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Short Note

Effect of surface drainage and ridge planting on soil aeration and productivity of soybean (*Glycine max* L) cultivars in wet temperate zone of Himachal Pradesh

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Abstract

A field experiment was conducted for three consecutive *Kharif* seasons on a silty clay loam soil at the research farm of CSKHPKV, Palampur (1290 m amsl) to find out the effect of surface drainage and ridge planting on performance of soybean cultivars. Twelve treatment combinations consisting of three drainage conditions (surface drainage not provided, surface drainage provided and ridge planting and four cultivars (Harit soya, Shivalik, Bragg and PK-472) were replicated thrice in a randomized block design. Ridge planting and surface drainage significantly decreased soil water content and soil aeration in 0-45 cm soil layer and improved grain yield over no surface drainage. Ridge planting was superior to surface drainage. The cultivar PK 472 out yielded other cultivars; Harit soya and Bragg were more sensitive to soil aeration.

Key words: Surface drainage, ridge planting, soybean cultivars, soil water content, aeration, porosity.

Soybean is an important crop of Himachal Pradesh sown during second fortnight of June with the onset of monsoon rains. In high rainfall areas, the continuous rains lead to saturated or sometimes temporary water-logging conditions during different growth stages. Water logging adversely affects the establishment and growth of arable crops mostly due to excess soil water called 'soaking injury' (Grable 1966), and restricted oxygen supply inadequate to sustain root respiration. It has been observed that soybean is sensitive to excess soil water conditions and shows decline in productivity. It may be possible to enhance soybean productivity in high rainfall areas by providing surface drainage so as to improve the soil aeration status. Soybean cultivars may respond differently to excess soil water conditions due to differences in their morphological characters. The current study was undertaken to evaluate the effect of excess water management on different cultivars of soybean. A field experiment with soybean was conducted for three consecutive Kharif seasons from 2005-07 on an Alfisol (Typic Hapludalf) at the experimental farm of CSKHP Krishi Vishvavidyalaya, Palampur, located at 32.6^0 N, 76.3^0E at an altitude of 1290 m above mean sea level. The area receives annual rainfall of more than 2500 mm, 70 % of which is received during the monsoon period (June - September). The experimental soil (0- 0.15 m) was silty clay loam (30 % clay, 50 % silt and 20 % sand) and had pH 5.6, cation exchange capacity 12 c mole (P^+)/ kg and organic carbon 0.95 per cent. It was low in available N and P and medium in K.

Twelve treatment combinations, consisting of three drainage systems (surface drainage not provided, surface drainage provided and ridge planting) and four cultivars of soybean (Harit soya, Shivalik, Bragg and PK 472) were replicated thrice in randomized block design with plot size of 10 m^2 in outward sloping terraced field . All the plots were surrounded on all sides with 15-cm high (bunds) dike. Surface drainage was provided by opening field dike on one side of the plot. The plot without surface drainage served as the control. In ridge planting, the soybean crop was planted on 30 cm high ridges spaced at 40 cm. Soybean cultivars were sown at seed rate of 100 kg/ha in lines, 40 cm apart, with the onset of monsoon rains during second fortnight of June, the normal time of sowing of soybean in the region. The crop was fertilized with basal dose of 20 N - 26P - 33 K kg/ha.

Soil moisture content was determined around flowering stage thermo-gravimetrically at 0-15 cm, 15-30 cm and 30-45 cm soil depths and multiplied with respective bulk density values for its conversion to volumetric moisture content. Depth –wise bulk density values were determined using soil core sampler (Blake and Hartage 1986) and particle density by using pycnometer method (Prihar and Sandhu, 1968). Total porosity was then calculated as:

$$\text{Total porosity (\%)} = 1 - \frac{\text{Bulk density}}{\text{Particle density}}$$

Air filled porosity was computed by subtracting volumetric moisture content from total porosity values. During 2005, there were 9, 21, 25 and 20 rainy days with total rainfall of 208, 716, 687 and 565 mm during June, July, August and September, respectively. During 2006, the rainy days during corresponding months were 11, 24, 26 and 15 with rainfall of 263, 664, 863 and 301 mm, respectively. The corresponding values of rainy days and rainfall during 2007 were 16, 23, 26, 15 days and 283, 435, 257, 248 mm, respectively.

Soil moisture and aeration

Surface drainage and ridge planting had significant effect on soil moisture content and soil aeration status in the root zone (Table 1) during all the study years. Soil moisture content at each layer under study within 0-45 cm depth was significantly higher in plots without drainage than in plots with drainage or ridge planting. Thus surface drainage as well as ridge planting decreased moisture content and increased soil aeration in the root zone, which was significantly reflected into increased soybean yield.

Soybean yield

The soybean yield in control plot was always the lowest, while highest soybean yield was in ridge planted plots, and the differences were statistically significant (Table 2). Ridge planting was significantly superior to surface

Table 1. Effect of surface drainage and ridge planting on soil water content and air filled porosity

Treatments	Soil water content (%)									Air filled porosity (%) of surface layer (0-15 cm)		
	Soil depth (cm)									2005	2006	2007
	2005			2006			2007					
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45			
Surface drainage not provided	35.7	34.3	33.3	31.4	27.5	25.8	30.9	29.6	29.9	8.03	13.34	13.92
Surface drainage provided	34.4	32.4	31.4	28.8	25.6	23.8	28.7	26.3	25.1	9.76	16.60	16.71
Ridge planting	34.4	32.9	31.9	27.4	23.9	22.2	26.9	25.2	23.3	9.62	18.31	18.97
CD (P=0.05)	0.98	0.92	0.93	1.41	1.91	1.76	1.15	1.26	0.98	1.21	1.75	1.42

Table 2. Effect of surface drainage systems and cultivars on grain yield of soybean

Treatments	Grain yield (t/ha)			
	2005	2006	2007	Mean
Drainage system				
Surface drainage not provided	0.91	1.15	1.11	1.06
Surface drainage provided	1.29	1.27	1.30	1.29
Ridge planting	1.18	1.62	1.57	1.46
CD (P=0.05)	0.16	0.14	0.13	0.10
Cultivars				
Harit soya	1.09	1.31	1.34	1.25
Shivalik	1.16	1.24	1.32	1.24
Bragg	0.94	1.30	1.25	1.16
PK-472	1.32	1.51	1.39	1.42
CD (P=0.05)	0.12	0.17	NS	0.12

drainage (21-28 %). Surface drainage and ridge planting increased grain yield over control by about 10-42 % and 30-41 %. The respective values for mean grain yield were 22 and 38 per cent. Sharma, *et al.* (2010) also reported higher yield of mash, soybean, brinjal and ladyfinger on raised bed than in unmodified flat and bunded beds due to better surface drainage of water.

Soybean cultivar, PK-472, always recorded the highest grain yield, and the differences in grain yield among cultivars in most cases were statistically significant. The PK-472 produced about 14-22 % higher mean grain yield than other cultivars. The interaction among soybean cultivars and drainage treatments was although statistically non significant, yet Bragg and Harit soya

appeared comparatively more sensitive to excess soil moisture condition.

From the present investigation it can be concluded that ridge planting and surface drainage decreased soil water content and increased soil aeration in 0-45 cm soil. It resulted in significantly higher soybean yield. Ridge planting was superior to surface drainage. The cultivar PK-472 out yielded other soybean cultivars; Harit soya and Bragg appeared comparatively more sensitive to soil aeration.

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