247	160	120
5	466	300	80	310	200	120
6	558	360	80	373	240	120
7	647	420	80	431	280	120
8	742	480	240	494	320	160

to April followed by 12 split doses from July to mid-September. Whereas, the recommended dose of FYM should be applied in December-January every year. The plants require only N fertilizer during pre-bearing stages; however, inorganic P_2O_5 and K_2O fertilizers should be applied during post-bearing stages via drip irrigation for quality fruit production. The dose of nutrients should be stabilized following the plant attains maturity after 8 years of plantation. This will save approximately 20% of fertilizers and provide higher fruit yield and improved quality attributes.

Guava

Fertigation technology saves approximately 35% of the irrigation water and 20% of the fertilizers. Fruit yield and quality were also improved by drip irrigation of the guava orchards. The following irrigation and fertigation schedule for guava was recommended by PAU Ludhiana.

Application of Fertilizers: The fertilizers were applied at weekly interval from July to September (12 splits) and March to May (12 splits).

Strawberry

The strawberry plant being a surface feeder requires frequent irrigations in order to maintain optimal soil moisture. The optimum vegetative growth of strawberries has been obtained under soil moisture conditions where tension does not exceed 1.0 atm. Strawberries are generally irrigated using the furrow method, but nowadays, drip irrigation is becoming popular pertaining to its higher water use efficiency. Fertigation via drip irrigation technique allows uniform distribution of plant nutrients within the root zone, however; majority of active roots are concentrated up to depth of 15-30 cm from soil surface leading to enhanced nutrient use efficiency. An ample supply of water is crucial throughout the growing season, especially during the plant growth and fruit development stages. Strawberry is highly sensitive to excessive soil moisture and irrigation must be applied through the drip system on a daily basis using lateral pipes with dripper discharge of 2.2 l/h and drippers are placed at 30 cm within a lateral pipe.

Application of Fertilizers: Fertigation should be commenced after six days after transplanting of the

Monthly recommendations for applying water (litre/day/plant) to guava trees (6 × 5 m) using drip irrigation system

Month	Age of trees								
	1	2	3	4	5	6	7	8	9
January	0.5	0.8	2.3	2.8	5.3	5.7	7.0	8.0	8.4
February	0.6	2.3	4.5	5.7	9.6	10.2	11.4	12.5	13.2
March	1.2	3.4	7.5	9.9	15.9	17.0	18.4	19.2	19.8
April	2.4	8.5	16.0	17.9	28.8	30.5	32.5	33.6	34.5
May	3.0	14.9	19.2	23.0	37.5	39.5	41.5	43.4	44.0
June	3.3	13.1	18.6	27.0	47.8	49.2	51.4	52.6	53.0
July	2.4	10.0	11.9	19.7	28.1	30.5	32.4	33.5	33.8
August	1.9	6.9	11.6	14.9	20.6	22.5	24.3	24.8	25.0
September	1.4	7.6	9.7	14.0	18.4	20.2	21.5	22.7	23.0
October	1.3	5.4	8.5	10.8	13.2	13.8	15.0	16.2	16.8
November	0.8	3.0	5.4	4.0	8.8	9.2	10.4	11.1	12.1
December	0.4	2.1	3.3	5.0	5.2	6.0	6.8	7.2	7.8

Fertigation plan for guava trees (6 × 5 m)

Age of trees	March-May(12 splits)			July-September (12 splits)		
	Urea	UP	MOP	Urea	UP	MOP
1	33	72	40	33	72	40
2	16	145	100	16	145	100
3	-	218	160	-	218	160
4	40	218	240	40	218	240
5	88	256	320	88	256	320
6	132	292	400	132	292	400
7	192	292	440	192	292	440
8	226	328	520	226	328	520
9 year	248	346	560	248	346	560

seedlings. Fertilizer doses of N: P₂O₅: K₂O:: 44:32:40 kg per acre have been recommended as per the given schedule.

In general, fruit growers have adopted drip irrigation systems in the arid irrigated zone of Punjab, where canal water is stored in communities and individual water tanks for subsequent irrigation purposes. This system has also been adopted in the *Kandi* and sub-mountainous zones, where the land is undulating in fruit crops.

Prospects

The availability of fresh water is alarming under Punjab conditions owing to traditional cropping patterns (Wheat-Rice). Diversification is the best option for reducing the load of irrigation water in this state.

Fruit plants are perennial in nature and require a regular supply of irrigation monthly according to the nature of the fruit plant. The precise utilization of irrigation using a drip irrigation system is a viable option for all annual/perennial crops. Therefore, there is a need to standardize drip irrigation and fertigation techniques.

Currently, micro-irrigation systems have received

Fertigation schedule for strawberry

Days after trans-planting (DAP)	Grades of water-soluble fertilizers	Applied fertilizer (Kg/day/acre)
6 -35	19 N:19 P ₂ O ₅ :19 K ₂ O	0.66
	17 N:44 P ₂ O ₅ :00 K ₂ O	0.80
	Urea (46% N)	0.52
36-60	19 N:19 P ₂ O ₅ :19 K ₂ O	1.34
	Urea (46% N)	0.18
	17 N:44 P ₂ O ₅ :00 K ₂ O	0.56
61-90	Muriate of Potash (MOP)60 % K ₂ O	0.65
	Urea (46% N)	0.80
	Sulphate of Potash (SOP) 41% K ₂ O	0.44
91-120	19 N:19 P ₂ O ₅ :19 K ₂ O	0.70
	Sulphate of Potash (SOP)41% K ₂ O	0.44
121-155	16 N:08 P ₂ O ₅ :24 K ₂ O	0.58

considerable attention from policymakers, researchers, and economists, due to their notable contribution to the management of groundwater, agricultural productivity,

Strawberry drip irrigation schedule in minutes/day

Month	November	December	January	February	March	April
Time in minutes	10	14	12	22	29	38

environmental sustainability and economic growth. Top of Form

The policy should focus on promoting drip irrigation techniques in areas where water and labour scarcity are principally alarming concerns. Additionally, it should aim to boost diversification programs in fruit crops.

Mission for Integrated Development of Horticulture (MIDH) provides subsidies to the growers to establish new plantations, install micro irrigation systems, construction community tanks/water harvesting systems, etc. in horticultural crops.

SUMMARY

Kinnow and Guava occupy approximately 68 % of the area under fruit crops in Punjab, whereas 80 % of this area is situated in the southwestern zone of Punjab. In this region, fruit growers face problems such as poor groundwater quality, water scarcity, and higher soil pH, which adversely affect plant growth, quality and yield

attributes. In this context, drip fertigation technology is a viable option to address the problems of water scarcity, poor groundwater quality and nutrient leaching. Drip fertigation technologies have been recommended for different fruit crops such as kinnow, guava, and strawberry. Drip fertigation technology saves nearly 20-35 % of irrigation water and 20 % of the recommended fertilizers in different fruit crops. By adopting this technology, qualitative and quantitative production is obtained and farmers will get good returns from the cultivation of fruit crops.

For further interactions, please contact:

¹Departement of Soil Water & Engineering ²PAU-Krishi Vigyan Kendra, Bathinda ³Professor (Fruit Science) Department of Fruit Science Punjab Agricultural University, Ludhiana 141 004
Corresponding author: navpremsingh@pau.edu

Success Story

Enhancing Farmers' Income via "Strawberry Cultivation" : A Case Study from Chittorgarh District of Rajasthan

Shri Nemichand Dhakar, a 32 years old farmer, having done Post Graduation, belonging to Sripura village in Nimbahera Tehsil of Chittorgarh district of Rajasthan State, has 6.00 ha cultivable land with two tube wells as well as open well as source of irrigation, besides owning a cattle dairy unit. After completing post-graduation in the year 2014, he started looking after his family farms, and realized that... only growing traditional crops like maize, wheat, mustard, gram and groundnut is not profitable; and hence, some innovative enterprise is necessary for enhancement of income. Then, he contacted some agriculture scientists and extension officers, several times, while having thorough discussions regarding various innovative options to enhance farm income. In 2015, he visited KVK, Chittorgarh; and subsequently, he underwent a training on improved cultivation practices of strawberry. In the same year, he started cultivating strawberry in a small area under the technical guidance of Scientists of that KVK. After getting encouraging results, he gained confidence, and extended strawberry cultivation to 1.00 ha in the year 2020. He brought mother plants of three varieties (*Winter Down*, *Winter Star* and *Sweet Sensation*), imported from California; and planted the same in his field. Afterwards, he was able to produce thousands of plants from runners of mother plants, and planted on raised bed, on mulching sheet, with drip irrigation system in September. He sold strawberry fruits in the market of Delhi, Jaipur, Ahmadabad and other metropolitan cities. He earned a net income of ₹11.60 lakh per ha with 5.83 BCR. Other than strawberry production, now he has also raised 2.00 lakh plants of strawberry and earned a gross income of ₹10.00 lakh, by selling of plants to the farmers during 2021. He has branded his strawberry as '*Shiv Shakti*', and started selling with proper modern-day attractive packing.

Adding an innovative enterprise to his farm has enormously increased his income. With an increased income, he not only has improved and secured his livelihood, but also has generated employment for his family members. He has also improved his social status with more acceptance, recognition and respect as an innovative young farmer, as he is the first farmer in the hilly area of Chittorgarh district to cultivate strawberry, successfully. Now more than 15 farmers from Rajasthan and adjoining state of Madhya Pradesh have been motivated to start cultivation of strawberry, and they approached him for planting materials and cultivation technology. For strawberry cultivation, several farmers visited his farm, and took technical advices regarding cultivation on large scale, on a sustainable basis.



A view of strawberry cultivation by
Shri Nemichand Dhakar



A view of strawberries harvested by
Shri Nemichand Dhakar

Source: ICAR-Annual Report 2022-23