RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 6 | Issue 1 | April, 2013 | 173–176

Effect of mole drain spacing and depths on the growth character and yield of soybean in vertisols of MP

S.S. DHAKAD, K.V.R. RAO, K.P. MISHRA AND D.K. PALIWAL

Received : 15.02.2013; **Revised :** 22.03.2013; **Accepted :** 16.04.2013

See end of the Paper for authors' affiliation

Correspondence to:

S.S. DHAKAD
Department of Agricultural Engineering, Krishi Vigyan Kendra (R.V.S.K.V.V.) DHAR (M.P.) INDIA

ABSTRACT : Effect of mole drain spacings and depths on the growth character of soybean was studied in the farmer's fields in Hoshangabad district of Madhya Pradesh. Mole drains were formed with a mole plough with a 75 mm bullet or expander diameter using a 75 hp wheeled tractor. The drains were formed at 2 m, 4 m, 6 m and 8 m spacing at an average depth of 0.4 m, 0.5 m and 0.6 m from ground surface. The average length of each lateral was 50 m and the tractor was operated with a speed of 0.80 kmph. 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.

KEY WORDS : Drainage, Mode drains, Mole drainage system, Soybean, Vertisols

HOW TO CITE THIS PAPER : Dhakad, S.S., Rao, K.V.R., 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. *Internat. J. Agric. Engg.*, **6**(1) : 173-176.

Drainage is a big problem in Vertisols specially in the area having rainfall. There are several drainage technologies available in these area but low cost semi-permanent structure mole drains may be a best option. Mole drains are pipeless drains that are formed a with 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 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. Mole drains are generally installed at a depth varying between 40 to 60 cm below the surface. The mole drains should be deep enough to be protected from the loads of heavy farm machinery and from the swelling and thawing effect of vertisols. The spacing of mole drains generally varies from 2 to 10 m. However, it depends on the soil permeability and the necessity of drainage also. If the spacing is less than 2 m, there is a danger of damage of the previously constructed drain, where as if the spacing is greater than 5 m, the fissuring effect may not cover the intervening space. Local experience rather than the adopting a particular value determines the spacing of the mole drain. The length of mole channels depends on the grade of the mole drains formed, soil type, shape, size and topography of the field. Flat slopes require shorter drain. A balance has to be found between risk of scouring with high water velocities on deep grades and risk of pond and channel collapse at low grades inorder to decide the length and grade of mole channel. In order to protect the outlet of mole drain, a small piece of approximately 1 m length pvc pipe is inserted at the outlet side of the drain. For longer life of mole drains, the timing of the installation is very critical. At the time of moling the soil at moling depth should be plastic and soil above this depth should be friable so that there is adequate traction and the soil will crack well from the leg slot to the soil surface. The ideal time for moling after one to two months after monsoon rains withdraws. Immediately after mole drains installation it would be better irrigate the field with sprinklers otherwise do not irrigate at all at least for a month, allowing the soil to ripen before the mole carries water. The useful life of mole channels varies from 2 to 10 years depending upon many factors. Success of moling depends on working with the correct soil type, and installing the mole drainage at the right depth and spacing at a optimum moisture content *i.e.*, near the lower limit of the 'plastic' range. The speed of operation of mole plough for mole drain formation is very important. Better mole drains are formed when the tractor speed is slow and steady. The generally recommended speed is less than 1.0 kmph.

■ METHODOLOGY

Location :

The study area is located in the farmer's fields in the village Bamuriya in Hoshangabad district of Madhya Pradesh. The area is situated between 22°38'10" N latitude and 77°40'59" E longitude with an altitude of 307 meters from MSL. The slope of the area is less than 1per cent with good drainage outlets.

Field layout :

Mole drains are unlined cylindrical channels which function like clay or plastic pipes and are formed using 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 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 dimensions of the mole plough designed and developed at CIAE included a leg with 1250 × 250 × 25 mm and a foot of 63 mm with 75 mm bullet or expander diameter. With a 3 point linkage the plough can be mounted on a wheeled tractor. The total weight of the plough was 75 kg. Mole drains were formed with a mole plough with a 75 mm bullet or expander diameter using a 75 hp wheeled tractor. The drains were formed at 2 m, 4 m, 6 m and 8 m spacing at an average depth of 0.4 m, 0.5 m and 0.6 m from ground surface. The average length of each lateral was 50 m and the tractor was operated with a speed of 0.80 kmph.

Soil analysis :

Soil samples were collected at farmer's fields to estimate the soil physical parameters. Using liquid limit apparatus the liquid limit of soils in the experimental plot was worked out as 48.81per cent and plastic limit was found to be 24.1 per cent. Thus, the plasticity index of the soil was worked out as 24.71 per cent. Soil samples were also collected for moisture content and bulk density estimation. The area under treatments was separated from control with interceptor surface drain formed with a ditcher. After installation, short lengths of perforated PVC pipe (1.0 m long) with 75 mm diameter was pushed up in each mole channel outlet .

Measurement of different growth characters and yield of soybean :

Plant height :

Plant height at 30, 45 and 60 days after sowing and at harvest stage was recorded. In each net plot five plants were selected randomly and tagged for periodic observation. The height (cm) was recorded at 30, 45, 60 DAS and at harvest stage of the crop in all the plots. It was measured from the ground surface to the main stem apex.

Root studies :

Root is a major part of the plant which provides anchoring and active participation in nutrient, moisture uptake and play effective role in fixation of atmospheric nitrogen. For root studies, observation on root length, root width and root dry weight were recorded and analysed statistically.

Root length :

Five plants were selected randomly from each plot and the length of root was taken in cm. The observation on root length was taken at 45 and 60 days after sowing.

Root nodules per plant :

As the root nodules play a vital role in the productivity, Five random plants dug up randomly in each plot and the nodules were washed out and counted. This study was done at 45 and 60 days after sowing.

Estimation of chlorophyll :

Chlorophyll was extracted by a non-macerated method using dimethyl sulphoxide. Fifty milligrams of finely chopped fresh leaf sample was placed in tubes to which 10 ml of dimethyl sulphoxide was added. The tubes were covered with aluminum foil and kept at 65^{0}C for 4 hours. Subsequently, the tubes were shaken to allow the pigment to distribute uniformly and absorbance was read at 663 and 645 nm. The amount of chlorophyll a and chlorophyll b (ì g/ml) was calculated using following formula :

$$\textbf{Chlorophyll a} = 12.7\ D_{663} - 2.69\ D_{645}$$

$$\textbf{Chlorophyll b} = 22.9\ D_{645} - 4.68\ D_{663}$$

where, D_{663} and D_{645} are the optical densities at the respective wavelengths. Total chlorophyll was determined by adding chlorophyll a and chlorophyll b contents. The amount of chlorophyll was finally expressed in terms of mg/g fresh weight.

Seed yield :

The soybean plants were harvested net plot-wise and then threshed after the sun drying. The seed yield of each net plot was recorded then converted in to kg/ha.

Net monetary returns :

Net monetary returns were obtained by subtracting cost of cultivation from gross monetary returns.

Benefit: cost ratio (B: C ratio) :

It was calculated by dividing the gross return under a treatment by the cost of cultivation under the same treatment and is expressed as returns per rupee invested.

■ RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized below:

Growth characteristics and yield of soybean :

Plant growth parameters were better in mole drains plot as compared to control because excess rainfall in experimental plot was drained by using mole drains. The plant height, root length, number of root nodules per plant, chlorophyll content and yield of soybean crop were recorded. The pooled average values of these parameters are presented in Table 1.

Plant height :

The highest plant height was recorded under S_1D_1 (mole drains at the spacing of 2 m on the depth of 0.4 m) followed by S_1D_2 (mole drains at the spacing of 2 m on the depth of 0.5 m), S_1D_3 (mole drains at the spacing of 2 m on the depth of 0.6 m) and S_3D_1 (mole drains at the spacing of 6 m on the depth of 0.4 m). Significantly lowest values of plant height were observed under absolute control followed by S_4D_3 (mole drains at the spacing of 8 m on the depth of 0.6 m) in all the growth stages. Mueller and Schindler (1992) and Jha and Koga (1995) also corroborated the same findings due to pipeless drainage.

Root length and no. of root nodules per plant :

The maximum root length and nodules were noticed under combination S_1D_1 (25.93 cm) followed by S_1D_2 (25.81cm). The significantly least values were recorded under control followed by S_4D_3 (mole drains at the spacing of 8 m on the depth of 0.6 m) at 60 DAS.

Chlorophyll content :

The soybean leaves under mole drains treatment 2m and 4m spacing were observed to be dark green due to higher value of chlorophyll content while in case of control it was pale green. Significantly highest values of chlorophyll were found under S_1D_1 (2m spacing x 0.4 m depth) followed by S_1D_2 (2m spacing x 0.5 m depth) and recorded lowest under S_4D_1 (8m spacing x 0.4 m depth) in case of the mole drain formation treatments. While in case of control, the values were found lower than this treatment. Ramana Rao *et al.* (2009) reported similar results from various field studies conducted at Central Institute of Agricultural Engineering on mole drainage in soybean crop.

Seed yield :

The highest productivity of 16.4 q/ha observed in the treatments with mole drains at 2m spacing with 0.4m depth while it was found lowest under control (8.4 q/ha) followed by S_4D_3 (mole drains at the spacing of 8 m on the depth of 0.6 m)

Table 1 : Effect of mole drains spacing and depths on growth parameters, yield and economics of soybean

Treatments	Plant height (cm) at harvest	Root length at 60 DAS (cm)	No. of root nodules per plant at 60 DAS	Chlorophyll content (mg/g of fresh leaves) at 60 DAS	Seed yield (kg/ha)	Net return (Rs/ha)	B:C ratio
S_1D_1 (Mole drains at the spacing of 2 m and depth of 0.4 m)	68.67	25.93	36.41	4.03	1640.66	19371	1.92
S_1D_2 (Mole drains at the spacing of 2 m and depth of 0.5 m)	66.92	25.81	35.33	3.94	1633.77	19116	1.91
S_1D_3 (Mole drains at the spacing of 2 m and depth of 0.6 m)	66.35	25.17	34.99	3.81	1554.70	16814	1.79
S_2D_1 (Mole drains at the spacing of 4 m and depth of 0.4 m)	65.42	23.14	33.63	3.71	1534.47	17621	1.86
S_2D_2 (Mole drains at the spacing of 4 m and depth of 0.5 m)	64.94	21.74	33.73	3.55	1483.48	16306	1.79
S_2D_3 (Mole drains at the spacing of 4 m and depth of 0.6 m)	65.06	22.45	32.35	3.53	1480.73	16405	1.80
S_3D_1 (Mole drains at the spacing of 6 m and depth of 0.4 m)	64.55	22.56	28.18	2.69	1467.93	16735	1.83
S_3D_2 (Mole drains at the spacing of 6 m and depth of 0.5 m)	60.32	20.26	27.25	2.56	1455.34	16140	1.80
S_3D_3 (Mole drains at the spacing of 6 m and depth of 0.6 m)	52.38	14.66	23.44	2.43	1333.31	12966	1.64
S_4D_1 (Mole drains at the spacing of 8 m and depth of 0.4 m)	51.50	15.32	23.67	1.97	1078.08	6916	1.35
S_4D_2 (Mole drains at the spacing of 8 m and depth of 0.5 m)	49.28	13.69	21.56	2.05	1036.38	5867	1.29
S_4D_3 (Mole drains at the spacing of 8 m and depth of 0.6 m)	47.99	13.89	19.69	2.03	1025.46	5835	1.29
S_0D_0 Control (no mole drains)	46.47	12.87	19.16	1.53	846.83	1568	1.08
S.E.±	1.28	0.59	1.05	0.04	11.41	292.7	0.01
C.D. (P=0.05)	3.94	1.83	NS	0.12	35.18	902.0	0.05

treatment. Under the absolute control the values were found to be lowest as compared to all the treatments. Variation of soil moisture content with mole drainage and its positive influence on the oat yield was noticed by Florescu *et al*. (1977). Eggelsmenn, 1987 also reported an increase in crop yield from 20 to over 100 per cent due to pipeless drainage. Better root growth may be incurred due to the better soil environment available due better drainage. The parameter *viz.,* plant height, root length, number of root nodules per plant, chlorophyll content and yield of soybean may be associated with this better root growth in different mole treatment as compared to control. Jha and Koga (1995) examined the impact of pipeless drainage on soil properties and on soybean growth in Bangkok soils and similar finding was also reported by Ramana Rao *et al.* (2009) confirmed the findings was of the experiment.

Net return and B: C ratio :

It can also be concluded from the Table 1 that highest net return (Rs 19371 per ha) and B:C (1.92) ratio were recorded under S_1D_1 followed by S_1D_2 (Rs 19116 per ha and 1.91, respectively) and the lowest net return (Rs 1568) and B:C ratio (1.08) of per ha was recorded under the control. Ramana Rao *et al.,* 2005 also reported similar results from various field studies conducted at Central Institute of Agricultural Engineering on mole drainage in soybean crop.

Conclusion :

Under actual field conditions studies on mole drains were taken up in Hoshangabad district of MP. The studies indicated that mole drainage is a cheaper and viable alternate to costly pipe drainage system. The net return from mole drains treatment at 2, 4 and 6 m drain spacings at 0.4 m depth were Rs. 19371, Rs.17621 and Rs. 16735, respectively per ha. The cost of installation can be met out in the first year itself, since the average yields obtained are very high over the yields obtained under no drainage conditions. Therefore, the pipeless drainage technology (mole drainage) may be recommended in Vertisols as it was found suitable, technically feasible and economically viable to drain excess water from root zone of all the crops specially in water sensitive crops for higher yields.

Authors' affiliations:

K.V.R. RAO, Irrigation and Drainage Engineering Division, Central Institute of Agricultural Engineering, BHOPAL (M.P.) INDIA

K.P. MISHRA, Faculty of Agricultural Engineering, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, CHITRAKOOT (M.P.) INDIA

D.K. PALIWAL, Krishi Vigyan Kendra, Kasturbagram, INDORE (M.P.) INDIA

REFERENCES

Eggelsmann, R. (1987). Subsurface drainage introductions. Bulletin of the German Association for Water Resources and Land Improvement, Verlag Paul Parey, Hamburg, GERMANY, pp. 83 - 120.

Floerescu, G., Dumitrescu, N. and Magdalina, I. (1977). Variations in soil moisture content with mole drainage and its influence on cat yield. Lucrari Stiintifice, Institute Agronomic.

Jha, M.K. and Koga (1995). Mole drainage: prospective drainage solution to Bangkok clay soil. *Agric. Water Mgmt.,* **28**(3) :253-270.

Mueller, L. and Schindler, U. (1992). Durability and hydraulic performance of mole channels in alluvial clay soils. Proc. of the Int. Agril. Engg. Con., 7-10 Dec.,1992,BANGKOK, THAILAND,pp. 889-896.

Ramana Rao, Kishore, K.V. Ravi and Singh, Ramadhar (2005). Mole drainage studies in vertisols of Bhopal region- a case study. Proce. of All India Seminar on Reclamation of waterlogged saline soils through drainage held at Kota during 4-5 December, 2005. pp.124-132.

Ramana Rao, Kishore, K.V. Ravi and Singh, Ramadhar (2009). Mole drainage a viable alternate to pipe drainage – a case study . Proceeding of 60th International Executive Council Meeting & 5th Asian Regional Conference, 6-11 December 2009, NEW DELHI, INDIA: pp. 1-6

Ramana, Rao, Kishore, K.V. Ravi and Singh, Ramadhar (2009). Mole drainage to enhance soybean production in waterlogged vertisols. *J. Agric. Engg.* **46** (4): 54 -58.

***