Int.J.Curr.Microbiol.App.Sci (2019) *8*(10): 1003-1011

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 10 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.810.117

Performance Evaluation of Subsurface Drainage System in Mallapur Village of TBP Command Area

Shrikantagouda[1*], B.S. Polisgowdar[1], M.S. Ayyangowdar[1], M. Nemichandrappa[1], J. Vishwanath[2] and A.V. Karegoudar[2]

[1]*Department of Soil and Water Engineering, College of Agricultural Engineering, UAS, Raichur, India*
[2]*AICRP on Management of Salt Affected Soils and Use of Saline Water, ARS Gangavathi, India*

**Corresponding author*

Keywords

Subsurface drainage, Hydraulic conductivity, Crop yield, Crop intensity

Article Info

Accepted:
10 September 2019
Available Online:
10 October 2019

A B S T R A C T

The introduction of irrigated agriculture in the arid and semi-arid regions of India has resulted in the development of twin problems of waterlogging and salinity. The problems also occurred in the valley bottoms of the Tungabhadra Irrigation Project (TBP). The subsurface drainage system was installed at 40, 50 and 60 m drain spacing to reclaim the salt affected soils in an area of 50 ha in the farmers' fields at Mallapur village, Sidhanur taluk, Karnataka. The monitoring and evaluation of subsurface drainage system revealed that, soil reactions (pH), soil salinity (EC_e) of the soil were decreased and it has been observed that 40 m drain spacing found better in improving the soil properties and then followed by 50 and 60 m drain spacing. The monthly average drain discharge was found to be maximum in 40 m spacing followed by 50 and 60 m drain spacing during *kharif* 2014 and *rabi* 2014-15 seasons, thus drain discharge was inversely proportional to the spacing. The total quantum of salt disposed along the drain discharge during *kharif* 2014 and *rabi*-2014-15 was maximum in 40 m spacing (35.92 t ha^{-1}), followed by 50 m (23.53 t ha^{-1}) and 60 m (17.23 t ha^{-1}) drain spacing respectively. The total quantity of nitrogen loss (NO_3-N) during *kharif* 2014 and *rabi* 2014-15 was maximum in 40 m spacing (43.09 kg ha^{-1}), followed by 50 m (32.88 kg ha^{-1}) and 60 m (26 kg ha^{-1}) drain spacing respectively. Crop yield was increased to the extent of 60.2, 50.4 and 40.8 per cent in 40, 50 and 60 m drain spacing respectively and cropping intensity was increased from 147 to 171 per cent after the installation of drainage system.

Introduction

Food, fiber and fodder are the three most important agricultural products necessary for sustenance, the two important product basis, land and water are however, limited and degradable over year of continuous irrigation to grow the crops without natural drainage will lead to problem of waterlogging and salinity in irrigated and unirrigated agricultural lands. According to the Food and Agricultural Organization much of the worlds land is not cultivated, but a significant proportion of cultivated land is salt-affected. Out of the current 230 M ha of worlds irrigated land, 45 M ha are waterlogged and salt-affected (19.5 per cent) and of the 1500 M ha under dry land agriculture, 32 M ha are salt-affected. These problems result in a monetary loss of about Rs. 1766.6 billion per annum and also about 1.85 M ha is being threatened by these problems every year. It is estimated that up to 20 per cent of irrigated land in the world is affected by different levels of salinity and sodium content (Fard *et al.*, 2007). In India as a result of introduction of irrigation in agriculture has resulted in the development of the twin problem of waterlogging and soil salinization. Considerable areas have already gone out of production or are being experiencing reduced yields. The state of Karnataka in India is no exception to these phenomena as the command areas of its many irrigation projects are suffering from water logging and salinity problems. Tungabhadra Irrigation Project (TBP) command is one such area afflicted by these problems. Approximately, 3.5 lakh ha area has been affected by waterlogging and salinity problems in the state, of which about 80,000 ha is in the Tungabhadra Project accounting nearly 25 per cent of the command area of 3.63 lakh ha (Manjunatha *et al.*, 2004).

The Rashtriya Krishi Vikas Yojana (RKVY) project was taken up with the main objective of increasing agricultural production and for sustainable irrigated agriculture in the command area and to demonstrate the drainage and water management technology towards tackling the twin problems of waterlogging and soil salinity. Under the above project, about 50 ha area was selected in the Mallapur area of Sindhanur taluk, Raichur district for project activities. Based on detailed pre-drainage investigations, the appropriate subsurface drainage system were designed and executed during 2012-13 and was monitored for two seasons *viz*., *kharif* 2014 and *rabi* 2014-15.

Materials and Methods

Study site

An area of 50 ha was selected at Mallapur village, Sindhanur taluk, Raichur district at which the subsurface drainage system was installed for the reclamation of waterlogged and salt affected areas in the farmers field. The study area lies under 15º 46 ' N latitude and 76º 46 ' E longitude at an elevation of 377 m from mean sea level. The area is a part of semi-arid region characterized by mild winter short monsoon and hot summer. The mean annual temperature is above 22º C. Summer season is very hot with a temperature of 43º C, whereas winter season (November to February) is relatively cool and dry. The hottest months are April and May, and December is the coldest month. The annual average rainfall nearest rain gauge station at Sindhanur is 582 mm of which 448.14 mm occurs during south-west monsoon (June-September) which is about 77 per cent of the average annual rainfall. Paddy is the main crop in the study area and is being taken two crops annually.

A field experiment was carried out at farmers field in Mallapur village (Sindhanur Taluk) in an area of 50 ha by considering three SSD spacing *i.e.*, 40, 50 and 60 m each with a lateral depth of 1.0 m. The study was carried out during *kharif* 2014 (*i.e.* from September to December) and continued up to *rabi* 2014-15 (*i.e.* from January to May).

Observations recorded

The soil samples were collected before transplanting of *kharif* 2014 crop and after harvesting of *kharif* 2014 and *rabi* 2014-15 crop at different depth (0-15, 15-30, and 30-60 cm). The pH was determined by digital pH meter, the EC of soil samples were determined by digital EC meter (Jackson, 1973). The drain discharges were monitored weekly during *kharif* 2014 (August 2014 to December) 2014 and in summer (January to April) season of 2015. The leachate water samples were collected on weekly interval during the study period from the outlets of 40, 50 and 60 m drain spacing respectively and analyzed for water quality parameters like EC, salt disposed and nitrogen loss (Mejia and Madramootoo, 1998).The monthly average data of drain discharge, leachate water salinity, quantum of salt removed, quantity of nitrogen loss were calculated by using weekly data of respective parameters.

Cropping intensity was calculated by considering the cultivated area and total area (50 ha). The crop cutting was carried out in an area of 2 x 2 m^2 at selected locations distributed among all the drain spacing throughout the study area. The yield of crop was later converted to quintals per hectare.

Results and Discussion

Drain discharge

The monthly average drain discharge of *kharif* 2014 was presented in Table 1. From the results it observed that the maximum flow rate was noticed during October (2.67 mm d^{-1}) in all the spacing because of occurrence of heavy rainfall. The minimum flow rate was observed during December-2014 (1.36 mm d^{-1}) in all spacing. This was due to the fact that crop was matured and ready to harvest hence no irrigation was given.

The monthly average drain discharge of *rabi* 2014-15 was presented in Table 2. From the results it was observed that the maximum flow rate was noticed during March-2015 (2.22 mm d^{-1}) in all spacing because of occurrence of heavy rainfall along with the irrigation given to the field, while the minimum flow rate was observed during April-2015 (0.97 mm d^{-1}) in all spacing which was mainly due to crop was matured and ready to harvest hence no irrigation was given.

Salinity of leachate water

It was observed that during *kharif* 2014 (Table 3) the monthly average leachate salinity was found to be 9.97, 8.60 and 7.22 dS m^{-1} in 40, 50 and 60 m drain spacing respectively. The maximum leachate salinity was observed in the month of September and lowest observed was in the month of December in all spacing.

Similarly, during *rabi* 2014-15 (Table 4) the monthly average leachate salinity was 9.93, 8.33 and 7.21 dS m^{-1} in 40, 50 and 60 m drain spacing respectively. The maximum leachate salinity was observed in the month of January and lowest observed was in the month of April in all spacing.

A portion of the salts accumulated during summer (before *kharif* 2014) due to high evaporative demands and capillary action, were leached to lower layers and in turn to drain outlets during *kharif* 2014 and further during *rabi* 2014-15. This is mainly because of leachate water salinity decreased with time as a consequence of leaching that resulted in lower salinity

Soil salinity

From the results it is observed that the maximum decrease in EC_e from pre-drainage to post drainage was found in 40 m spacing *i.e.* 34.9 to 17.8 dS m^{-1}, 26.8 to 19.4 dS m^{-1} and 24.6 to 21.1 dS m^{-1} at 0-15, 15-30 and 30-60 cm depths respectively, followed by 50 m *viz.*,10.5 to 6.2 dS m^{-1}, 9.8 to 7.4 dS m^{-1} and 9.2 to 8.1 dS m^{-1} and 9.0 to 5.4, 8.4 to 6.3 and 7.3 to 6.7 dS m^{-1} for 60 m drain spacing for respective depths 0-15, 15-30 and 30-60 cm. It was observed that total percentage reduction in soil salinity as compared to the pre-drainage condition was maximum in 40 m followed by 50 and 60 m drain spacing. The EC_e values were found to be directly proportional to the drain spacing as the leaching is inversely proportional to the spacing. Similar results are reported by Srikanth (2001) and Singh *et al.*, (2002)

Impact of SSD on salt disposed

During the period of *kharif* 2014 (Fig. 1), the total quantum of salt disposed was maximum in 40 m spacing (20.33 t ha^{-1}), followed by 50 m (13.42 t ha^{-1}) and 60 m (9.62 t ha^{-1}) drain spacing respectively. The maximum salt disposed was noticed during October-2014 in all spacing, while the minimum salt disposed was observed during December-2014 in all spacing. Similarly, During *rabi* 2014-15 (Fig. 2), the total quantum of salt disposed was maximum in 40 m spacing (15.59 t ha^{-1}), followed by 50 m (11.11 t ha^{-1}) and minimum (7.61 t ha^{-1}) was observed in 60 m drain spacing respectively.

The maximum quantity of salt disposed was noticed during March-2014 in all spacing, while the minimum quantity of salt disposed was observed in the month of April-2014 in all spacing.

It is observed that in the month of October in *kharif* 2014 and March-2014-15 in *rabi* 2014-15 season irrigation along with rainfall leads to maximum flow rate of drain discharge and in turn drain discharge will carry more amounts of salts along with it. In the month of December during *kharif* 2014 and April in *rabi* 2014-15 seasons field was left for drying, to carry out the easy harvesting operation hence drain discharge was very less resulted in to carry less amount of salts during these months.

Impact of SSD on nitrogen loss

The monthly nitrogen loss along with the drain discharge during *kharif* 2014 is presented in Figure 3. A higher nitrogen loss was observed during September month as the fertilizer (urea) applied during that was maximum in which 50 per cent of recommended dose of fertilizer was applied during first week and 25 per cent during last week of September of *kharif* 2014. During *rabi* 2014-15 (Fig. 4) 50 percent of nitrogen was applied during January month and another 50 percent applied during February month but nitrogen loss observed to be maximum during February month because of the fact that drain discharge was high in February month as compared to the January month. It is also observed that higher nitrogen loss was noticed in 40 m drain spacing followed by 50 and 60 m during all the months of both seasons. It is evident that closer drain spacing results into higher nutrient loss in the form of nitrate-nitrogen which adds up to the cost of cultivation. The wider drain spacing will help to conserve the applied fertilizer but may result in to ground water pollution.

Crop yield

Crop performance under subsurface drainage system was studied by crop cutting at 18 observation points distributed among the all spacing. During pre-drainage paddy yield was ranged from 22-27 q ha^{-1}. After installation of subsurface drainage, paddy yield was increased substantially from 22-27 q ha^{-1} to 53.3, 48.8 and 44.5 q ha^{-1} in 40, 50 and 60 m drain spacing respectively during *kharif* 2014 and improved further to 57.5, 52.2 and 46.7 q ha^{-1} during *rabi* 2014-15 for the respective drain spacing. The per cent increase in paddy yield after harvest of *kharif* 2014 crop during 2014 and *rabi* during 2014-15 was calculated by taking the pre-drainage yield as reference and are presented in Table 3. After the harvest of *kharif* 2014 crop, percentage increases in the yield were found to be 58.7, 48.8 and 39.3 per cent in 40, 50 m and 60 m spacing respectively. Similarly after the harvest of *rabi* 2014-15 crop, futher per cent increases in yield were 61.7, 52.1 and 42.2 per cent respectively for the spacing of 40, 50 m and 60 m spacing.

Table.1 Monthly average drain discharge during *kharif* 2014

Spacing	Drain discharge, mm d^{-1}			
	Sep-2014	Oct-2014	Nov-2014	Dec-2014
40 m	2.23	3.40	2.82	1.73
50 m	1.78	2.49	2.31	1.35
60 m	1.58	2.14	2.00	1.02
Average	1.87	2.67	2.38	1.36

Table.2 Monthly average drain discharge during *rabi* 2014-15

Spacing	Drain discharge, mm d^{-1}			
	Jan-2015	Fab-2015	Mar-2015	Apr-2015
40 m	1.82	2.43	2.68	1.16
50 m	1.45	2.12	2.23	0.94
60 m	1.30	1.60	1.74	0.81
Average	1.52	2.05	2.22	0.97

Table.3 Monthly average leachate water salinity EC_{dw} during *kharif* 2014

Spacing	September	October	November	December	Average
40 m	11.43	10.53	9.82	8.10	9.97
50 m	10.28	8.82	8.24	7.06	8.60
60 m	8.15	7.54	7.41	5.79	7.22

Table.4 Monthly average leachate water salinity EC_{dw} during *rabi* 2014-15

Spacing	January	February	March	April	Average
40 m	11.09	10.85	9.89	7.89	9.93
50 m	9.51	9.22	8.35	6.23	8.33
60 m	8.25	8.02	7.09	5.5	7.21

Table.5 Crop yield under different drain spacing

Spacing (m)	Paddy yield			Pooled average	Percent increase in Crop yield (%) during post-drainage		
	Pre-drainage (q ha^{-1})	Post-drainage			*Kharif* 2014	*rabi* 2014-15	Pooled average
		kharif 2014 (q ha^{-1})	*rabi* 2014-15 (q ha^{-1})				
40 m	22	53.3	57.5	55.4	58.7	61.7	60.2
50 m	25	48.8	52.2	50.5	48.8	52.1	50.4
60 m	27	44.5	46.7	45.4	39.3	42.2	40.8

Table.6 Effect of SSD on cropping intensity

Particulars	Total area, ha	Cultivated area, ha		Annual Cropping intensity (%)
		Kharif	*Rabi*	
Pre-drainage 2012	50	39.5	34.4	147
Post-drainage 2015		44.5	41	171

Fig.1 Monthly amount of salt disposed during *kharif* 2014

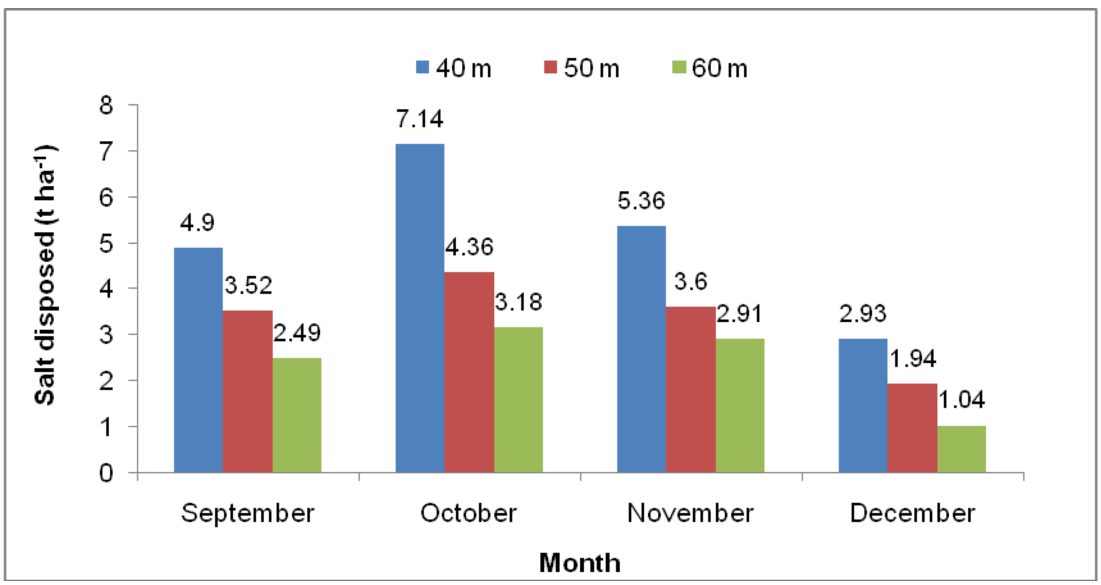


Fig.2 Monthly amount of salt disposed during *rabi* 2014-15

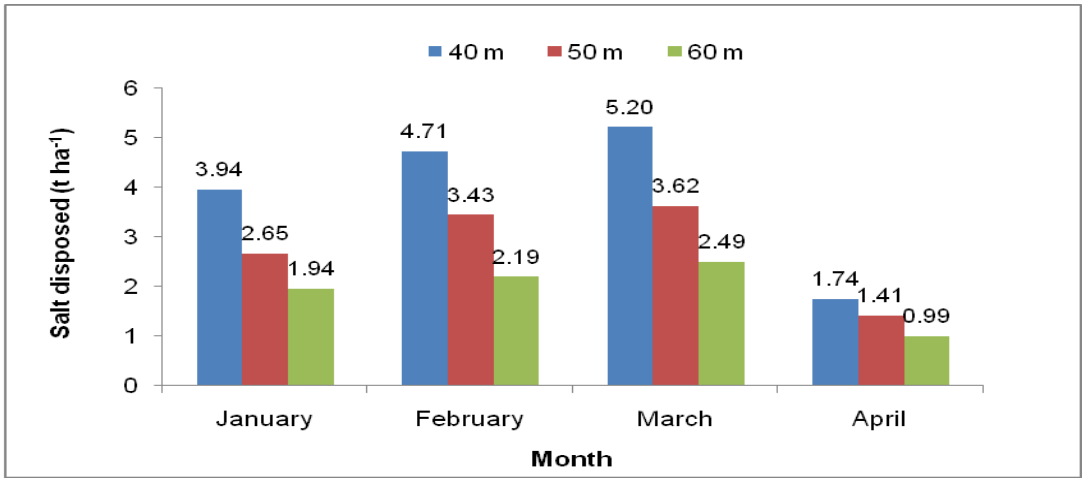


Fig.3 Monthly nitrogen loss through drain discharge during *kharif* 2014

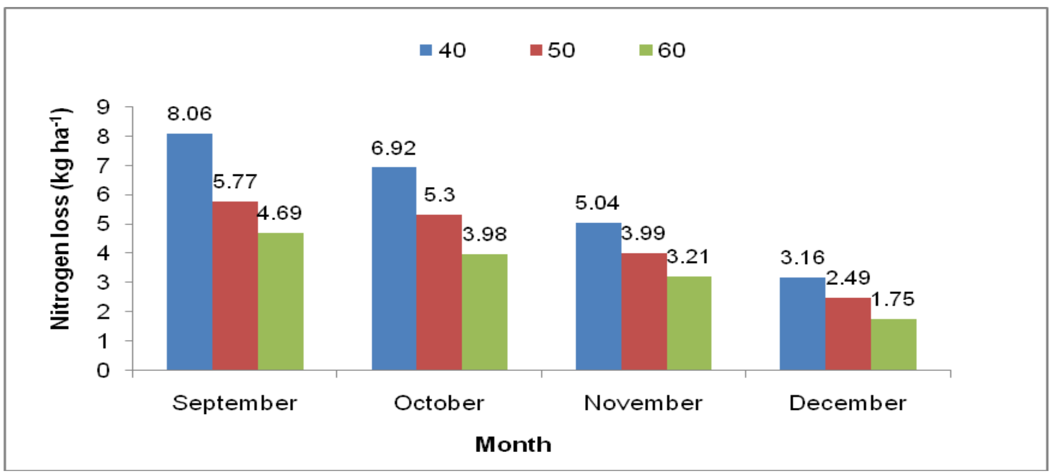
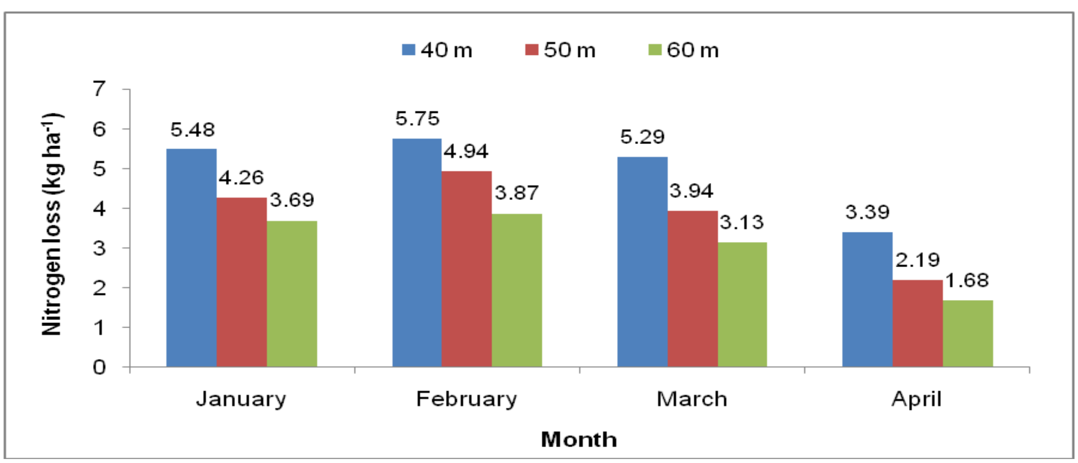


Fig.4 Monthly nitrogen loss through drain discharge during *rabi* 2014-15



The percentage increase in the pooled average of the two seasons (*kharif* 2014 and rabi 2014-15) also calculated (Table 5) and were found to be 60.2, 50.4 and 40.8 per cent respectively for 40, 50 and 60 m spacing as compared with the pre-drainage condition. The overall maximum increase in yield was found in 40 m spacing followed by 50 and 60 m drain spacing. The improvement in paddy yield can be attributed to decrease in soil salinity (Ritzema *et al.,* 2008) by subsurface drainage system Mathew *et al.,* (2001), Girish (2003), Satyanarayana and Boonstra (2007).

Cropping intensity

Besides the increase in crop yield, a significant increase in the annual cropping intensity of the study area was observed and presented in Table 6. From the results it is observed that annual cropping intensity before the installation of subsurface drainage was 147 per cent which were improved to 171 per cent after the installation of subsurface drainage system. This improvement in the cropping intensity was mainly due to reclamation of the salt-affected soils and more area was brought under cultivation (Manjunatha *et al.*, 2004).

In conclusions, the soil salinity of the study area was decreased from its initial values during post drainage conditions and maximum per cent of reduction in EC_e was found in 40 m spacing followed by 50 and 60 m drain spacing. The introduction of SSD in the study area was resulted in to increase in paddy yields to the extent of 60.2, 50.4 and 40.8 per cent in 40, 50 and 60 m respectively. Similarly, annual cropping intensity was increased from 147 to 171 percent after the installation of drainage system. Based on the comparison of the overall impact of various lateral drain spacing on reclamation, increase in crop yield and cropping intensity it can be suggest that a lateral spacing of 40 m, 50 m and 60 m can be adapted respectively depending upon the availability of funds.

References

Fard B M, Heidarpour M A, Abbas and Feizi M. 2007. Effects of irrigation wat salinity and leaching on soil chemical properties in an arid region, *Intl. J. Agric. Biol.*, 9(3): 74-78.

Girish, B. D., 2003, Studies on performance of subsurface drainage system of phase-I area under Indo-Dutch network project in Upper Krishna Project command. *M. Tech. Thesis* submitted to Uni. Agric. Sci., Dharwad.

Jackson M L. 1973. *Soil Chemical Analysis*, Prentice Hall of India, Pvt. Ltd., New Delhi, Pp. 498.

Jadhao S M, Konde N M, Patil A S and Nillam M K. 2009. Impact assessment of sub-surface drainage with saline-sodic swell shrink soils. *Indian J. Agric. Res.*, 43(2): 113-118.

Manjunatha M V, Oosterboan R J, Gupta S K, Rajkumar H and Jansen H. 2004. Performance of subsurface drains for reclaiming waterlogged saline lands under rolling topography in Tungabhadra irrigation project in India. *Agric. Water Manage.*, 69(1): 69-82.

Mathew, E. K., Panda, R. K. and Madhusuda, N., 2001, Influence of subsurface drainage on crop production and soil salinity in low laying acid sulphate soil. *Agric. Water Manage.*,

Mejia M and Madramootoo C. 1998. Improved water quality through water table management in eastern Canada, *J. Irri. Drain. Engg*., 124(2): 116-122.

Ritzema H P, Satyanarayana T V, Raman S and Boonastra J. 2008. Subsurface drainage to compact waterlogging and salinity in irrigated lands in India: Lessons learned in farmers fields. *Agric. Water Manage.*, 95(1): 179-189.

Satyanarayana, T. V. and Boonstra, J., 2007, Subsurface drainage pilot area experiences in three irrigated project commands of Andhra Pradesh. *Irrig. Drain.*, 56: 245-252

Singh, M., Bhattacharya, A. K., Nair, T.V.R and Singh, A.K., 2002, Nitrogen loss through subsurface drainage effluent in coastal rice field from India. *Agric. Water Manage.* 52: 249-260.

Srikanth, I., 2001, Studies on the performance of subsurface drainage system under phase-II of Indo-Dutch network in upper Krishna command area. *M. Tech. Thesis* submitted to Uni. Agric. Sci., Dharwad.

Srinivasulu A, Satyanarayana T V and Kumar H V. 2005 Subsurface drainage in a pilot area in Nagarjuna Sagar right canal command, India. *Irrig. Drain. System*, 19(1): 61-70.

How to cite this article:

Shrikantagouda, B.S. Polisgowdar, M.S. Ayyangowdar, M. Nemichandrappa, J. Vishwanath and Karegoudar, A.V. 2019. Performance Evaluation of Subsurface Drainage System in Mallapur Village of TBP Command Area. *Int.J.Curr.Microbiol.App.Sci.* 8(10): 1003-1011.
doi: https://doi.org/10.20546/ijcmas.2019.810.117