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Influence of drip lateral placement depth and fertigation level on germination, yield and water-use efficiency of cucumber (*Cucumis sativus*)

SANTOSH S MALI[1], RANVIR SINGH[2], A K SINGH[3] and MUKESH MEENA[4]

ICAR-Research Complex for Eastern Region, Research Centre, Ranchi, Jharkhand 834 010

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ABSTRACT

A field experiment was conducted from February to June for three years (2009-2011) to evaluate the response of cucumber (*Cucumis sativus* L.) under 0 (surface) (D00), 5(D05), 10 (D10) and 15 (D15) cm depth of lateral placement and four levels of fertilizer application with NPK in the ratio of 50:30:30, 100:60:60, 120:90:90 and 150:120:120 kg/ha (F1, F2, F3 and F4). Uniformity of water application through subsurface drip irrigation (SDI) system was assessed every year. Soil moisture content in root zone, germination percentage, vine length and yield per plot were recorded and irrigation water use efficiency (IWUE) was estimated.It was observed that soil moisture content was higher and moisture profile was more uniform under SDI. Shallower depths of lateral, D00 and D05, resulted in higher seed germination percentage (92.8 and 90.2 %). Increased moisture and nutrient availability under D10 and D15 resulted in higher vine length (2.49 and 2.36m). During 2011, treatments D10 and D15 recorded highest mean yields of 31.7 and 32.9 t/ha, respectively. Fertigation level F3 recorded consistently higher mean yields for three consecutive cropping seasons yielding higher mean IWUE under D10 (0.49 to 0.81 t/ha/cm) and D15 (0.50 to 0.85 t/ha/cm).The results showed that SDI maintained uniform moisture in soil profile, minimized the evaporative loss and consequently increased IWUE. The SDI system with lateral placement depth of10 cm and fertigation level F3 is recommended as an optimum practice for better yields and increased IWUE of cucumber cultivation.

Key words: Cucumber, Fertigation, Lateral depth, Subsurface drip

The main design parameter in SDI system is depth of installation of drip line. Decision on depth of lateral placement is based on size and shape of wetting zone attained in soil, which is essentially a function of soil structure, texture, dripper discharge and spacing, and crop's rooting characteristics. Site-wise and crop-wise variations of these parameters preclude the possibility of framing general recommendations for depth of lateral placement under SDI system (Patel and Rajput 2007). The numerical modelling of soil water dynamics under DI and SDI showed that as the depth of placement increases, the deep percolation increases at a higher pace than evaporation decreases, resulting in low irrigation efficiency (Diamantopoulos and Elmaloglou 2012). SDI with 20 cm lateral depth reduced water consumption by 6.7 and 7.3% and increasedthe bell pepper yield over DI significantly by 4% and 13%, for the two years of experimentation respectively (Kong *et al.* 2012). Patel and Rajput (2009) reported maximum onion yield and IWUE of 0.55 tonnes/ha/cm under 10 cm lateral depth. SDI fertigation of tomato resulted in higher yield (50.5 tonnes/ha) when laterals were kept at 25 cm depth as compared to DI (Sharda *et al.* 2011).Several factors need to be considered in deciding the appropriate lateral depth. In order to achieve higher water and nutrient use efficiency, the crop and site-specific irrigation and fertigation management guidelines need to be formulated.

In India, cucumber (*Cucumis sativus* L) is an important summer vegetable crop of Cucurbitaceae family with a production of 607.16 thousand tt from 39.77 thousand ha area (NHB 2013). The average productivity of cucumber in India is 15.27 tonnes/ha (NHB 2013) which is much less than the world average of 35.25 tonnes/ha (FAO 2013). In order to increase the production and productivity of cucumber through efficient water and nutrient management under subsurface drip, it is imperative to study the interaction between different nutrient levels and depths of lateral placement and their effect on crop yields. The specific information on response of cucumber crop to different fertigation levels under SDI and depths of drip line placementis seriously lacking. The present study was planned to assess the performance of cucumber crop,in

[1]Scientist (SWCE) (e mail: santosh.icar@gmail.com); [2]Principal Scientist (Horticulture) (e mail: rnvr.sngh123@gmail.com), Horticulture Division, ICAR, New Delhi 110 012; [3]Principal Scientist (Plant Breeding) (e mail: headicarrcerranchi@gmail.com); [4]Scientist (Soil Science) (e mail: mukesh.icar@gmail.com), ICAR-Research Complex for Eastern Region, Patna 800 014

terms of germination percentage, vine length, yield and IWUE, under different depths of lateral placement and four fertigation levels.

MATERIALS AND METHODS

The present study wascarried out at the research farms of ICAR Research Complex for Eastern Region located at Ranchi Centre (23°16' N - 50° 85' E and 629 m amsl), Jharkhand, India, during February to June for three years (2009, 2010 and 2011). Climate of Ranchi is sub-tropical with hot and dry summers (T_{max}: 37°C and T_{min}: 20°C) and cool winters (T_{max}: 22°C and a T_{min}: 2°C)and has average annual rainfall of about 1350 mm and annual evaporation of about 1963 mm. The soil in experimental plot was deep, well drained, sandy loam comprising 70.8% sand, 16.4% silt and 12.8% clay. The soil had acidic reaction (p^H=5.46) and the bulk density was 1.59 g/cm^3.

A field plot of size 49 × 25 m was divided into four main plots of size 49 × 3 m leaving 1m isolation strip between each main plot as well as on both ends of the field. Each main plot was divided into sub plots of size 5 × 3 m leaving 1 m isolation strip between each sub plot and also at both ends of main plot. The 48 sub plots were grouped into 3 blocks. Four depths of drip lateral placement, 0 cm (D00), 5 cm (D05), 10 cm (D10) and 15 cm (D15) and four fertiliser application levels with N, P and K in the ratio of 50:30:30 (F1), 100:60:60 (F2), 120:90:90 (F3) and 150:120:120 (F4) kg/ha were considered in the study. The experiment was laid out in split plot arrangement with fertigation levels on main plots and treatments on depths of lateral placement in sub plots. Each treatment was replicated three times.

Water was applied using 12 mm diameter lateral with 2.4 l/h in-line drippers at a spacing of 40 cm between two consecutive emitters (Jain Irrigation Systems Ltd, J-Turbo Aqura®). In each subplot, two laterals were provided for two rows of cucumber spaced 1.5 m apart. Cucumber seeds (*cv*. Sheetal) were sown on 24 February during 2009 and on 19 February during 2010 and 2011 at a plant to plant and row to row spacing of 50 cm and 150 cm respectively. Two seeds per hill were sown at a depth of 3 to 4 cm below soil surface.

Uniformity of water application of the drip irrigation system, in terms of coefficient of variation (CV), emission uniformity (EU) and statistical uniformity (SU), was determined in the month of January every year. Discharge data was collected from 40 randomly selected drippers from head, middle and tail ends of the laterals located all over the experimental field.The performance parameters were estimated as follows (Ortega *et al*. 2002).

$$CV=s/q \quad (1)$$

$$EU=(q_{lq}/q)\times 100 \quad (2)$$

$$SU=(1-s/q)\times 100 \quad (3)$$

where, s = standard deviation of dripper discharge, q =mean dripper flow rate, l/h, qlq = mean of lowest one-fourth of emitter flow rates, l/h.

Reference crop evapotranspiration (ET_0) was estimated from pan evaporation (E_p) as $ET_0 = E_p \times K_p$ where K_p = pan coefficient. Pan evaporation data was collected from the field meteorological observatory located at about 150 m away from the experimental site. The actual crop evapotranspiration (ET_c) was estimated by multiplying reference crop evapotranspiration with crop coefficient (K_c), i.e. $ET_c = ET_0 \times K_c$ (Doorenbos and Pruitt 1992). In the present study, the K_p value of 0.75 was adopted as suggested in FAO-56 for high relative humidity (RH>70) and moderate wind speed (2-5 m/s) prevailing in the study area (Allen *et al.* 1998). The K_c values adopted were 0.6, 1.0 and 0.75 at initial, middle and maturity stages of crop respectively (Allen *et al.* 1998). Net irrigation water requirement was determined based on the difference between ET_c and effective rainfall. Irrigation efficiency of 90% was adopted in the present study. The effective rainfall was estimated using dependable rainfall method as suggested in FAO CROPWAT model. The net irrigation water requirement for the cropping seasons of 2009, 2010 and 2011 were about 459 mm, 540 mm and 351 mm respectively (Table 1). Irrigation was applied every alternate day throughout the growing season. The IWUE (t/ha/cm) was determined as $(Y/I_r)\times 100$ (Kanber *et al.* 1992), where, Y is cucumber yield (t/ha) and I_r is the total amount of irrigation water applied (cm). Fertigation was done using a 19 mm (3/4 inch) diameter ventury fertigation system having injection rate of 70.8 l/h at inlet and outlet pressures of 1 and 0.2 kg/cm^2, respectively. The combination of urea ($CO(NH_2)_2$) (46% N) and water soluble fertilizer (water soluble solid- *Samadhan*) having N:P:K ratio of 19:19:19 were used to get the desired fertilizer levels. Fertigation was done twice a week. No fertigation was done for last two weeks of the growing season.

The soil moisture content in the profile was estimated using gravimetric method. Soil samples were collected from directly below the lateral and midway between two emitters at the depths of 0-5, 10-20, 25-35 and 40-50 cm. The 192 soil samples were weighed and then oven dried at 105°C for 24 hr to determine soil water content in the root zone. The numbers of seed germinated were counted on 12th day after sowing every year and germination percentage was determined by dividing the seedling count by total number of seeds sown. Data on vine length was recorded at 30, 60 and 90 days after sowing (DAS) for two tagged healthy plants from each sub plot.

Table 1 Net irrigation water requirement at different growth stages and ET_c (mm)

Year	Growth stage				I_r† (mm)	ETc
	Initial (20 days)	Develop-mental (30 days)	Middle (45 days)	Maturity (15 days)		
2009	53.4	126.1	196.6	83.0	459.0	494.4
2010	30.5	108.4	225.1	176.0	539.9	559.5
2011	38.5	130.1	200.6	21.7	391.0	497.5

†Seasonal irrigation water requirement of cucumber crop

The mature cucumber fruits were manually picked 14, 18 and 15 times during the cropping seasons of 2009, 2010 and 2011 respectively and weight of fresh cucumber fruits was recorded under each sub plot. A two-way analysis of variance (ANOVA) was used to determine the significance of the main plot and sub plot treatments on germination percentage, vine length at 90 DAS and cucumber yield. Duncan's Multiple Range test at P <0.05 was used to compare the significance of difference between different treatment means. Statistical analysis was performed with SPSS statistical program (v. 17.0, SPSS Inc. 1996).

RESULTS AND DISCUSSION

System uniformity

The performance parameters of the installed drip irrigation system were determinedbefore every cropping season and are presented in Table 2. The coefficient of variation (CV) was in the range of 0.062 to 0.077 for three cropping seasons. As per the ASAE's qualitative classification of CV of dripper discharge, the value of CV<0.1 is considered as acceptable (Safi *et al.* 2007). The values of EU and SU were in the range of 91.36 to 90.11% and 93.76 to 92.35% respectively. According to Pitts (1997), for excellent functioning of the drip system the values of SU and DU should be greater than 90 and 87%, respectively. The higher values of EU and SU (>90%), for three successive growing seasons, indicated that the performance of the drip irrigation system was excellent.

Table 2 Performance coefficients of subsurface drip system

Year	CV†	Statistical uniformity coefficients (%)	
		EU*	SU§
2009	0.062	91.36	93.76
2010	0.071	90.73	92.87
2011	0.077	90.11	92.35

†Coefficient of variation, *emission uniformity, §statistical uniformity

Soil moisture distribution

The soil surface wetting after 24 hr of first irrigation event of 2 hr is presented in Fig 1.Width of the surface

Fig 1 Soil surface wetting after 24 h of first irrigation event of 2 h (a) 0 cm (surface), (b) 5 cm, (c) 10 cm and (d) 15 cm depths of lateral placement

wetting strip observed in case of surface drip (D00) was more as compared to D10 and D15 treatments, which shows that surface drip system is prone to higher evaporation loss from soil surface. Throughout the cropping seasons the soil surface under D10 and D15 appeared moist but did not get saturated at any point of time.

Soil moisture distribution pattern in the root zone varied as per the depth of lateral placement. Distribution of water content in the soil profile under surface drip showed higher (25.1 to 26.5%) in top 5 cm of soil and it decreased with depth (Fig 2). The soil surface remained relatively dry (17.3 to 19.3% moisture content) under D10 and D15 treatments. Deeper placement of laterals resulted in higher soil moisture content at 45 cm soil depth. SDI with 10 cm depth of lateral placement maintained highest average water content (24.2%) in soil profile (0-50 cm) as compared to D00 (22.6%), D05 (23.3%) and D15 (24.0%). At shallow depths of lateral placement (D00 and D05) the soil surface remained wetter due to the prominent capillary rise of water from dripper to soil surface. Increased evaporation loss under D00 and D05 resulted in low soil moisture in the root zone and crop was under stress. Under water stress, plants may modify their water extraction pattern from the soil, minimize water loss by closing their stomata, reduce leaf area expansion and, in extreme cases, lose leaf area through abscission and/or senescence. Such modifications have implications on the overall productivity of a crop (Gaveh *et al.* 2011). The SDI with D10 and D15 maintained relatively drier soil surface which helped in reducing evaporation from soil surface and maintained higher soil moisture content in the crop root zone which was favourable for better cucumber growth.

Germination percentage

Germination percentage was found to be significantly (P<0.05) affected by depth of lateral placement. It decreased with increase in depth of lateral placement, and this trend was observed for all three cropping seasons. The highest germination percentage (94.17%, 89.79% and 94.70%) was observed under surface drip (D00)for the growing seasons of 2009, 2010 and 2011 respectively (Table 3). Difference in mean germination percentage under D00 and D05 was not statistically significant (P<0.05) for all cropping seasons. Placement of lateral at 10 cm and 15 cm also did not show significant difference in mean germination percentage, except for the year 2009. The treatment D15 resulted in poor crop establishment with germination percentage values in the range of 65.62% to 75.21% for the three years of experimentation. The level of fertigation did not show any significant effect on cucumber germination. The interaction effect of fertigation level and depth of lateral placement was also insignificant during all the cropping seasons. The upward capillary movement of water under D10 and D15 was not sufficient to maintain optimum moisture content required for germination of cucumber seed. Schwankl *et al.* (1991) recommended continued initial irrigation until the soil surface above the lateral is visibly wetted and this practice improved germination of tomato seeds to acceptable level. This strategy of over wetting of soil during emergence period can be a better option as compared to installation of alternate irrigation method for germination. In present study, the non-germinated seeds were replaced with nursery grown cucumber seedlings so that the plant population in all treatments (all sub plots) remains same and results can be compared. The date of sowing of cucumber seeds in nursery was kept same as that of field experiments.

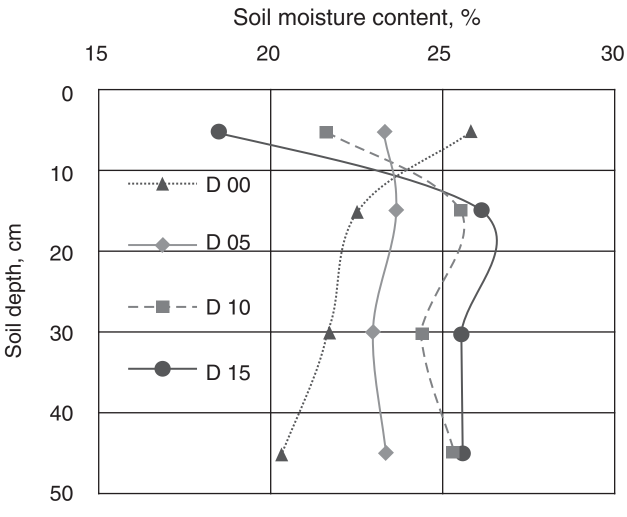

Fig 2 Distribution of soil moisture in the soil profile under different depths of lateral placement

Table 3 Germination percentage of cucumber as enfluenced by fertigation levels and depth of lateral placement

Factor and levels	Growing season			
	2009	2010	2011	Mean
Fertigation level[1]				
F1	88.25	77.71	85.00	83.65
F2	87.97	84.58	84.79	85.78
F3	87.29	78.96	83.45	83.23
F4	86.67	78.75	85.00	83.47
Depth of lateral[2]				
D00	94.17[a†]	89.79[a]	94.70[a]	92.88
D05	95.63[a]	90.21[a]	90.83[a]	92.22
D10	85.13[b]	74.37[b]	82.92[b]	80.81
D15	75.21[c]	65.62[b]	69.79[b]	70.21
	F value (Sig)			
Fertigation level(F)	0.074 (0.974)[NS]	0.580 (0.633)[NS]	0.024 (0.90)[NS]	
Depth of lateral(D)	13.443 (<0.001)*	8.790 (<0.001)*	5.331 (0.004)*	
F × D	1.526 (0.181)[NS]	0.778 (0.638)[NS]	0.921 (0.519)[NS]	

†Mean values within columns followed by the same superscript are not significantly different (P<0.05) according to Duncan's multiple range test within same season. The absence of letters indicates no significant difference between treatments. F-fertigation level, D-depth of lateral, * statistically significant, NS-not significant

Cucumber vine length

During early stages of the plant growth (30 DAS and 60 DAS) the difference in vine length was not significant. The fertigation level and depth of lateral placement had significant effect on cucumber vine length at 90 DAS. The vine lengths under fertigation dose F1 were significantly lower than that under F3 and F4 for all the cropping seasons (Table 4). The maximum (2.525 m) and minimum (1.875 m) vine lengths were recorded in F4 and F1 respectively. During the cropping seasons of 2009 and 2010 there was no significant difference in vine lengths recorded under the treatments F3 and F4.

Changes in growth of the cucumber plant were significant under different fertigation levels as well as depth of lateral placement. Crop performance was enhanced with subsurface placement of laterals. Subsurface placement of lateral at 10 cm (D10) and 15 cm (D15) significantly increased the vine length as compared to surface drip. In two cropping seasons, the maximum cucumber vine length was recorded under D15. Difference in mean vine length under D00 and D05 was statistically insignificant. The interaction effect between fertigation level and lateral depth were also insignificant during all the growing seasons. Singh and Rajput (2007) also reported significant changes in okra plant height under subsurface drip system and suggested that 10 cm lateral depth is optimum for better growth of okra. Better growth of cucumber plants can be obtained by placing the lateral between 10 to 15 cm below the soil surface and with F4 fertigation level.

Table 4 Mean cucumber vine length (m) at 90 DAS as enfluenced by fertigation levels and depth of lateral

Factor and levels	Growing season		
	2009	2010	2011
Fertigation level[1]			
F1	1.875[a]	2.108[a]	1.892[a]
F2	2.083[ab]	2.292[ab]	2.192[b]
F3	2.392[c]	2.475[b]	2.183[b]
F4	2.250[bc]	2.517[b]	2.525[c]
Depth of lateral[2]			
D00	1.950[a]	2.142[a]	1.925[a]
D05	2.058[a]	2.317[ab]	2.192[ab]
D10	2.283[b]	2.492[b]	2.308[b]
D15	2.308[b]	2.442[b]	2.367[b]
		F value (Sig)	
Fertigation level (F)	8.691 (<0.001)*	5.473 (0.004)*	7.394 (0.001)*
Depth of lateral (D)	5.341 (0.004)*	3.797 (0.020)*	4.237 (0.012)*
F × D	0.580 (0.803)[NS]	0.292 (0.972)[NS]	0.220 (0.980)[NS]

[1]Average of four lateral depths, [2]average of four fertigation levels, [†]values within columns followed by the same superscript are not significantly different (P<0.05) according to Duncan's multiple range test, F-fertigation level, D-depth of lateral, *statistically significant, NS-not significant

Cucumber yield

Cucumber yield was significantly affected by the fertigation levels (F) and depths of lateral placement (D). However, the interaction effect (F × D) was not significant during any of the cropping seasons. Fertigation level F3 resulted in higher meancucumber yields (23.6, 28.5 and 35.1 t/ha during 2009, 2010 and 2011 respectively) as compared to other fertigation levels (Table 5). The cucumber fruit yields obtained under higher fertilizer dose (F4) were lower than that under F3; however, the difference was not statistically significant. There was significant polynomial correlation between yield and level of fertilizer application (Fig 3a). The cucumber yields increased with increasing fertigation level, reaching a maximum value at F3 fertigation level. Thereafter, cucumber yield decreased with increase in fertigation amount.

Placement of lateral on surface resulted in lower yields compared to all SDI treatments. Treatment D15 recorded highest yields (22 tonnes/ha and 32.5 tonnes/ha) during 2009 and 2011 while during 2010 the highest yield (26.6 tonnes/ha) was obtained under D10 (Table 5). Compared to surface drip irrigation (D00), the cucumber fruit yields under D05, D10 and D15 increased by 9.1%, 19.5% and 20.3% respectively. This shows that altering the nutrient and moisture regimes in the soil through subsurface placement of laterals significantly affects the crop

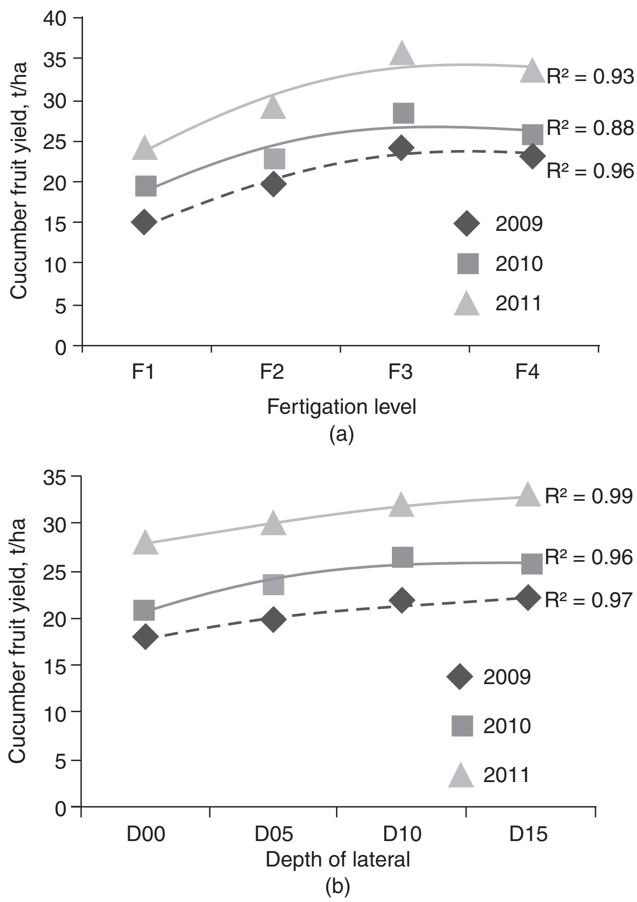

Fig 3 Relationship between (a) yield and fertigation level and (b) yield and depth of lateral

Table 5 Effect of fertigation level and depth of lateral on cucumber yield (tonnes/ha)

Year	Lateral depth (D)	Fertigation level (L) F1	F2	F3	F4	Mean[1]	ANOVA Factor (df)[2]	P > F
2009	D00	13.6	17.3	21.2	20.2	18.1[a]	F (3)	<0.001*
	D05	13.8	18.5	23.2	22.7	19.6[a]	D (3)	0.002*
	D10	15.5	23.5	25.0	23.0	21.8[b]	F x D (9)	0.894[NS]
	D15	15.9	21.8	25.3[†]	25.0	22.0[b]		
	Mean[1]	14.7[e]	20.3[f]	23.6[g]	22.7[g]			
2010	D00	16.9	19.9	24.8	22.7	21.0[a]	F (3)	0.001*
	D05	18.1	21.8	30.3[†]	23.8	23.5[ab]	D (3)	0.010*
	D10	21.1	26.5	30.1	27.4	26.3[b]	F x D (9)	0.889[NS]
	D15	22.3	23.4	28.1	28.8	25.6[b]		
	Mean[1]	19.6[e]	22.9[f]	28.3[g]	25.7[fg]			
2011	D00	21.5	28.6	31.7	30.0	27.9[a]	F (3)	< 0.001*
	D05	26.0	29.6	33.7	30.8	30.0[ab]	D (3)	0.029*
	D10	25.8	28.2	37.9	35.0	31.7[b]	F x D (9)	0.523[NS]
	D15	23.0	33.2	36.9	38.3[†]	32.9[b]		
	Mean[1]	24.1[e]	29.9[f]	35.1[g]	33.5[g]			

[1]Mean values in a column or row with same superscript are not significantly different using Duncan's multiple range test (P<0.05), [2]degrees of freedom, F: fertigation level, D: depth of lateral, * statistically significant, NS-not significant, [†]highest yield

productivity. Zotarelli *et al.* (2009) reported that SDI with lateral placed at 15 cm below soil surface consistently increased tomato yields and improved IWUE. The higher yields under SDI can be attributed to uniform and comparatively higher soil moisture content and availability of fertilizer directly in the active crop root zone. At all fertigation levels, cucumber yield showed significant polynomial correlation with depth of lateral placement (Fig 3b). The coefficient of determination (R^2) was in the range of 0.96 to 0.99 among different fertigation treatments for three growing seasons. The trend line showed increase in yield with increase in the depth of lateral. However, one cannot presume that increasing lateral depth beyond 15 cm will further enhance the yield. This needs experimental confirmation.

The variance analysis carried out for pooled data of three years, including year as one of the variable, showed that experimental year (Y), fertigation level (F) and depth of lateral placement (D) significantly influenced the cucumber yield (Table 6). There was no significant interaction effect between Y, F and D except between Y × F. Difference in mean cucumber yield obtained under D10 and D15 was not significant. As discussed in previous section, placement of laterals at 15 cm depth showed lower germination percentage than D10. Also it is obvious that the cost of placement of lateral at deeper depth (15 cm) will be higher than that at 10 cm below soil surface. Considering these facts, the lateral depth of 10 cm below the soil surface can be a better option from economic as well as management point of view.

Table 6 Variance analysis for pooled cucumber yield data of three year (Tests of Between-Subjects Effects)

Source	Type III sum of squares	df[1]	Mean square	F	Sig.
Year (Y)	2382.66	2	1191.33	94.432*	0.000
Fertilizer level (F)	1551.40	3	517.13	40.991*	0.000
Lateral depth (D)	477.84	3	159.28	12.626*	0.000
Y × F	176.63	6	29.44	2.333*	0.038
Y × D	14.40	6	2.40	0.190	0.979
F × D	58.45	9	6.49	0.515	0.861
Y × F × D	164.80	18	9.16	0.726	0.777
Error	1211.11	96	12.62		
Total	96297.52	144			
Corrected total	6037.33	143			

R squared =0 .799 (adjusted R squared =0 .701), [1]degrees of freedom, Y: Year, F: Fertigation level, D: lateral depth, * significant at P<0.05

Irrigation water use efficiency

IWUE was calculated to determine the efficiency with which the crops translated the water supplied into production of marketable and edible yields. Fertigation level F3 showed highest mean IWUE (0.46 to 0.81 tonne/ha/cm) during all the experimental years (Table 7). Subsurface placement of laterals showed higher IWUE. Lateral placement at 15 cm recorded highest mean IWUE during 2009 (0.43 t/ha/cm) and 2011 (0.75 t/ha/cm) under fertigation level F3. Occurrence of rainfall events during the late stage reduced the quantity of irrigation water applied which resulted in increased IWUE for the cropping season of 2011. Significant polynomial relationship was observed between depth of lateral and IWUE (Fig 4). The R^2 varied from 0.75 under F4 to 0.99 in case of F3. Patel and Rajput (2007) observed the similar polynomial relationship between IWUE and depth of lateral in case of potato crop.

Fertigation level as well as depth of lateral placement

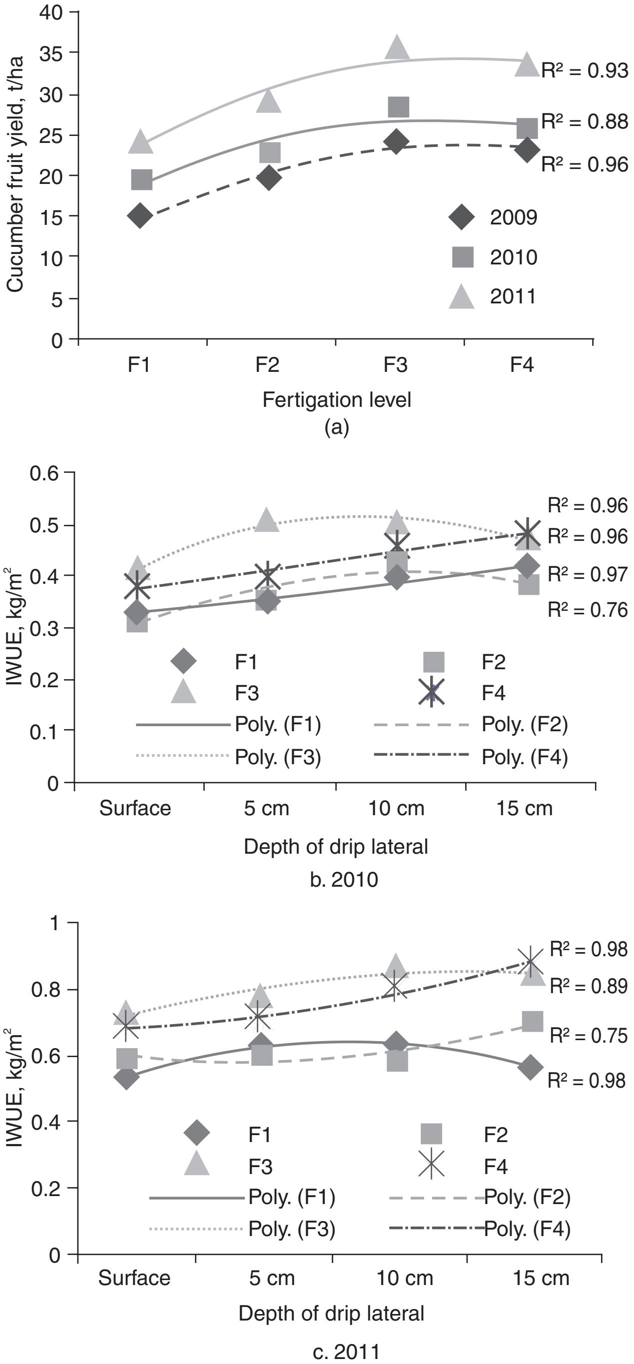

Fig 4 IWUE at different depths of lateral placement during cropping seasons of (a) 2009, (b) 2010 and (c) 2011

significantly affected cucumber yield and IWUE, however, the interaction effect was not significant (P<0.05). Low moisture availability in top 5 cm of soil profile due to limited upward capillary movement of water under deeper lateral depths (10 and 15 cm) resulted in reduced germination of cucumber seeds. With increasing depth of lateral the cucumber yields increased, reaching maximum value at 15 cm lateral depth. Mean cucumber yields and IWUE for two cropping seasons were significantly higher under F3 level of fertigation and drip lateral placed at 10 cm below soil surface. Cucumber plant was found to be sensitive to

Table 7 IWUE (t/ha/cm) under different depths of lateral placement and fertigation levels

Depth of lateral	Year and fertigation Levels F1	F2	F3	F4	Mean
			2009		
D00	0.27	0.34	0.41	0.40	0.35
D05	0.27	0.36	0.45	0.45	0.38
D10	0.30	0.46	0.49	0.45	0.43
D15	0.31	0.43	0.50*	0.49	0.43†
Mean	0.29	0.40	0.46†	0.45	
			2010		
D00	0.32	0.32	0.41	0.38	0.36
D05	0.34	0.35	0.51*	0.40	0.40
D10	0.39	0.42	0.50	0.46	0.44†
D15	0.41	0.37	0.47	0.48	0.43
Mean	0.37	0.37	0.47†	0.43	
			2011		
D00	0.53	0.59	0.73	0.69	0.63
D05	0.63	0.61	0.78	0.71	0.68
D10	0.63	0.58	0.87	0.81	0.72
D15	0.56	0.70	0.85	0.88*	0.75†
Mean	0.59	0.62	0.81†	0.77	

†highest mean IWUE, *highest individual treatment IWUE value

fertigation level and lateral depth. Therefore, placing the drip lateral at 15 cm below the soil surface and fertigation level F3 is recommended as optimum practice for cucumber cultivation under SDI system in eastern plateau region of India.

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