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IRRIGATION PRACTICES IN VEGETABLE CROPS : A REVIEW

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Abstract

Irrigation water play a vital role in Indian agriculture and in horticulture also. Water availability in the soil is one of the most important requirements for successful crop production. Good growth of the totally depend upon the adequate moisture percent present in the soil. We can say that irrigation water is very much important factor responsible for good growth of the crop. Adequate moisture percent present in the soil directly helps in growth, yields and quality of vegetable crops. Irrigation water should be applied to the crop in particular stage when it is really require. Applying irrigation water in perfect stage can minimize the disease incidence and it will also reduce the spreading of few pathogens. In vegetable cultivation few crops are direct seeded and few are transplanted. To raise the seedling in nursery generally either raised or flatbed can be prepared. It has been observed that raised bed, ridges are dry out faster than flat bed. But for certain crops only ridges can be prepare to avoid water logging conditions like potato and sweet potato. Requirement of water differ crop wise as well as growth stage of the vegetables. For flowering vegetables, such as pea, beans, cucurbits and tomatoes critical stage of water requirement is at flowering and fruit or seed development stage. An adequate supply of water is essential for root crops once the roots start enlarging. For heading crops, such as lettuce and cabbage, the most critical period for water is at heading stage. The availability of water in soil for crop growth is very crucial factor so that the suitability and the quality of water available for irrigation should be tested before sowing and transplanting of vegetable crops.

***Keyword*:** Irrigation practices, vegetable crops, depth of the soil and yield.

Introduction

Best crop management practices of vegetable crops not only includes nutrient management and rate of fertilizers applied for good crop growth but also focused on the amount of water applied for good crop growth. The irrigation water is the vector of off-site nutrient movement of nitrate in solution and phosphate in sediments as well as other soluble chemicals, proper irrigation management directly affects the efficacy of a best management practices (BMP) plan. Vegetables that are set as transplants, rather than direct seeded require irrigation for crop establishment in excess of crop evapotranspiration (ET). Irrigation requirements necessary to meet the ET needs of a crop depend on the type of crop, field soil characteristics, irrigation system type and capacity, and stage of crop development. Different crops have growth characteristics that result in different relative water use rates (Simonne *et al*., 2010).

Water requirement for solanaceous vegetable crops:

Tomato: Tomato has a deep root system and can draw soil water from deeper layers. It should be grown without irrigation when the water table was at 91.44 to 121.92 cm depth (Mukherjee and Chatterjee, 1967). Water requirement and consumptive use of tomato were 95.0 and 77.5 cm respectively and the optimum water regime was found to be 100 to 60 percent of water availability in the top 120 cm of soil layer in New Delhi (Kulkarni and Dastane 1966). The crop is irrigated usually by the bed and furrow method. Drip irrigation may also be suitably adopted.

Potato: Potato requires a good amount of water and a large part of it is transpired. The transpiration ratio was observed as 544 at Banaras (Singh *et al*., 1935). The water requirement of the crop varies widely with the variety, length of growing season, soil and climate. It is 63.5 and 76.2 cm respectively for short and long duration varieties in Jalandhar (Singh, 1968), whereas it is 45.0 cm at Kharagpur (West Bengal) (Moolani and Hukkeri, 1965). The consumptive water use and water requirement of potato were found to be 31.8 and 47.0 cm respectively in sandy loam soil at Delhi when the crop was irrigated at 0.15 to 0.3 atmospheric tensions at 15 cm depth of soil and that involved 10 irrigations, each of 4.7 cm mean depth of water (Dastane *et al*., 1970).

Frequency of irrigation in potato: Being a shallow rooted crop it requires frequency irrigations of shallower depth rather than a few heavy irrigations. On an average, 6 to 7 irrigations are applied to early maturing varieties and 9 to 11 irrigations to late varieties. The interval between irrigations may be from 6 to 7 days for sandy loam soils and 9 to 10 days for loam soils. On reviewing the results obtained by various workers, Dastane *et al*. (1970) stated that the interval of irrigations might be 6 to 7 days on sandy soils and 10 to 12 days on heavy soils. Intervals are usually longer in the beginning and then the same is made shorter with the increased vegetative growth and tuberisation of the crop. It may be 12 to 15 days during the first month after sowing (2 irrigations), then 9 to 11 days in the second month(3 irrigations) and 7 to 9 days subsequently till 15 days before harvesting. Based on experiments in Bihar, Uttar Pradesh and Punjab, Puskarnath and Swaminathan (1963) concluded that: i. Potato on sandy loam soil needed irrigation at 8 to 9 days intervals, ii. A total delta of 63.5 cm gave better performance, iii. The total of 9 irrigations required distribution as, 3 irrigation during tuberisation and 2 irrigations during maturation. Water-use-efficiency of potato crop varied between 5.4 to 12 kg/m^3 with respect to irrigation, programme regime, amount of fertilizer and production technique (Wright and Stark, 1990). The water use efficiency for irrigated potato crops in humid and sub-tropics areas lies between 4-7 kg/m^3 (Dorenbos and Kassam, 1979).

Depth of irrigation for potato crop: The depth of irrigation on sandy loam soil at the rate of 5 cm is considered optimum for the potato.

Method of irrigation in potato: Potato is best irrigated by furrow method, although sprinkler irrigation may be adopted. While irrigating the crop the field or ridges are never flooded and the water is led to the furrow in such amounts that it does not flood the ridges more than two-thirds of heights. Generally furrow method of irrigation is recommended for potato. However, upto 38 per cent irrigation water could be saved by applying water in alternates furrows irrigation turn at the expenses of 10.7 per cent decrease in yield (Bhan and Dharma 1982).

Chilli: Water requirement of chilli variety K-l response to drip irrigation at Coimbatore in Tamil Nadu. The water saving of 62 percent, yield increase by 25 per cent and reduction in weed infestation by 50 percent was observed in drip over farrow irrigation. Yield of chilli was 60.8 and 39.8 q ha'during summer and winter season, respectively under drip irrigation as compared to 42.3 and 37.3 q ha'1 under farrow (Sivanappanef *et al.,* 1978 and Sivanappan, 1979).

Water requirement of cole crops:

Cauliflower: Cauliflower is a shallow rooted vegetable crop and extracts most of its water need from the upper 30 cm soil layer. The top 15 cm soil layer contributes 57 to 61 percent of the total water use. Two to four irrigations were found necessary when the water table was at 110 to 120 cm depth from the soil surface. They suggested that the crop should be irrigated at 50 percent soil water availability. The crop is irrigated by the furrow method.

Cabbage: Cabbage is a shallow rooted vegetable crop. The crop could be raised with a supply of 40 cm water with irrigations of 5 cm depth each at an interval of 16 days in medium black soil of Pune during the rabi season (Jadav and Sreeenivas, 1968). The increases were not appreciable with more supply of water applied more frequently. The crop is irrigated through furrow method.

Water requirement of root crops:

Radish, Turnip and beet root: Root crop such as radish, Turnip and beet root are shallow rooted and they draw most of their water needs from the upper 30 cm depth of soil layer. The water requirements, consumptive uses and optimum water regimes for these crops given in table 1.

Table 1 : Optimum water regime and requirements and Consumptive use of as radish, Turnip and beet root

Crop	Optimum water regime	Depth of soil water measurement(cm)	Water requirement(cm)	Consumptive use(cm)
Radish	Field capacity to 0.2 atmospheric tension	15-22.5	227	152
Turnip	-do-	-do-	243	155
Beet root	-do-	-do-	330	286

Source: Dastane *et al.* (1970)

It was observed that radish, turnip and beet root crops required 14, 15 and 27 cm of water respectively as net irrigation. Pandey (1966) found that optimum irrigation requirements of beet root, turnip and radish were 13.5 cm water and the irrigation was needed at 10000 ohms resistance under gypsum block under Delhi conditions. The water table was within 90 cm from the soil surface and an average rainfall of about 26.5 cm was received during the growing period. Hegde (1987) reported that frequent irrigation at 0.2 to 0.4 bar soil water potential resulted in higher root yield and water use efficiency than irrigation at 0.6 bar. Irrigations at 0.3 atmospheric tensions were observed as adequate for turnip (Banarasi Lal, 1968). These crops is irrigated through shallow furrows.

Water requirement of bulbous vegetable crops:

Garlic: Garlic is an important condiment very commonly used in daily cookery in India. The crop has a great value in the market and is a remunerative crop.

Onion: The consumptive use was 63.73 am at New Delhi (Narang, 1965). The irrigation requirement was 70 cm under Delhi conditions (Dastane *et al.,* 1970).The water requirement was noted as 104.14 cm at Padegaon, Maharashtra (Anonymous, 1963 a).

Frequency of irrigation: Onion is shallow rooted crop. It needs frequent irrigations. The number of irrigations required for the crop was 12 to 15 for the October planed crop, 15 to 20 for the summer planted crop and 5 to 6 for June planted crop (Purewal, 1954, Rao and Purewal, 1967). The frequency for irrigation could however be reduced by providing shelterbelts around the crop to reduce the advective energy and the evaporation losses. The interval between irrigations may vary from 7 to 13 days according to the evaporative demand of the climate. It was 13 days during November to December, 10 days during January, and 7 days duration February to March at Poona. A 10 days interval at Lucknow and Niphad (Mukherjee and Chatterjee, 1967) and 5 days interval for the December-May crop at Anantharajypet, Andhra Pradesh were found optimum (Dastane *et al*., 1970).

Scheduling irrigation: Hedge (1986) observed that intermediate frequency of irrigation at 0.45 to 0.65 bar soil water potential gave the maximum bulb yield(Sadaria *et al*., 1997) noted that IW/CPE ratio of 1.2 gave the highest yield of onion. Mishra (1994) and Patel *et al*., 1992 made similar observations.

Table 2: Critical period of water need in vegetable crops

S.No	Name of the crops	Critical period
1.	Asparagus	Brush
2.	Broccoli and Cabbage	Head development
3.	Eggplants, Melons (musk melons& watermelons) and Cucumbers	Flowering and fruit development
4.	Onions (dry)	Bulb enlargement
5.	Peas	Seed enlargement and flowering
6.	Cauliflower	Curd development
7.	Potatoes (white)	Tuber set and tuber enlargement
8.	Turnips	Root enlargement
9.	Tomatoes	Early flowering, fruit set, and enlargement

Critical periods of water need: Adequate soil water should be maintained during the whole period of growth of onion. The most critical stage of water need is the bulb formation stage followed by the 30 days period of bulb development (Dastane *et al*., 1969). Onion meets most of its water need (90per cent) from the top 30 cm soil layer (Narang and Dastane 1968). The crop is irrigated by the check basin method.

Water requirement of peas and beans:

French bean: Frenchbean is usually grown under rainfed conditions during *Kharif* season. Its root system is shallow and highly sensitive to soil water balance and a slight stress may result in reduced yield. The *kharif* frenchbean does not require irrigation if the rainfall is moderate. The *rabi* frenchbean is grown under irrigation and three to four irrigations are necessary. In the central and western regions, usually four irrigations are applied at 25, 50, 75 and 100 days after sowing and in north and eastern India two to three irrigations are beneficial. Heavy irrigation may result in excessive vine growth and may delay maturity. Light irrigations are favored.

Pea: Pea crop is mainly grown under rainfed condition depending on the conserved soil water from the preceding monsoon season and the winter rains received during its growing period. However, irrigation benefits the crop. One irrigation has been found to be very beneficial at the stage of flowering. Maity and Jana (1987) found one irrigation at pre-bloom stage as best, Ali (1989) found two irrigations on field pea, one at branching and the other at flowering or pod formation stages, were optimum for pea at Dholi (Bihar) and Navgaon. At Navgaon even one irrigation at flower-initiation stage gave nearly equal yield as two irrigations. In Delhi, three irrigations have been found optimum in years of lower rainfall and flowering and pod swelling stages are the most critical stages of water requirement (Gautam and Lenka, 1968). Pannikkar (1963) reported that pea gave a better yield with one or two irrigations. The crop is usually sown with a pre-sowing irrigations. At Hissar, one irrigation at flowering (82 days after sowing) in addition to the pre-sowing irrigation was observed as optimum in loam soil when the rainfall was about 22.3 cm during the crop period. The crop needed a total delta of 17.5 cm (Behl *et al*., 1968). Furrow irrigation is adopted when crop is sown on raised beds with a furrow in between two bed.

Cowpea: Cowpea is grown under rained conditions during the rainy season and no irrigation is usually required. The crop is drought tolerant. The seasonal water use varies from 400 to 600 mm. Water use efficiency may be as high as 10 kg grains/ha-mm of water with usual range of 4.2 to 6.2 kg grains/ha-mm. It is necessary to make provision to drain out excess water from the field after heavy rains since the crop cannot stand water logging. In dry areas, irrigation becomes necessary particularly at the flowering and pod formation stages, in rain fails. One pre-sowing irrigation may be given if rains are delayed at sowing time. One irrigation may be necessary during flowering or pod-setting stage, if long dry spell continues. During summer season, cowpea requires irrigation and the crop is essentially grown only with irrigation facilities. Two irrigations are required after a pre-sowing irrigation. Irrigations are scheduled one at the stage of flowering (about 30 to 35 days after sowing) and the second at grain development stage. If the water is available for only one irrigation, it should definitely be applied at flowering stage. Singh and Lamba (1971) reported that the crop should be irrigated at 35 per cent available soil water. At TNAU, Coimbatore, Selvaraju 1999 noted that irrigation at vegetative, flowering and pod filling stage with moderate stress in growing vegetative period produced equally good yield of cowpea on black sandy clay soil as with full irrigation without any water stress at any part of the growing period. Even irrigation applied either at vegetative and flowering stage or at flowering and pod filling stages increasing the yield by 162 and 172 per cent respectively.

Cluster bean: As it is drought resistant it is adopted to dry farming conditions it is grown under rainfed conditions depending on rains during the rainy season without any irrigation. Only when long period of drought occurs one irrigation at flowering or pod formation stage it applied. The crop is however shown early in May where some irrigation water is available and the crop is give a re sowing irrigation and one irrigation subsequently before monsoon starts. The spring summer crop in northern India is given four to five irrigations.

Water requirement of cucurbits:

Cucumber: In cucumber, water stress has caused yield losses and fruit yield was higher generally under higher water applied conditions. However use of excess water for cucumber gives lower fruit yields. Yield parameters like fruit length, fruit diameter, number of fruit, fruit weight were also positively affected with irrigation quantities. So, determining of water use efficiency is essential to obtaining optimal irrigation level. Generally irrigation water use efficiency (IWUE) for cucumber was the lowest under unstressed conditions (Poornima *et al*., 2016).

Conclusion

Irrigation water is most important factor in crop growth. Water stress during critical growth periods reduces yield and

quality of Crops. Crop water use (ET) at critical growth stages can be used in irrigation scheduling to avoid stressing Crops. Crop water use (ET) is weather dependent as well as soil, water and plant dependent. Periodically check soil water at different depths within the root zone and at different growth stages to avoid stressing the crop during critical growth stages.

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