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Performance of pea under different irrigation systems

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ABSTRACT

The field experiment was conducted at Precision Farming Development Centre, Central Institute of Agricultural Engineering, Bhopal on influence of different irrigation methods in three continuous years (2010-2013) on the performance pea crop. Conventional flood irrigation, micro sprinkler and drip irrigation systems were adopted as three treatments and with seven replications in each treatment in the study. Pea (Arkel variety) crop was sown at a spacing of 45 X 10 cm. During the period of experiment flood irrigation were applied on weekly basis and micro irrigation and drip irrigation systems were operated every third day to meet the crop water requirement. The total quantity of water applied in flood, drip irrigation and micro sprinkler systems were 387.5, 244.7 and 273.5 mm respectively. Maximum crop yield was observed under micro sprinkler system (98.60 q/ha) followed by drip and conventional irrigation system. Saving of water was found better under drip irrigation over micro sprinkler irrigation system.

Key words: Conventional, Drip irrigation , Pea, Sprinkler irrigation, Water productivity.

INTRODUCTION

Pea (*Pisum sativum*) is an important pulse crop native to the Mediterranean region of Southern Europe. In India, Uttar Pradesh is the major pea growing state and is also grown in Punjab, Haryana, Delhi, Himachal Pradesh, Bihar and Madhya Pradesh. Green peas are available for almost 5 months during winter season mostly for vegetable and dry seed purposes. Peas have nutritive value and are richer and cheaper source of protein. On an average, it contains 93% calories, 72% moisture, 15.9% carbohydrates and 20-22% protein in addition to 0.1 g fat, 9.0 mg vitamin, 0.25 mg thiamine, 0.01 mg riboflavin, and 21.5 mg mineral per 100g of edible portion. Among winter season pulses, field pea is ranked second after chickpea in India.

Conventionally pea is irrigated with flood irrigation and light and frequent irrigations are provided for better performance of the crop. Generally, first irrigation is provided after 45 days of sowing, second at pod formation and rest of the irrigations on 15 day interval. Conventional irrigation leads to water loss, increases energy use for pumping, causes leaching of nitrogen and other micronutrients .Improper irrigation and fertilization management can be a major contributor to groundwater contamination (Mehta *et al*. 1993). Pressurized irrigation systems have been widely used for irrigating vegetables and other crops for enhanced water and agro-chemicals use efficiencies. Adopting proper irrigation management strategies can reduce the negative impacts of conventional irrigation and provide a balance between the crop water requirement and available water.

The objective of irrigation management is to establish proper timing and amount of irrigation for achieving higher water use efficiency. This will minimize yield loss due to water stress, maximize yield response to other management practices and optimize yield per unit of water applied, contributing to farm profitability. Poor irrigation management that results in either excessive or inadequate water application can significantly reduce the potential for profitability. Proper irrigation management also helps reduce the potential for runoff and reduce soil erosion.

MATERIALS AND METHODS

An experiment was conducted at PFDC, CIAE Bhopal to study the performance evaluation of micro irrigation systems on pea during 2010 to 2013 continuously for three years. Irrigation methods viz. flood irrigation, drip irrigation and micro sprinkler irrigation were adopted as three treatments and were replicated seven times. The soil at experimental site was classified as heavy clay soils with clay content varying between 49.7 to 53.7 % with field capacity ranging between 28.5 to 31%. Pea crop (Arkel variety) was sown at spacing of 45 x 10 cm. During the period of experiment water through flood irrigation was applied on weekly basis and in micro irrigation and in drip irrigation on three day interval to the crop to meet the crop water requirement. Weeds were controlled by the hand weeding on 20, 40 and 60 day after sowing in all the treatments. Plant protection measures were adopted to keep crop free from insect and diseases. Five randomly selected plants just after the germination from each plot were used to record average plant height, number of branches per plant, number of pods

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per plant and yield (q/ha). Water saving (%), water productivity (kg/m^3) were also calculated. The collected data were analyzed by using Fisher's analysis of variance technique and RBD test at 5% to compare the difference among treatments means (Steel *et al*, 1997). Water requirement of pea (Table 1) was calculated from the 30 years of pan evaporation data of institute metrological observatory. The schedules of irrigation and fertigation are shown in Table 2. Crop water requirement at different important crop growth stages were calculated and are presented in Table 3. Theoretical water requirements were estimated by assuming water application efficiencies of flood, micro-sprinkler and drip irrigation as 40 %, 75% and 90 % respectively.

RESULTS AND DISCUSSIONS

Performance of different irrigation systems in pea was evaluated continuously for three years. The average values of the crop growth parameters collected for the crop in each treatment for the three years were pooled and the average values are presented in Table 4. The plant growth parameters such as average plant height was significantly higher under micro sprinkler irrigation (59.7 cm) followed by drip (55.8 cm) irrigation. Average number of branches per plant were higher in micro sprinkler irrigated pea (3.4) followed by drip irrigated (2.8) and lowest in conventional irrigated pea crop. Average numbers of pods per plant (18.7) were significantly higher under micro sprinkler irrigation followed by drip irrigation (14.8) and conventional irrigation (12.6). According to (Bernstein,1975) sprinkler irrigation often allow much more efficient use of water and a reduction in deep percolation losses and increase the potential of crop yield. The highest average yield was obtained under micro sprinkler irrigated pea with (9.81 t/ha) followed by drip irrigation with (7.74 t/ha). The reduced yields in conventional irrigated pea over micro sprinkler or drip irrigated is due to the fact that the reduced oxygen concentrations in soil due to wet conditions leading to stomatal closure of plants, thus reducing the transpiration rate and subsequently the crop yield. Many studies proved that the transpiration and crop yield were strongly and linearly correlated (Narayanamoorthy *et al*, 2003). The percentage of increase in yield over conventional irrigation is highest under micro sprinkler irrigation (67.1).

Table 1: Water requirement of pea

	Initial stage	Developmentalstage	Middle stage	Maturity stage
No. of days	20	25	40	20
Crop coefficient	0.5	0.8	1.15	1.1

Source: Allen *et.al.*, 1998.

Table 2: Irrigation and fertigation schedule for pea

Treatments	Method of irrigation	Irrigation schedule	Fertigation schedule
T1-Conventional irrigation	Flood irrigation	Weekly	50% N:P:K as basal dose
T2- Drip irrigation	2 lph in line drip lateral with dripper spread at 20 cm distance	Every third day	50% N:P:K fortnightly in equal
T3- Micro sprinkler irrigation	40 lph discharge with 2.5m radiation	Every third day	Split doses during the crop period

Table 3: Water requirement at different important crop growth stages

Crop growth stages	No. of days	Irrigation water applied as per theoretical estimates and actual water applied at root zone, l/m^2					
		Flood Irrigation		Drip Irrigation		Micro Sprinkler	
		Theoretical estimation	Applied water	Theoretical estimation	Applied water	Theoretical estimation	Applied water
Initial	20	48.58	34.70	41.648	21.92	42.875	24.5
Development	25	83.26	59.47	71.364	37.56	73.465	41.98
Middle	40	235.09	167.92	201.495	106.05	207.4275	118.53
Maturity	20	175.52	125.37	150.442	79.18	154.8575	88.49
l/m^2= mm		542.40	387.5	464.9	244.7	478.6	273.5

Table 4: Crop growth and yield parameters of pea under different irrigation systems

Treatments	Average plant height (cm)	Average no. of branches/plant	Average no of pods/plant	Average yield % (t /ha)	increase in yield over conventional irrigation
T1-Conventional irrigation	52.4	2.1	12.6	5.87	-
T2- Drip irrigation	55.8	2.8	14.8	7.74	31.8
T3-Micro sprinkler irrigation	59.7	3.4	18.7	9.81	67.1
CD (5%)	2.61	0.37	3.27	17.42	-

Table 5: Water productivity and economics (Three year pooled data)

Treatments	Quantity of water available to the plants, mm	% water saving over conventional irrigation	Water productivity (kg/m^3)
T1-Conventional irrigation	387.5	-	1.17
T2- Drip irrigation	244.7	37	2.49
T3-Micro sprinkler irrigation	273.5	29	2.65
CD			0.13

Water Productivity: The study results indicated that the drip and micro sprinkler irrigation systems saved 38 and 26 percent of water over conventional practice (Table 5). The water productivity is the ratio between the production per unit of water applied. Though, the percentage of water saving under micro sprinkler irrigation is less than the drip irrigation, the water productivity under micro sprinkler (2.65 kg/m^3) was higher than under the drip (2.49 kg/m^3) irrigation and significantly higher than under conventional irrigation system (11.17 kg/m^3), these results are in conformity with the findings of Badr, 1993, who reported that the sprinkler irrigation gives more concentrated wetted area around the vegetable plants than drip irrigation system and consequently higher the water use efficiency.

CONCLUSIONS

With the increase demand for scarce natural resource, the efficient on-farm water management practices are essential to produce more crop from the drop of water. In the present study three irrigation methods, one that is being conventionally followed by the farmers was compared with advanced irrigation systems of drip and micro sprinkler irrigation. The study concludes that the performance of pea crop was found to be better under micro sprinkler irrigation, considering the crop growth parameters, crop yield and water productivity in comparison with drip and conventional irrigated pea.

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