The Andhra Agric. J 63 (2): 408-414, 2016

Comparison of Sugarcane Yields under Various Drainage Systems at Kapileswarapuram, East Godavari District

M Karunya, H V Hema Kumar, M RaghuBabu, I BhaskaraRao and G Veera Prasad
College of Agricultural Engineering, Bapatla 522 101, Andhra Pradesh

ABSTRACT

Drainage system plays a vital role to combat waterlogging in agricultural lands. Conventional drainage measures require huge capital investment and require lot of integrity among farmers in terms of maintenance too, it is felt that the mole plough drainage technology could be popularized in the waterlogged sugarcane fields, could be easily adapted by the farmers without disturbing the natural recourses with proper ecological, economical disturbance. Further the mole plough could be easily fabricated by among village artisans. Major agricultural fields of some of the coastal districts namely Guntur, Prakasam, Krishna, East Godavari and West Godavari of Andhra Pradesh (A.P) suffer with waterlogging and salinity problems. Under the close supervision and guidance of the subject matter experts of Acharya N G Ranga Agricultural University, a network of drainage systems, namely open, mole and subsurface drainage systems were installed in farmers' fields of Kapileswarapuram, East Godavari with the support of M/s Sarvaraya sugars private Limited, Chelluru, East Godavari District to benefit the farming community in terms of recommending better drainage system and better crop variety in their waterlogged fields. Two varieties of sugarcane CO7805 and 2000V46 were planted in study area within these two verities 2000V46 variety gave high yield compare to other variety. Among all drainage systems mole drainage system gave high yield 63.23 t/ha followed by open drainage system. The yields under SSD were found not satisfactory because of less pumping hours by the field staff in accordance with the adjoin paddy growers.

Key words : Mole drainage, Subsurface drainage and Open drainage.

In Andhra Pradesh alone, the estimated area under waterlogging is 2.66 lakh hectares. The land subject to waterlogging results in reduction of agriculture production. Seepage from reservoirs, canals, distributaries, field channels and percolation losses from irrigation water results rise in ground water table over a period of time and in some instances, tend to come near the land surface. This ultimately results waterlogging and affect crop production considerably.

The main causes of waterlogging are grouped into natural and artificial. The natural causes are rainfall and geological features. Rising water tables may also bring up harmful salts to the land surface leading to salinization and alkalinization and consequent fall in agriculture production.

Mole drains are unlined conduits of circular cross section drawn at a depth below the soil surface using an implement called a mole plough. The mole plough consists of a cylindrical foot attached to a narrow leg. Connected to the back of the foot is a slightly larger diameter than that of cylindrical expander. The foot and expander form the drainage channel as the implement is drawn through the soil and the leg leaves a slot and associated fissures. The fissures extend from the surface and laterally out into the soil. Any surplus water above moling depth can, therefore, move rapidly through these fissures into the mole channel. The success of a mole drainage system depends on correct soil type, soil physical parameters, drain depth and quality of making the mole drains. Norum *et.al.,* (1970) investigated to determine the feasibility of using unlined mole lines for irrigation under conditions where a water table did not fall within the root zone of a crop. They concluded that this technique of applying water might offer potential as an irrigation method since capital investment and labour costs are relatively low. Spoor *et.al.,*(1982) conducted a study on mechanism by which water flows to mole drain. RamanaRao *et.al.,* (2009) conducted experiments on the feasibility of mole drainage for draining excess rain water in Vertisols. A 56 PS wheeled tractor was used in drawing mole drains at 2, 4 and 6 m spacing and at a constant depth of 0.60 m at a grade of 0.8 per cent. The soil moisture content was 22.5% at moling depth. The crop yields increased by about 50% in the mole drained plots, as compared to the control. Dhakad *et.al.,*(2013) reported that mole drains formed with a mole plough with a 75 mm bullet or expander diameter using a 75 hp wheeled tractor. The plant height, number of branches per plant, dry matter accumulation per plant and yield of soybean crop were highest in 2 m drain spacing followed by 4m, 6m, 8m and control plot in all selected depths. Major agricultural fields of some of the coastal districts namely Guntur, Prakasam, Krishna, East Godavari and West Godavari of Andhra Pradesh (A.P) suffer waterlogging and salinity problems. Hence, it is felt that the mole plough drainage technology if could be popularized in these farms, could be easily adapted by the farmers without disturbing the natural resources. Further the mole plough could be easily fabricated by among village artisans.

Under the close supervision and guidance of the subject matter experts of Acharya N G Ranga Agricultural University, a network of drainage system were installed in farmers' fields of Kapileswarapuram, East Godavari with the support of M/s Sarvaraya sugars PVT Limited, Chelluru, East Godavari District to benefit the farming community as public-private partnership mode for giving recommendations on better drainage system and better crop variety in their waterlogged fields.

MATERIAL AND METHODS

Study area description

The project site is located in Kapileswarapuram (latitude 16.779^0 and longitude 81.896^0) in East Godavari district. East Godavari district covers a vast portion of the delta area of the Godavari river. The study area for conducting experiment for the proposed research is selected in one of the farmer's fields of the Sarvaraya sugars private limited 15 km away from Chelluru. Climate is comparatively moderate throughout the year except during the months of April to June when the temperature reaches a maximum of 48^{0}C. The normal rainfall of this district is 1280mm. The main soils in the district are alluvial (clay loamy) red soils, sandy loam and sandy clay. There is mostly alluvial soil in Godavari delta and clay soil at the tail and portions of Godavari River, red loamy soil in upland and agency area of district. The farm holdings of the individual farmers vary from 0.25 to 2 ha only. Most of the farmers are small farmers. They take up the cultivation by themselves. Sugarcane is the main crop cultivated in the project area of all irrigation systems. Since from the last few years sugarcane was not cultivating because of waterlogging sugarcane yields were declined. So farmers were chosen instead of sugarcane Paddy crop grown in both the crop periods. The drainage system includes mole drainage in 3 ha area.

Immediately after harvesting of paddy in adjoining field the waterlogging was observed as in plate.1 and while the sugarcane crop in the study area with poor establishment during the growing period, the effect of waterlogging could be observed from Plate 2. Before the layout of the different drainage systems, open, mole and SSD, the contour map of the area was prepared and is shown in Fig. 1. As per the operational convenience of easy drainage from one treatment of drainage system to another, the layout was planned and is given in Fig. 2. The soil sample analysis results of 44 locations is averaged and the soil chemical parameters like, pH, EC, organic carbon, HCO_3, Ca^{+2}, Mg^{+2} and exchangeable sodium are 8.21, 055ds/m, 0.32meq/l, 13.24meq/l, 48.72meq/l, 22.85meq/l and 1.49 meq/100 g soil respectively. The texture of the soil was found as clay loam present in the study area. The soil was non-saline.

Construction of various drainage systems

In the study area for installing different drainage systems, semi-mechanical construction was done. Digging of drains was carried out mechanically using poclain. Laying of drainpipes and back filings were done manually. With the help of staff gauges and dumpy level the depth of cut was monitored throughout the digging operation to ensure proper gradient in the laterals and collector lines. Trench digging for collector line was completed before taking up digging for the lateral lines. Cleaning and smoothening was done manually along the bottom of the lateral and collector lines to attain proper surface conditions for laying the pipes. With the help of mole plough moles were formed at a spacing of 3m. Similarly open drains with a spacing of 18m 36m, (design spacing) and 54m were made

Plate 1: Water logging due to seepage just beside the canal

Plate 2: Waterlogging causes poor establishment of sugarcane crop

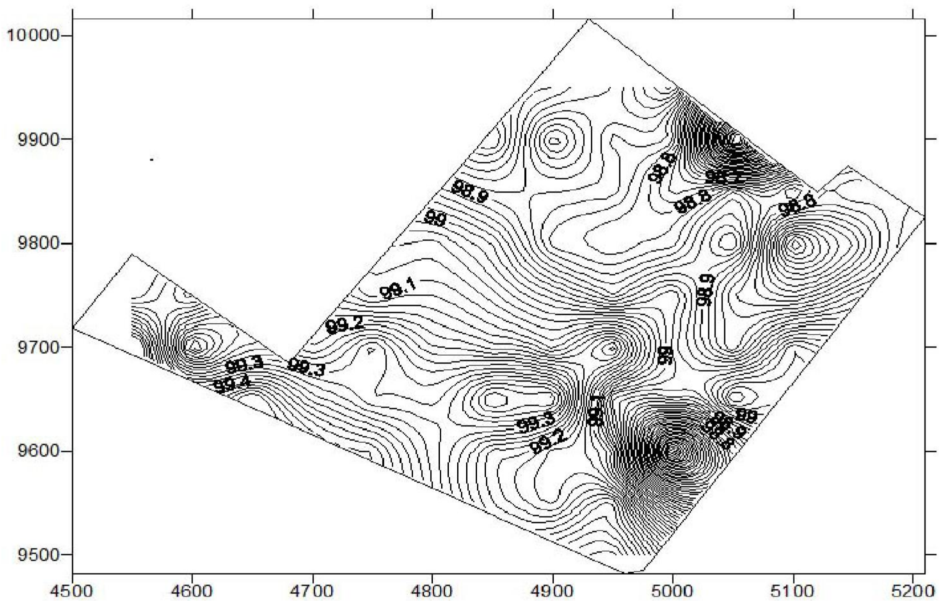

Fig. 1: Contour map of study area in Kapileswarapuram

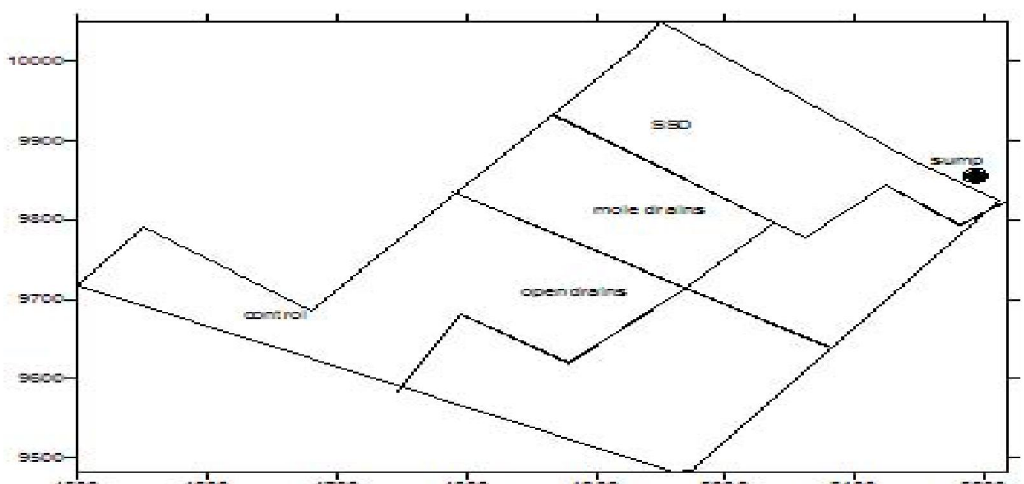

Fig. 2. Layout of various drainage systems at Kapileswarapuram.

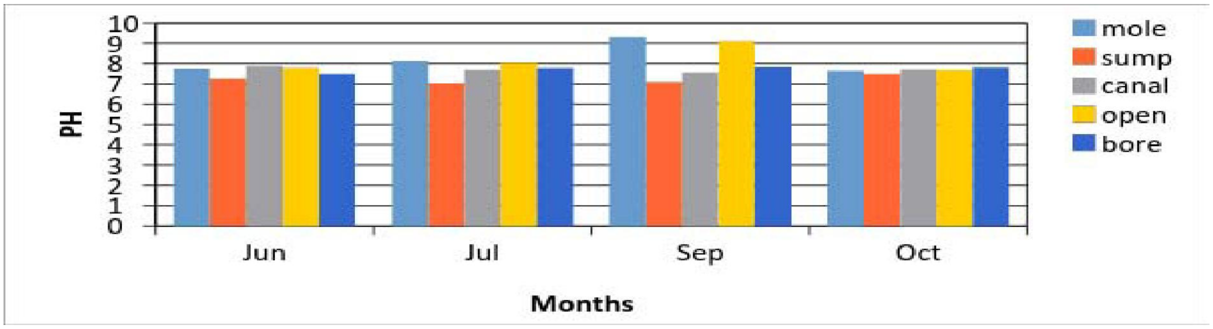

Fig.3. pH of the effluent samples from different drainage systems.

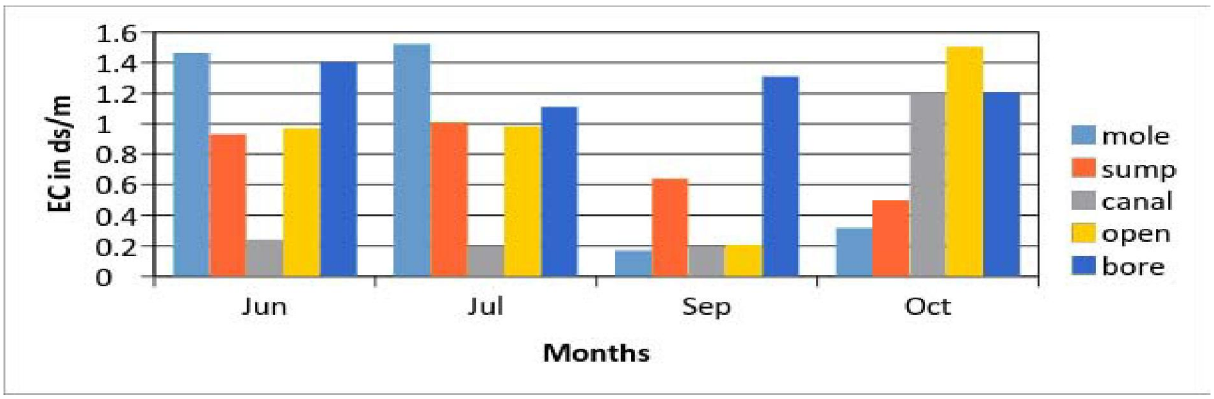

Fig. 4. EC of the effluent samples from different drainage systems.

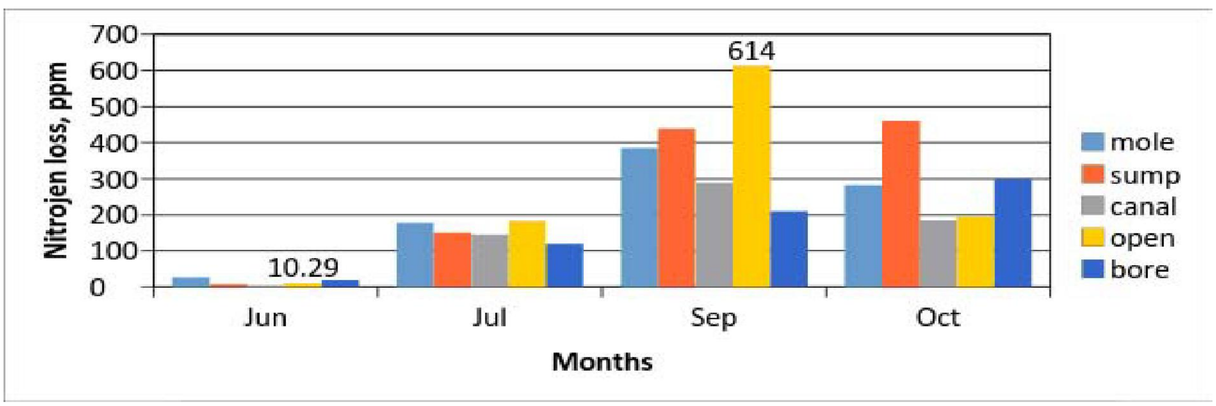

Fig.5. Nitrogen losses in effluent samples from different drainage systems.

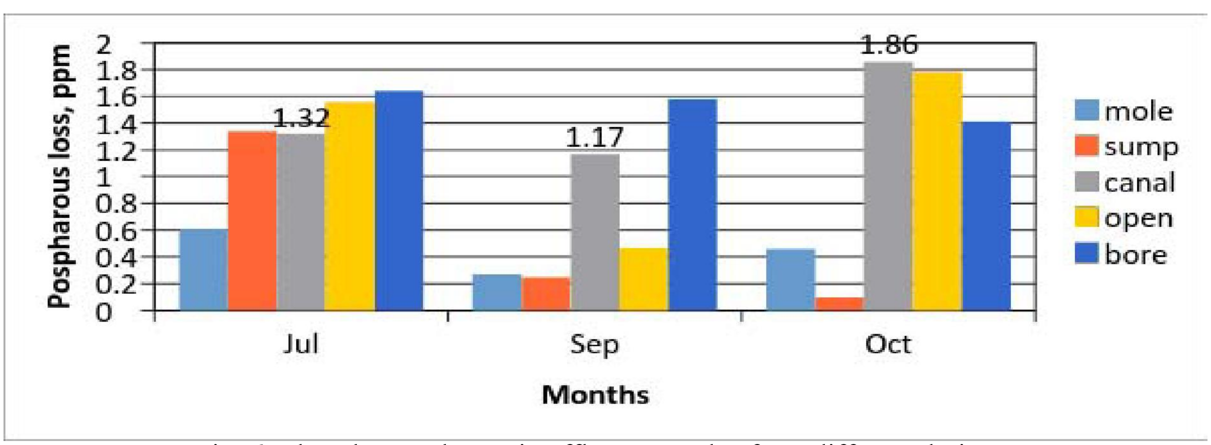

Fig. 6. Phosphorous losses in effluent samples from different drainage.

before the transplanting of sugarcane crop in the study area.

RESULTS AND DISCUSSION

In the present article, the variation of pH, EC, losses of major nutrients N,P,K in different treatments and finally the yield comparison from various drainage systems and from different varieties planted are discussed.

pH and EC of effluent water samples

The two most important soil chemical properties relevant to drainage are soil salinity and soil reaction. Soil salinity is expressed through the value of its conductivity and reaction is expressed through its value of pH.

The effluent water samples collected from open, mole and subsurface drainage systems were regularly analyzed in the laboratory available at the Sri Sarvaraya Sugars Pvt. Limited at Chelluru near Rama Chandra Puram. The results of investigation are presented in Fig. 3.

pH is almost same in all cases, except in the month of September. In sugarcane fields fertilizer application was done in September. The pH of soil water drastically increased from neutral range to alkaline range in mole drainage system and in open drainage system in the month of September only afterwards came down to neutral in the month of October. The reason is due to usage of different fertilizers. Fertilizers having different P^H ranges dissolve in soil water making the pH of effluent to vary. Further it was observed that because of the presence of more fissures in mole channels, the water samples from mole drains gave highest pH followed by in open drainage system.

When the samples are subjected for the analysis of EC, it was found that the EC was rapidly changing, but found within safe limits (Fig. 5). From this graph, it could be concluded that the EC was found highest during the months of June and July, being rainy months immediately after summer months. In rain water the top layer salts were soluble and increasing the EC of the water. More reduction of salinity from water samples was found from mole drains.

Loss of major nutrients from drainage systems

Though it is proved that the drainage system improve the yields of crops because of better aeration of the root zone followed by green matter and yield, there is a limitation of draining the valuable major nutrients also in the dissolved form contributing a considerable loss on the part of the farmers. Hence the water samples were collected from the open, mole, canal SSD sump, bore well in regular intervals immediately few days followed by the application fertilizers for the sugarcane crop.

Nitrogen is an important and essential component of plant food. Only a few crops (such as Bengal gram/chickpea and similar other crops which have nodules in the roots) have the capability of extracting nitrogen from the atmosphere and convert it into plant food. Mostly nitrogen and other fertilizers are applied externally. Plant availability of nitrogen of the applied fertilizer increases in well drained soils and loss of Nitrogen due to denitrification is minimized. Besides, chance of pollution of groundwater due to leaching down of unused nitrogen by the plants under waterlogged condition is reduced.

In the present study, only the major nutrients, Nitrogen, Phosphorous and Potassium traces only analyzed from the effluent water samples and were presented graphically in Fig.5, 6 and 7 respectively.

From the above figures, it was found that the trend of the occurrence of traces of major nutrients N, P and K were different in different months and in different systems. The Nitrogen traces were found much in open drainage effluent water sample because of volatilization. The trend was reversed during September and October months. More nitrogen traces are found in rainy season. Similarly the trends for phosphorous traces were found to be well within the limits in all the months of study. But more potassium traces were found in the initial months from mole drainage water samples followed by open drainage and SSD respectively. This may be due to the application of more potassium based fertilizers initially or the dissolution of potassium based nutrients in the effluent and leached out during the initial months but all major nutrient losses in all drainage systems were within the safe limit only except in open

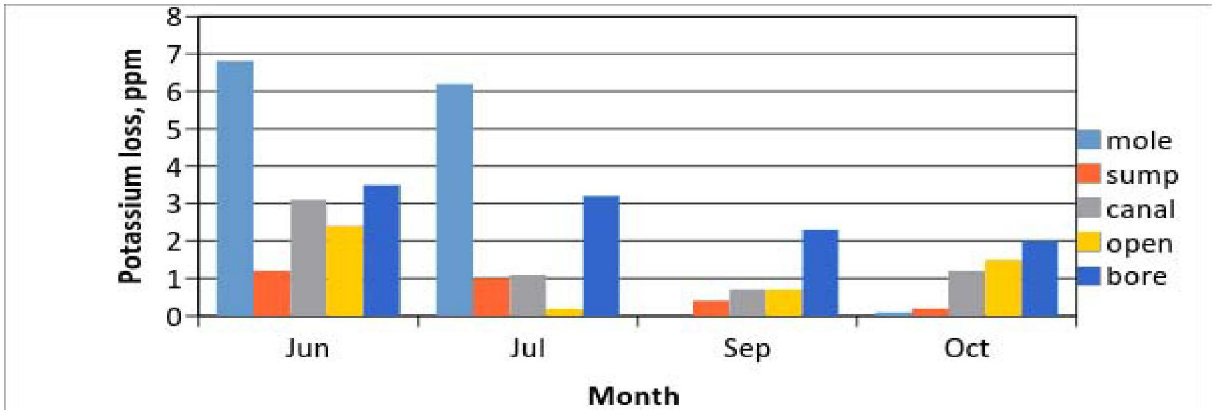

Fig.7. Potassium losses in effluent samples from different drainage systems.

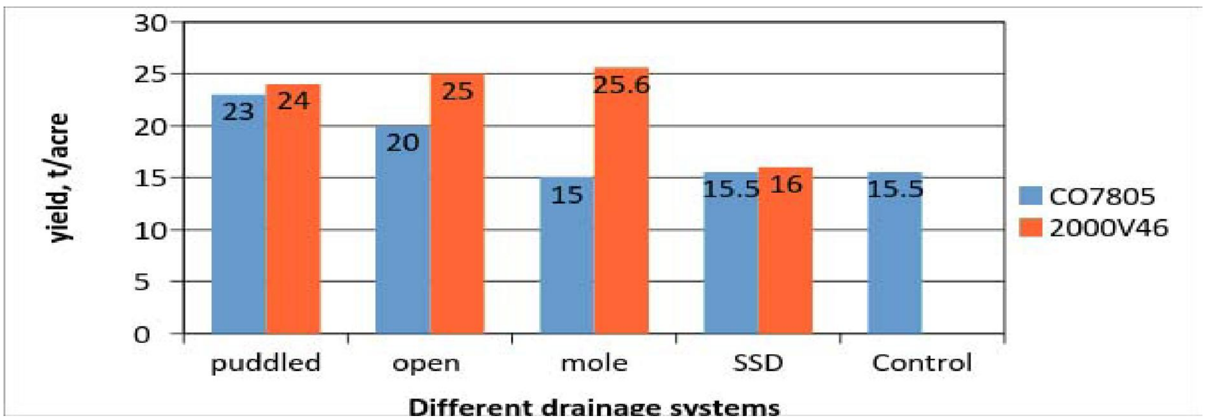

Fig. 8. Sugarcane yields obtained from different drainage systems installed fields.

drainage system. But the estimation of this quantity needs a thorough investigation for advising the farmers in controlling the drainage systems.

Comparative sugarcane yields under different drainage systems

The performance of sugarcane crop in terms of yield under various drainage systems is presented in Fig.8. Two varieties of sugarcane CO7805 and 2000V46 were planted in study area within these two verities 2000V46 variety gave high yield compare to other variety. Among all drainage systems mole drainage system gave high yield 25.6 t/acre. After that open drainage system gave best results. SSD is not gave satisfactory results because of lack of maintenance means continues water pumping is not occurred from the sump. Puddle field also gave satisfactory results because that field was situated in higher elevation compare to other fields.

Conclusions

As per the one year study on sugarcane crop yields under open, mole and subsurface drainage systems, the following major conclusions could be drawn. The extent of nitrogen traces are considerable when compared to phosphorous 1.86 ppm and potassium 8.6ppm which are far within the limits in the drainage effluent immediately after application of fertilizers. The nitrogen present during September was the highest i.e. 614ppm as against 10.29ppm at the time of transplanting. The yield of sugarcane crop was the highest in mole drainage plots with 200V46variety in the tune of 25.6 tons/ha. Because of operational difficulty with the adjoining farmers, the SSD pumping could not be done by the Factory Management. However for valid conclusions, it is to be ensured the farmers' cooperation and continued functioning of all the systems at least for a total of 4 years.

LITERATURE CITED

Anonymous 2002 Bi-Annual report, Indo-dutch Network Operational Research Project, Bapatla Center.

Dhakad S S, RamanaRao K V, Mishra K P and Paliwal D K 2013 Effect of mole drain spacing and depths on the growth character and yield of soybean in vertisols of MP. *International Journal of Agricultural Engineering*,Vol.6(1)173-176.

Spoor G, Hann M J, Godwin R J and Leeds-Harrison P B 1982 Water flow to mole drains. *Journal of Agricultural Engineering*, Vol.27:81-91.

RamanaRao K V, Ravi Kishore and Ramadhar Singh 2009 Mole drainage enhance soybean production in waterlogged Vertisols .*Journal of Agricultural Engineering,* Vol. 46(4), 54-58.

Norum D I and Don Gray M 1970 Unlined mole lines for irrigation. *American Society of Agricultural Engineers,* 13(5):661-668.

(Received on 16.06.2015 and revised on 11.04.2016)