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Effect of Levels of Compaction and Potassium on Chilli (*Capsicum annum* L.) on Typic-Ustipsamments

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ABSTRACT

Field experiment was conducted with three levels of compaction (0, 1 and 2 passing of 500 kg iron roller) at proctor moisture and four levels of potassium (0, 30, 60 and 90 kg K_2Oha^{-1}) in split plot design. The results indicated that sub-surface compaction decreased the hydraulic conductivity and K-mobility, while it increased the bulk density, moisture retention capacity, potassium retention, plant growth (i.e. plant height, number of primary branches and yield attributes (i.e. number of flower per plant, number of ripen frutls per plant, yield of fruits per plant, average fruit weight, fruit length and fruit volume). There was increase in plant growth and yield attributes with increasing levels of potassium.

Introduction

Chilli (*Capsicum annum* L.) is one of the most important commercial grown spices and vegetable crop. The chillies are used green as well as in dry powdered form. It is a rich source of vitamin A and vitamin C among the vegetables. Sandy and loamy sand soils are excessively permeable mainly because of their coarse texture, losseness and poor organic matter content. Their moisture retentive capacity is also very low and more than one third of applied or rain water gets lost as deep percolation along with soluble nutrients (Majumdar, 1994). Mechanical compaction of sub-surface soils is an important alternative to over come the above constraints. Nutrients enhance the production potential of crop, if they are supplied in recommended quantities and in balanced proportion. Potassium generally improves growth, yield and quality of many crops and particularly in chilli. Looking to the cost of potassic fertilizer and constraints associated with these soils, an experiment on appropriate tillage in combination with potassium levels was designed to generate a suitable technology in order to have maximum utilization of water and nutrient under present conditions of soil system.

Materials and Methods

The present investigation was carried out in a soil Chomu Series having loamy sand texture and has been classified as hyperthermic family of Typic-Ustipsamments. Experiment was laid out in split plot design having four replications. The tillage treatment (compaction) had been kept in main plot whereas the levels of potassium treatments were kept in sub plot. The treatment consisted of three levels of tillage (compaction) i.e. no passing (C_0), 1 passing (C_1 and 2 passing (C_2) of 500 kg iron roller at proctor moisture and the potassium levels were I (k_0), 3O (K_1), 60 (K_2), 90 (K_3) kg K_2O ha^{-1} through muriate of potash. Nearly one month old seedlings of chilli were transplanted in the treated plots of 2.7 x 1.5 m^2 at a spacing of 45 x 30 cm. a basal dose of FYM@25 t ha^{-1} was applied before transplanting. Recommended dose of N and P_2O_5 were applied. Potassium was applied as per treatment combination. Soil physical parameters *viz.*, bulk density, hydraulic conductivity and moisture content were determined by using undisturbed cores as described by Gupta and Dakhsinamurti (1981). Fruit growth, yield and yield attributes were recorded as per the general norms.

Results and Discussion

Effect of compaction on physical properties of soils

Highest increase in bulk density was observed in sub-surface (15-30 cm) layer, the values being 1.63, 1.68, 1.79 Mg m^3 under two passings of 500 kg iron roller at transplanting, flowering and at harvest stage, respectively (Table 1). These data confirm that the maximum compaction occurs not immediately below the passing surface but at some distance below it. These observations are in conformity with the findings of Nateson *et al.* (1991) who observed that 15-30 cm layer is the zone of maximum bulk density following compaction.

Table 1. Effect of comapction onthe average bulk density (Mg m^3), saturated hydraulic conductivity (cm hr^{-1}) and moisture content (percent) of soil at different stages of crop growth

Crop stage	Soil depth (cm)	Bulk density			Saturated hydraulic cond.			Moisture content		
		0 passing	1 passing	2 passing	0 passing	1 passing	2 passing	0 passing	1 passing	2 passing
Transplanting	0-15	1.518	1.542	1.585	8.756	7.932	6.515	6.688	8.150	9.781
	15-30	1.520	1.580	1.630	6.908	6.285	5.630	6.972	9.380	10.412
	30-45	1.538	1.570	1.622	7.155	6.488	5.658	7.442	9.244	10.278
Flowering	0-15	1.530	1.568	1.610	6.232	5.525	4.387	10.450	11.492	12.638
	15-30	1.555	1.615	1.678	5.845	5.170	4.050	10.684	12.383	13.315
	30-45	1.538	1.602	1.660	5.685	5.185	4.130	10.742	12.145	12.918
Harvest	0-15	1.535	1.585	1.630	4.840	4.390	3.480	9.070	9.685	10.350
	15-30	1.580	1.630	1.690	4.610	4.006	3.022	8.890	10.025	10.585
	30-45	1.590	1.625	1.670	4.510	4.160	3.028	8.685	9.555	10.010

Highest decrease in saturated hydraulic conductivity was observed in sub-surface (15-30 cm) layer. The values were 5.63, 4.05, and 3.02 cm hr^{-1} under two passing of 500 kg iron roller at transplanting, flowering and at harvest, respectively in comparison to the values (6.90, 5.84 4.61 cm hr^{-1}) obtained with no passing for the above stages in 15-30 soil layer (Table 1). Saturated hydraulic conductivity was affected by compaction mainly due to increase in bulk density values in these layers. These observations are in conformity with the findings of Patel and Singh (1981) who observed that hydraulic conductivity of compacted soil cores drastically decreased as their bulk density increased from 1.5 to 2.0 Mg m^{-3}.

Similarly highest increase in moisutre content was observed under two passings of 500 kg iron roller, the values being 9.78, 10.41 and 10.28 percent in 0-15, 15-30 and 30-40 layers, as compared to no passing of iron roller, the values being 6.67, 6.97 and 7.44 percent, respectively at transplanting for the same layer (Table 1). These observations are in conformity with the findings of Agarwal *et al.* (1987).

Effect of compaction and potassium on growth and yield of chilli

Compaction significantly influenced the plant height, number of primary branches and number of flowers per plant (Table 2). Maximum plant height 68.15 (cm), number of primary branches per plant (9.11) and number of flowers per plant (67.75) were observed under two passings of 500 kg iron roller treatment. Application of potassium also significantly influenced the plant height, number of primary branches and number of flowrs per plant (Table 2). The maximum plant height (69.32 cm), number of primary branches (8.79) and number of flowers per plant (67.98) were observed in 90 kg K_2O ha^{-1} treatment application.

Table 2. Effect of compaction and potassium on growth of chilli

Treatment	Plant height (cm)	No. of primary branches/ plant	No. of flowers/ plant
Compaction level			
C_0	59.51	7.32	59.50
C_1	65.65	8.15	62.66
C_2	68.15	9.11	67.75
S.Em±	0.163	0.014	0.070
C.D. at 5%	0.565	0.025	0.244
Potassium level			
K_0	56.14	7.32	56.90
K_1	63.19	7.98	62.89
K_2	69.10	8.68	65.48
K_3	69.32	8.79	67.98
S.Em±	0.144	0.017	0.046
C.D. at 5%	0.446	0.037	0.133

Compaction significantly influenced the number of green chilli fruit per plant and yield of fruits per plant. The maximum number of green fruits (46.54) yield of fruits per plant (268.12 gm) were observed under two passing of 500 kg iron roller treatment (Table 3). Increasing levels of potassium significantly increased the number of fruits per plant, and yield of fruits per plant. The maximum green

Table 3. Effect of compaction and potassium on yield and yield attributes

Treatment	No. of green fruits/plant	Yield of fruits/ plant (g)
Compaction level		
C_0	3.44	163.12
C_1	41.14	213.12
C_2	46.54	268.12
S.Em±	0.685	2.093
C.D. at 5%	2.364	7.224
Potassium level		
K_0	36.89	201.66
K_1	39.09	211.25
K_2	44.05	227.08
K_3	41.48	219.16
S.Em±	0.722	2.311
C.D. at 5%	2.090	6.688

Table 4. Effect of compaction and potassium on fruit quality

Treatment	Av. Fruit wt. (gm)	Fruit length (cm)	Fruit volume (ml)
Compaction level			
C_0	4.73	10.17	7.00
C_1	5.17	11.86	8.13
C_2	5.75	13.80	9.50
S Em±	0.046	0.287	0.112
C.D. at 5%	0.159	0.992	0.158
Potassium level			
K_0	4.30	9.78	7.27
K_1	5.14	11.18	7.96
K_2	5.53	12.71	8.51
K_3	5.90	14.10	9.11
S.Em±	0.107	0.042	0.106
C.D. at 5%	0.31	0.146	0.307

fruits per plant (44.05) and yield of fruits / plant (222.08 gm) were observed under 90 kg K_2O ha^{-1} treatment.

Effect of compaction and potassium on fruit quality of chilli

The average fruit weight (gm), fruit length (cm) and fruit volume (ml) increased significantly with increasing levels of compaction from C_0 to C_2 (no compaction to two passings of 500 kg iron roller). The C_2 treatment recorded the maximum average green fruit weight (5.75 gm), fruit length (13.80 cm) and fruit volume (9.50 ml). Application of potassium influenced the average fruit weight (gm), fruit length (cm) and fruit volume (ml), significantly over no potassium application (Table 4). the maximum average fruit weight (5.90 gm), fruit length (14.10 cm) and fruit volume (9.11 ml) were obtained under 90 kg K_2O ha^{-1}.

Effect of compaction and potassium on distribution of potassium in soil

Considerable amount of K moved in the profile at different depths under control whereas maximum retention of K upto the 45 cm depth was observed under two passing of 500 kg from iron roller treatment. The highest retention of water soluble and exchangeable K in 15-30 cm depth followed by 30-45 cm depth under two passing of 500 kg iron roller + 90 kg K_2O ha^{-1} levels was noted when compared with one passing of 500 kg iron roller + all the K-levels and no comapction + all the K-levels treatments.

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Effect of Compaction on Soil Physical Properties and Nitrogen Utilization by Wheat and Pearl Millet Crops in Loamy Sand

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ABSTRACT

Field experiments were conducted during 1995 and 1996 on highly permeable loamy sand to evaluate the effect of compaction and nitrogen on change in soil physical properties, yield and nitrogen utilization efficiency by wheat and pearl millet crops. The results indicated that sub-surface compaction decreased the saturated hydraulic conductivity and total porosity besides increasing the bulk density,moisture storage capacity and retention of applied N in the root zone during both the cropping seasons. The yield and N uptake by wheat and pearl millet increased significantly with increasing levels of compaction and N. The N use efficiency of wheat and pearl millet improved significantly with increasing levels of compaction at a given level of N application but it decreased significantly with increasing levels of N application at a given level of compaction.

Introduction

The agricultural production potential of highly permeable and light textured soils in arid and semi-arid regions of Rajasthan are low due to high water and nutrient losses from the effective root zone during rainy season or under heavy irrigation. More over, these soils have excessive non-capillary porosity at the cost of capillary porosity (Somani and Kumawat, 1986). Use of surface mulches to retard evaporation, artificial barriers of asphalt, bitumen and cement in the sub soil zone of sandy soils have been found to reduce the water and nutrient losses and improve crop yield, but their adoption on a large scale has been limited by the high cost of the technology. However, compaction of such soil was proposed to alleviate the physical property of excessive water loss so as to improve moisture and nutrient retentivity besides improving the crop yields.

Materials and Methods

Field experiments were conducted during *rabi* 1995-96 with wheat (cv. Raj. 3077) and during *kharif* 1996 with pearl millet (cv. MH 179) at the experimental farm of the College of Agriculture, Jobner on Chomu series (loamy sand, mixed hyperthermic family of typic Ustipsamment) to assess the effect of compaction on soil physical properties, NO_3-N distribution pattern and crop response. The soils of the experimental site (85 to 86% sand, 6 to 8% silt and 6 to 7% clay) have pH 8.0 to 8.2, EC 0.40 to 0.85 dSm^{-1}, organic carbon 0.15 to 0.16%, CEC 4.5 to 4.6 c mol (p+) kg^{-1}, NO_3-N 3.2 to 3.5 mg kg^{-1}, available N, P, K, 108 to 110, 24 to 25, 154 to 155 kg ha^{-1}, respectively. The bulk density and moisture content at 0.33 and 15 bar varied from 1.48 to 1.51 Mg m^{-3}, 10.8 to 11.2 and 2.3 to 2.5 per cent, respectively. The treatments consisted of three levels of compaction (0, 4 and 8 passings by 500 kg manually driven iron roller having 125 cm length and 75 cm diameter with 10 cm x 125 cm actual area of contact, creates pressure per unit area of 0.40 kg cm^{-2} in main-plots for both the crops) and four levels of N(0, 40, 80 and 120 kg N ha^{-1} for wheat and 0, 30, 60 and 90 kg N ha^{-1} for pearl millet) through urea in sub-plots of 3 x 2 m^2 size. The experiments were laid out in split plot design with four replications. The soil of the treatment plots were compacted at optimum moisture (Proctor, 1933) following pre sowing irrigation of 7 cm on November 13, 1995 and 134 mm rainfall received in the third week of June, 1996. The wheat and pearl millet seeds @ 120 and 4 kg ha^{-1} were sown on November 15, 1995 and June 25, 1996 at a row distance of 22.5 and 40 cm, respectively. Uniform basal dose of 40 kg P_2O_5 ha^{-1} and 30 kg K_2O ha^{-1} was applied through single super phosphate and muriate of potash for wheat and 30 kg P_2O_5 ha^{-1} as SSP for pearl millet. One third dose of N as per treatments through urea were applied at sowing and remaining dose of N were top dressed in two splits one and two months after sowing in both the crops. The cultural operations were performed as per recommended practice. Wheat crop received nine irrigations during its entire growth period whereas pearl millet was raised under rainfed condition.