



Effect of different mole drain spacings on the growth characters and yield of soybean in Raisen district of MP

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Abstract: On farm trials were conducted on farmer's fields at Raisen district of Madhya Pradesh during 2008 to 2009 to assess mole drain spacing for soybean crop in temporary waterlogged vertisols. The four types of mole drain spacing viz. 2, 4, 6 & 8 m with 0.5 m depth from ground surface were assessed under trial. The average length of each lateral was 50 m and a 75 hp tractor was operated at a speed of 0.80 kmph during the mole drain formation. Soybean crop during kharif was selected in the study to optimize the drain spacing. Plant height, number of branches per plant, root length, number of root nodules per plant and yield of soybean crop were recorded for consecutive two seasons. On the basis of the results obtained from the experiment, it can be concluded that mole drains at a spacing of 2 meter was found optimal for better soybean productivity.

Key words: Drainage, Mole drains, Drain spacing, Soybean, Vertisols

Introduction

In rainfed agriculture, drainage is required to increase sustainable agricultural production by preventing temporary waterlogging and flooding of lowlands. The practice of fallowing the vertisols in central India including Madhya Pradesh during the rainy season and growing crops on residual soil moisture in *rabi* has been in vogue for several years. The average annual rainfall of the region varies from 750 mm to 1200 mm bearing few years. It was estimated that 2.02 million ha accounting for 6.57% of the total area of the state were under fallowing due to temporary waterlogging conditions during *kharif*. In vertisols, as the hydraulic conductivity is very poor, the successful drainage requires very closely spaced drainage systems, in the order of two to ten metre spacings. In many situations it would be too costly using underground pipes and would be impractical with open ditch systems. Mole drains are pipeless drains formed with the help of specially designed mole plough. The mole plough consists a cylindrical foot which is attached with narrow leg and back of the foot, a slightly larger diameter cylindrical expander connected. As the implement is drawn into the soil, the foot and expander form a drainage channel in the form of 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 of 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 between two mole drains generally varies from 2 to 10 m.

Several researchers, mostly from outside India have studied the influence of mole drainage on crop production. Eggelsmenn (1987) reported an increase in crop yield from 20 to over 100% due to pipeless drainage. Jha and Koga (1995) carried out a field experiment in conjunction with soybean crop in the central plain of Bangkok to examine the impact of pipeless drainage on soil properties and plant growth. Pipeless drainage were installed at a depth of 55 cm, spaced 2 m apart and at 1% slope by using a mole plough having a torpedo of 8.5 cm and an expander of 9.5 cm in diameter. The effects of pipeless drainage on soil physical and chemical properties were found to be very significant: basic infiltration rate increased by about 2.7 fold, porosity increased by 14% at 25 cm depth and by 19% at 40 cm depth, soil aeration improved markedly, saturated hydraulic conductivity increased by 34 fold at 25 cm depth and by 61 fold at 40 cm depth, and pipeless drains with liming showed long-lasting improvement in soil pH and E_c in the lower soil profile. Because of these improvements in the soil properties it was found that the soybean crop responded very well to pipe less drainage. There was about 46% increase in grain yield and 118% increase in the dry matter per plant. Mueller and Schindler (1992) also found a significant increase in crop yields due to pipeless drainage over 10 years.. Kolekar et. al. (2011) study that the effect

Table -1: Soil physical properties for mole drains formation in Vertisols

Treatment	Soil texture (%) at 40-60 cm soil depth			Soil moisture content (%) at 40-60 cm soil depth	Bulk density (g/cc) at 40-60 cm soil depth
	Sand	Silt	Clay		
S ₀ D ₀ : Control	21.84	25.90	52.24	22.5	1.434
S ₁ D ₁ : 2m S X 0.5 m D	22.40	25.92	51.62	21.8	1.435
S ₂ D ₁ : 4m S X 0.5 m D	23.48	24.44	52.10	23.2	1.422
S ₃ D ₁ : 6m S X 0.5 m D	21.02	26.12	52.84	22.4	1.428
S ₄ D ₁ : 8m S X 0.5 m D	22.12	24.88	53.00	21.9	1.433
Average	22.17	25.45	52.36	22.36	1.430

Table-2:Field capacity of mole plough under various mole drain treatments

Treatment	Field capacity of mole plough (ha/hr)
S ₀ D ₀	0.000
S ₁ D ₁	0.183
S ₂ D ₁	0.370
S ₃ D ₁	0.557
S ₄ D ₁	0.720

of mole drains spacing on the crop parameters on summer groundnut. A tractor 65 HP was selected to make drains of 2, 4 and 6 m. The plant height, number of branches per plant, number of pods per plant, weight of pods per plant and total yield were highest in 4m drain spacing followed by 6 m, 2 m and control and total yield in 4 m drain was 69.2% more than the control. El-Adl (2011) reported that the effects of different types of mole drains on some clay soil properties and wheat yield were tested in this study. The experimental studies were conducted in heavy clay soil. Moles were composed of 3 different materials; compost, sand and mixture of compost with sand (1:1). Two depths of moles (0.3 and 0.5 m) and three distances among moles (10, 15 and 20 m) were investigated in this work. The results indicated that: The highest yield (2737 kg/fed) was obtained by using compost, 10 m distance among moles and 0.5 m moles' depth.

Material and Methods

The experimental area was located in the farmer's fields in the village Hinotia mahalpur and Amkheda in Raisen district of Madhya Pradesh. The experiments were conducted in different farmer's fields of adopted villages of the district during kharif seasons of 2008 and 2009. The adopted villages are situated at Raisen Sagar road (NH-86) 25 km away from Raisen. Formation of mole drains (pipe less drains) depends on the soil physical properties such as soil texture, liquid limit, bulk density and soil moisture content at moling depth. Therefore, these parameters were analyzed using the standard protocols (Baruah and Barthakur, 1997). At Central Institute of Agricultural Engineering field studies were carried out on mole drainage for soybean crop in temporary waterlogged vertisols (K.V. Ramana Rao *et al.*, 2005) The slope of the area is less than 1% with good drainage outlets. The dimensions of the mole plough used and developed at Central Institute of Agricultural Engineering, Bhopal include 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. The success of a mole drainage system depends on the proper soil type, soil physical parameters, drain depth, proper timing of operation and mole drain spacing. Soil samples were collected from farmer's field to estimate the soil moisture content and bulk density. An experimental layout of mole drains was prepared with 4 different spacings (2, 4, 6 and 8 m) with 0.5 m depth from ground surface and 4 replications with 6 m buffer strip. Mole drains were installed at a longitudinal gradient of 0.8 % during last week of October 2007 and utilized for kharif 2008 and 2009 for soybean crop (variety JS 9305) during experiment.

Results and Discussion

Soil physical properties for mole drains formation: Success of mole drains formation depends on the soil physical properties. Therefore, soil properties like soil texture, soil moisture and bulk density were determined at time of mole drains formation and depicted in Table 1. It was found that mole drains can be formed in vertisols at different treatment when the average soil moisture content was between 22.36 % and average clay content is 52.36 % at moling depth. The average bulk density recorded at soil depth 40-60 cm was 1.43 g/cc.

Field capacity of mole plough at the time of mole drains formation: The data in Table 2 reveals that the effect on field capacity of mole plough for drains formation were recorded highest under S₄D₁ (mole drains at the spacing of 8 m on the depth of 0.5 m) and lowest under S₁D₁ (mole drains at the spacing of 2 m on the depth of 0.5 m).

Growth characteristics and yield of soybean: Plant growth parameters were found better in mole drains plot as compared to control plot. The increase in plant growth might be due to proper drainage of excess rainfall through mole drains. The plant height, root length, number of root nodules per plant and yield of soybean crop were recorded. The pooled average values of these parameters are presented in Table 3.

Plant height: The highest plant height was recorded under S₁D₁ (mole drains at the spacing of 2 m on the depth of 0.5 m) followed by S₂D₁ (mole drains at the spacing of 4 m on the depth of 0.5 m), S₃D₁ (mole drains at the spacing of 6 m on the depth of 0.5 m). Significantly lowest values of plant height were observed under absolute control

Table-3: Effect of mole drains spacing on growth parameters, yield and economics of soybean

Treatment	Plant height (cm) at harvest	Root length at 60 DAS (cm)	No. of root nodules per plant at 60 DAS	Seed yield (kg/ha)	Net Return (Rs/ha)	B:C ratio
S ₀ D ₀ :Control	46.47	12.92	19.86	946.83	1868	1.08
S ₁ D ₁ :2mSX0.5mD	69.67	24.9	32.42	1641.68	19780	2.02
S ₂ D ₁ :4mSX0.5mD	66.48	21.14	28.62	1455.34	16140	1.86
S ₃ D ₁ :6mSX0.5mD	61.52	18.56	24.18	1333.31	15932	1.64
S ₄ D ₁ :8mSX0.5mD	51.56	15.32	21.67	1078.08	10117	1.35

followed by S₄D₁ (mole drains at the spacing of 8 m on the depth of 0.5 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 S₁D₁ followed by S₂D₁. The significantly least values were recorded under control followed by S₄D₁ (mole drains at the spacing of 8 m on the depth of 0.5 m) at 60 DAS.

Seed yield: The highest productivity of 16.41 q/ha observed in the treatments with mole drains at 2 m spacing with 0.5 m depth, whereas it was found lowest under control (9.46 q/ha) followed by S₄D₁ (mole drains at the spacing of 8 m on the depth of 0.5 m) treatment. Under the absolute control the values were found to be lowest as compared to all the treatments. Jha and Koga (1995) & Ramana Rao *et al.* (2009 and 2012) examined the impact of pipeless drainage on soil properties and on soybean growth in vertisol soils and confirmed the findings of the experiment.

Net return and B: C ratio: Highest net return (Rs 19780 per ha) and B: C ratio (2.02) were recorded under S₁D₁ followed by S₂D₁ (Rs 16140 per ha and 1.86 respectively). Whereas, the lowest net return (Rs 1868) and B:C ratio (1.1) per ha was recorded under the control plot. Rao *et al.* (2005) also reported similar findings from various field studies conducted at Central Institute of Agricultural Engineering on mole drainage in soybean crop.

Mole drains can be formed in vertisols under different treatment, when the average soil moisture content was between 22.36 % and average clay content is 52.36 % at moling depth. Field capacity of mole plough for drains formation recorded highest under S₄D₁ (mole drains at the spacing of 8 m on the depth of 0.5 m)

and lowest under S₁D₁ (mole drains at the spacing of 2 m on the depth of 0.5 m). Mole drain with S₁D₁ (spacing of 2 m at the depth 0.5 m) was found better in comparison with all other mole drain spacings as well as over control. Effect of mole drainage on the growth parameters & productivity of soybean in various mole drains treatments were found better in comparison with control (No mole drain).

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