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Identification of suitable soils for cultivation of pomegranate *(Punica granatum)* cv Ganesh

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ABSTRACT

An experiment was conducted during 2008-13 to study the performance of pomegranate (*Punica granatum* L) cv. Ganesh with respect to changes in soil properties, plant growth, fruit yield and disease incidence on the plants grown under different soil types. After five years of experimentation, soil pH and organic carbon was increased while calcium carbonate content decrease in most of the soils. Plants grown on heavy textured soil have better macro-nutrient uptake, leaf chlorophyll content and vigorous plant growth compared to light textured soil. Fruit yield was highest in the plants grown on clayey soils having 30 cm depth. Plant growth and fruit yield were drastically reduced with the increase in depth of clayey soil (90 and 120 cm). Better quality fruits were produced on the plants grown in gravelly, sandy loam texture soil having depth of 60 cm and even in the plants grown on weathered rock only. Incidence and severity of bacterial blight and wilt disease was higher in the plants grown on clay textured soils compared to light textured soils.

Key words : Bacterial blight, Fruit yield, Fruit quality, Nutrient, Pomegranate, Plant growth, Soil types, Wilt

In India, the cultivation of pomegranate (*Punica granatum* L.) is spread in an area of 113 thousand ha, out of which 78 thousand ha (69%) is confined to Solapur, Nasik, Ahmadnagar and Pune districts of Maharashtra (Anonymous 2013). The hot, dry and arid to semi-arid climate of the region favours a congenial atmosphere for the production of this crop. But majority of the soils in these areas are on undulating lands having shallow depth, high gravel percent, sandy texture, low organic matter, and low fertility status. During last few years, pomegranate has emerged as a 'Dollar crop' and has been considered most promising for earning foreign exchange due to its high economic returns and nutraceutical value (Newman and Lanksy 2007). This has paved the way for expansion of area under cultivation to a greater extent, bringing different kinds of lands under cultivation without properly assessing its suitability for pomegranate. The extensive surveys undertaken in pomegranate growing areas of Maharashtra revealed that it has been cultivated inadvertently on least promising soils, barren lands and even on the hilly terrains (Marathe *et al.* 2006) by digging the pits or trenches of different sizes, and refilling it with topsoil of the concerned site or nearby location. The precise requirement of soil or type of soil material to be used for plantation is still not available. Under such circumstances, the yield potential of pomegranate remains unexplored and suffers from management problems with regard to pest and diseases. Hence, the present investigation was conducted to evaluate the performance of pomegranate under different types of soil using different soil material used for pit filling.

MATERIALS AND METHODS

The field experiment was conducted during 2008 - 2013 at the research farm of National Research Centre on Pomegranate, Solapur, Maharashtra located at 17°65'' N latitude, 75°90'' E longitude and 457 m above mean sea level. The original soil of the experimental field was gravelly, 5-10 cm deep underlain by weathered rock (murrum). With the information available from surveys and soil map of the region, major pomegranate growing soil types in terms of depth, soil texture, stoniness and horizonation were identified. To find out comparative performance of pomegranate under different types of soils with similar climatic and management practices, large trapezoidal pits of 1.5 × 1.5 m top width and 1.2 × 1.2 m bottom width having varied depths were dug in the field. The pits were filled by different types of soil material as it occurs in nature. Some important textural, physico-chemical properties and fertility status of the soil material used for pit filling are mentioned in Table 1 and 2 respectively. The material contained larger proportions (volume) of coarse fragments of weathered rock having montmorillonitic mineralogy, that disintegrated over a period of time. Some important characteristics of the soil material used were as follows:

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pH 7.32 - 8.33, and EC 0.12 - 0.18 dS/m, organic carbon 0.28 - 0.79 %, calcium carbonate 3.09 - 19.24 %, available N 190.0 - 337.3 kg/ha, P 9.5 - 13.0 kg/ha, K 93.3 - 218.9 kg/ha, Fe 1.00 - 2.45 ppm, Mn 3.49 - 8.35 ppm and Cu 1.71 — 3.95 ppm. The experiment was laid out in randomised block design with 11 treatments, 3 replications having 2 plants per unit. The treatments involved refilling of pits with gravelly, light textured soil to a depth of 30 cm (T_1); gravelly, light textured soil to a depth of 60 cm (T_2); sandy loam soil to a depth of 60cm (T_3); loamy soil to a depth of 60 cm (T_4); clayey (black) soil to a depth of 30 cm(T_5); clayey (black) soil to a depth of 60 cm (T_6); clayey (black) soil to a depth of 90 cm (T_7); clayey (black) soil to a depth of 120 cm (T_8); mixture of clayey (black) soil (50%) and river sand (50%) to a depth of 60 cm (T_9); mixture of clayey (black) soil (75%) and river sand (25%) to a depth of 60 cm (T_{10}) and weathered rock (murrum) only (T_{11}). In all treatments 25 kg organic manure was applied in each pit. The pits were planted with 150-days-old saplings of pomegranate cv. 'Ganesh' derived from air-layers and maintained by adopting similar cultivation practices.

Soil samples were collected at the start and end of the experiment, dried and analysed to determine physical and chemical properties and fertility status. The soil texture was measured using international pipette method (Singh 1989). The soil pH, electrical conductivity, calcium carbonate, organic carbon and available N and P were determined following standard procedures (Jackson 1973), while available K using flame photometer. The DTPA-extractable micronutrients, viz. Fe, Mn, Zn and Cu were determined by the method of Lindsay and Norvell (1978) using Atomic Absorption Spectrophotometer (Perkin Elmer, USA make Analyst 400).

Leaf samples were collected from individual plants and washed thoroughly in sequence with water, liquid soap, acidic water and glass redistilled water and dried in shade for four days followed by oven drying at 70 ^{o}C till constant weight. The dried samples were ground, mixed well and used for analysing total N by micro-kjeldhal steam distillation method. The samples were digested in di-acid mixture (Chapman and Pratt 1961) and analyzed for P using Vanadomolybdo phosphoric acid method, K using flame photometer, Ca and Mg by titrimetric method employing disodium salt of EDTA and micronutrients, viz. Fe, Zn, Mn and Cu using Atomic Absorption Spectrophotometer (Perkin Elmer, USA make Analyst 400).

Vegetative growth in terms of plant height and plant spread was recorded in each year. The fruit yield data were recorded both in terms of number (count) and fruit weight basis during the year 2010 and 2013. Total soluble solids (TSS) in juice were measured with hand refractometer, acidity by titration following the procedure of Ranganna (1986). Chlorophyll content in the leaf was measured during 2012 using chlorophyll meter (KONICA MINOLTA SPAD-502) as indicated by SPAD values. Data obtained from the experiment were analysed statistically using analysis of variance (ANOVA). Significance of difference among the treatments effects was tested through 'F' test and critical difference was calculated wherever the results were significant (Panse and Sukhatme 1989).

Incidence of bacterial blight disease (BBD) on the plants was recorded on leaves during August 2009 and June-July 2013 before adopting chemical treatment. Observations on lemon size fruits were taken during August 2013 and infected fruits were removed from the plant to check further spread of disease.

RESULTS AND DISCUSSION

Changes in soil physical and chemical properties

After four year of experimentation, significant influence in different soil properties was observed over initial values (Table 2). Considerable increase in soil pH values were recorded in light soils, probably due to continuous irrigation to the plant which brought salts to the surface of the soil. Clay soils showed little variation probably due to its strong buffering capacity. Considerable increase in organic carbon

Table 1 Initial textural and chemical properties of the soil material used for pit filling

Treatment (Soil material used for pit filling)	Coarse fragments* (> 2.0 mm)	Sand (%)	Silt (%)	Clay (%)	pH	EC (dS/m)	Organic carbon (%)	$CaCO_3$ (%)
Gravelly soil, depth 30 cm	54.6	62.2	22.5	15.3	7.32	0.12	0.44	4.67
Gravelly soil, depth 60 cm	54.6	62.2	22.5	15.3	7.37	0.14	0.38	4.27
Sandy loam soil, depth 60 cm	18.3	74.2	10.0	15.8	7.50	0.14	0.38	3.09
Loamy soil, depth 60 cm	12.8	57.4	22.7	19.9	7.55	0.14	0.52	3.75
Clayey soil, depth 30 cm	8.4	26.6	20.8	52.6	8.02	0.16	0.79	8.79
Clayey soil, depth 60 cm	8.4	26.6	20.8	52.6	7.99	0.17	0.69	7.77
Clayey soil, depth 90 cm	8.4	26.6	20.8	52.6	7.82	0.18	0.62	7.81
Clayey soil, depth 120 cm	8.4	26.6	20.8	52.6	7.82	0.15	0.66	6.31
Mixture of Clayey soil (50%) and river sand (50%), depth 60 cm	8.4	26.6	20.8	52.6	8.33	0.11	0.28	19.24
Mixture of Clayey soil (75 %) and river sand (25%), depth 60 cm	8.4	26.6	20.8	52.6	8.12	0.11	0.56	15.38
Weathered rock (murrum)	78.7	78.3	9.5	12.2	7.70	0.16	0.43	6.61

*Per cent of coarse fragments is in total soil fraction while sand, silt and clay is in remaining portion of soil material

Table 2 Changes in soil chemical properties after four years of experimentation

Treatment	pH		EC(dS / m)		Organic carbon (%)		$CaCO_3$(%)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Gravelly soil, depth 30 cm	7.32	7.85	0.12	0.37	0.44	0.85	4.67	2.69
Gravelly soil, depth 60 cm	7.37	7.85	0.14	0.42	0.38	0.98	4.27	3.46
Sandy loam soil, depth 60 cm	7.50	7.90	0.14	0.41	0.38	0.73	3.09	3.71
Loamy soil, depth 60 cm	7.55	7.88	0.14	0.38	0.52	0.83	3.75	3.54
Clayey soil, depth 30 cm	8.02	8.05	0.16	0.34	0.79	1.12	8.79	9.55
Clayey soil, depth 60 cm	7.99	8.04	0.17	0.41	0.69	0.95	7.77	8.46
Clayey soil, depth 90 cm	7.82	7.93	0.18	0.45	0.62	1.09	7.81	8.07
Clayey soil, depth 120 cm	7.82	7.88	0.15	0.49	0.66	1.39	6.31	10.32
Mixture of clayey soil (50%) and river sand (50%), depth 60 cm	8.33	8.00	0.11	0.30	0.28	0.93	19.24	13.21
Mixture of Clayey soil (75 %) and river sand (25%), depth 60 cm	8.12	7.88	0.11	0.43	0.56	1.43	15.38	12.35
Weathered rock (murrum)	7.70	7.68	0.16	0.58	0.43	0.79	6.61	3.67
CD (P=0.05)		NS		0.051*		0.36*		1.82*

*Significant at 0.01 level

content was observed in all the treatments due to periodical addition of organic manures in the pits. Decrease in calcium carbonate content was observed in light soils, while it increased in heavy, black soils. The lowering of calcium carbonate values in light soils could be ascribed to increased permeability and consequently leaching of salts (Srikant *et al*. 2000).

Clayey soil material had higher pH, EC and organic carbon content compared to light soils. Addition of river sand in the soil material resulted into drastic reduction in organic carbon content and fertility status of the soil materials while highest pH (8.33 and 8.12) values were recorded because of the presence of calcium carbonate nodules in river sand as reflected by high calcium carbon content (19.24 and 15.38 %) in these treatments.

Soil fertility status

Soil fertility as indicated by macro- and micro-nutrient status showed significant variation amongst the treatments (Table 3). After four years of experimentation increase in soil available N content was observed in almost all treatments except in the pits filled with clayey, black soil having depth of 30 and 60 cm. Availability of P also increased while availability of K was exceedingly higher over initial values in all treatments. The farmyard manure contains appreciable quantity of P (0.45%) and K (0.76%). Probably the process of mineralization due to increased biological activities might have increased their availability in soil. The acidulation effect of farmyard manure on applied and native P also enhanced the P availability (Prakash *et al.* 2002). Increased K availability is attributed to direct addition of K through organic manure and solubilisation of K by organic acids besides the reduction in K fixation and release of K due to interaction of organic matter with clay (Bellakki *et al.* 1998). The higher increase observed in heavy, black soils might be due to high nutrient holding capacity of these soils. Similarly, micro-nutrients, viz. Mn, Cu and Zn recorded considerable increase in all treatments. Availability of Fe in the soils remained more or less same and no fixed trend was observed amongst the treatments. Increase in micro-nutrients content was mainly due to addition of organic manure which contains considerable amount of micronutrients. Addition of sand recorded considerable decrease in soil fertility status especially micro-nutrient content in the soil. The higher calcium carbonate content in these treatments might have played vital role for the fixation of these nutrients in the soil. It was also observed that availability of major and micro-nutrients was sufficient in case of pits filled only with weathered rock.

Nutrient content in the leaves

The two years pooled analysis data showed large and significant variations (Table 4) in leaf nutrient content of P (0.12 to 0.17 %), K (1.51 to 1.87 %) and Ca (1.69 to 2.12 %) amongst the treatments. Highest leaf N content was found in the leaves of the plants grown on pits filled with loamy soils and gravelly light soils during the year 2007 and 2010, respectively. The uptake was also better in heavy, black soil filled up to 60 cm soil depth and gravelly loamy soil having 30 cm depth. Good aeration in these treatments might have favoured uptake of these nutrients by the plants. Phosphorus content in the leaves showed highly significant variation during both the years and significantly higher values were observed in the plants grown on clayey, black soils having varied depths. As black soils of central India are rich in potassium bearing minerals, it resulted in higher availability of this nutrient to the plant. Plants grown on clayey, black soil having 120 cm depth had significantly highest calcium content. Magnesium content was consistently non-significant during both the year (2007 and 2010). Mixing of sand in the soil was found to reduce uptake of major nutrients in the leaves. Plants grown on weathered rock (murrum) were found to have sufficient

Table 3 Changes in nutrient availability of major and micro-nutrients after four years of plantation

Treatment	N(kg/ha)	P(kg/ha)	K(kg/ha)	Fe(ppm)	Mn(ppm)	Cu(ppm)	Zn(ppm)
Gravelly soil, depth 30 cm	285.2	24.3	486.5	2.57	14.14	10.10	5.51
Gravelly soil, depth 60 cm	296.6	32.9	494.4	1.77	14.70	9.24	7.72
Sandy loam soil, depth 60 cm	319.1	34.7	557.1	2.06	14.38	10.62	6.66
Loamy soil, depth 60 cm	297.7	40.3	524.4	1.83	16.29	13.31	6.60
Clayey soil, depth 30 cm	290.4	42.6	581.1	1.59	10.00	10.84	4.64
Clayey soil, depth 60 cm	329.8	40.6	761.6	1.39	12.80	12.95	8.06
Clayey soil, depth 90 cm	364.9	43.4	692.2	1.58	15.75	12.67	6.63
Clayey soil, depth 120 cm	367.1	47.1	709.5	1.27	16.15	19.20	6.80
Mixture of clayey soil (50%) and river sand (50%), depth 60 cm	265.9	14.3	497.1	1.49	10.92	13.05	5.03
Mixture of clayey soil (75 %) and river sand (25%), depth 60 cm	325.9	32.7	559.7	1.54	15.67	13.17	5.35
Weathered rock (murrum)	313.8	31.4	449.3	1.43	17.03	13.96	5.92
CD (P=0.05)	27.3*	6.8*	46.1*	0.44*	NS	2.45*	1.9

*Significant at 0.01 level

content of major nutrients in the leaves of pomegranate (Table 4).

Amongst micronutrients, pooled analysis data of Cu (45.5 to 77.9 ppm) and Zn (23.6 to 32.2 ppm) revealed highly significant variation (Table 4) and was highest in the plants grown on gravelly, light soil having depth of 30 cm. Iron and Mn content showed significant variation only during 2010. Highest content of Fe was observed in leaf of the plants grown on gravelly loam soil having depth of 60 cm followed by same soil having 30 cm depth while Mn content was highest in clayey (black) soil having depth of 30 cm followed by clayey soil having depth of 60 cm. In general, it was observed that micronutrients, viz. Fe, Cu and Zn uptake was better under light soil conditions compared to heavy soil which might be due to the fixation of micronutrients by carbonates present in substantial amount in high pH, heavy textured soils (Singh 2000).

Vegetative growth of the plants

During initial years of plantation, rapid increase in plant growth was observed in all treatments (Table 5) which stabilized afterwards due to periodical training and pruning and as a management practice for the control of bacterial blight disease. During 2008-09, significantly highest plant height (252.5 cm) was observed in the plants grown on pits filled with clayey soil having 60 cm depth followed by sandy loam soil having 60 cm depth (248.2 cm). Plant spread was highest (218.0 cm) in loamy soil filled up to 60 cm depth. During 2009-10, no fixed trend was observed amongst different treatments. However, highest plant height (200.3 cm) was observed in the plants grown on loamy soil having depth of 60 cm while average plant spread was highest (230.8 cm) in clayey (black) soil having depth of 60 cm. Earlier studies by Reddy *et al*. (1998) revealed that Jyothi, Ganesh and Raichur-I clones of pomegranate performed well under the Vertisols of Tungabhadra project area in Karnataka.

During 2012-13, plant growth in terms of all the parameters was highest in the plants grown on clayey (black) soil having depth of 60 cm followed by clay textured (black) soil having depth of 30 cm and loamy textured soil having depth of 60 cm. These soils have better water and nutrient holding capacity and shallower depth provides better drainage and well aerated conditions that results into better nutrient availability and its uptake by the plants (Table 3 and 4). With increase in depth of these soils (90 and 120 cm), drastic reduction in growth of plants was witnessed which might be due to poor drainage conditions prevailing in such soils. This is further supported by the fact that increased plant growth was recorded with the addition of the sand in same soils. Though, growth of the plants grown on the pits filled with weathered rock was better during initial years, but after four years of the experimentation, plant growth was significantly low as compared to other soil types. In Uzbekistan, Saidaliev (1985) evaluated 46 varieties of pomegranate and found better performance of some varieties on gravelly soils of Fergana Valley.

For the improvement of drainage conditions of heavy soils, addition of sand to the extent of 50 % was not beneficial as it recorded less growth of the plants. This might be due to lower availability of the nutrients in soil as well as in the leaves (Table 3 and 4). Addition of sand to the extent of 25 % was found beneficial for the growth of the plants. Petrosyan (1984) suggested some agro-techniques like replacement of heavy textured saline-sodic soils with normal soil or filling of 20 cm thick layer of gravels at the bottom of pits or trenches to improve drainage conditions and make them suitable for the cultivation of grapes and other fruit crops under arid hot climatic conditions of India.

Chlorophyll content in the leaves of the plants as expressed by SPAD values significantly varied from 57.75 to 61.92 and was highest in the plants grown in clayey soil having depth of 30 cm, followed by clayey soil mixed with 50 % sand. This might be due to increased uptake of N,

Table 4 Leaf nutrient content of pomegranate plants grown on different soil material (Pooled data of two years)

Treatment	N(%)	P(%)	K(%)	Ca(%)	Mg(%)	Fe(ppm)	Mn(ppm)	Cu(ppm)	Zn(ppm)
Gravelly soil, depth 30 cm	1.66	0.160	1.71	1.81	0.49	111.1	39.7	77.9	32.2
Gravelly soil, depth 60 cm	1.62	0.143	1.63	1.88	0.47	113.1	38.9	70.7	28.4
Sandy loam soil, depth 60 cm	1.63	0.161	1.65	2.12	0.51	107.4	38.5	64.8	29.4
Loamy soil, depth 60 cm	1.56	0.170	1.69	1.81	0.55	105.4	38.7	59.3	26.7
Clayey soil, depth 30 cm	1.58	0.129	1.84	1.51	0.55	112.3	42.2	55.8	28.8
Clayey soil, depth 60 cm	1.67	0.149	1.76	1.69	0.58	106.5	43.6	53.9	28.8
Clayey soil, depth 90 cm	1.57	0.130	1.69	1.85	0.49	101.1	42.0	52.3	29.6
Clayey soil, depth 120 cm	1.60	0.154	1.87	1.97	0.66	104.5	41.7	57.6	30.1
Mixture of Clayey soil (50%) and river sand (50%), depth 60 cm	1.44	0.137	1.72	1.82	0.57	96.0	37.3	38.8	23.6
Mixture of Clayey soil (75 %) and river sand (25%), depth 60 cm	1.52	0.120	1.77	1.74	0.43	102.4	38.8	45.5	29.4
Weathered rock (murrum)	1.45	0.164	1.51	2.02	0.63	101.5	41.9	60.9	26.3
CD (P=0.05)	NS	0.03	0.11*	0.22*	NS	NS	NS	10.4*	2.8*

*Significant at 0.01 level

Mg and Fe (Table 4) which have important role in chlorophyll formation (Shaahan *et al*. 1999). The values were lowest in the plants grown on weathered murrum.

Fruit yield

Yield in terms of number of fruits showed significant variation amongst the treatments (12.0 to 27.7 fruits / plant) and was highest in the plants grown on clayey soils having depth of 30 cm. Yield in terms of fruit weight also followed more or less same trend (Table 5). Fruit yield was equally better in the plants grown on mixture of clay soil (50%) and river sand (50%), clayey soil having depth of 60 cm and loamy soil having 60 cm depth. Clayey soils of central India have very good water and nutrient holding capacity. These soils with shallow depth and better drainage conditions resulted in better nutrient availability and its uptake by the plants (Table 4). Marathe and Bharambe (2007) reported significant relationship between yield of sweet orange fruits with maximum water holding capacity (r = 0.25), infiltration rate (r = 0.227) and cumulative infiltration (r = 0.260) of clayey black soils of central India. Fruit yield was drastically reduced in plants grown on clayey soils having depth of 90 and 120 cm. These types of soils have poor drainage conditions (Gupta and Ranade 1988) which results in poor yield of fruit crops like Nagpur mandarin (Marathe *et al*. 2003). Average weight of fruit

Table 5 Vegetative growth, chlorophyll content and fruit yield of pomegranate grown under different soil types

Treatment	2008-09 (cm)		2009-10** (cm)		July 2012-13*** (cm)		Chlorophyll content (SPAD)	No. of fruits/ plant	Wt. of fruits/ plant (kg)	Average fruit weight (g)
	Plant height	Average Plant spread	Plant height (cm)	Average Plant spread	Plant height (cm)	Average Plant spread				
Gravelly soil, depth 30 cm	216.5	196.8	171.7	196.2	162.5	142.5	58.37	17.0	3.785	222.9
Gravelly soil, depth 60 cm	230.2	190.5	185.5	209.5	161.7	140.0	58.37	18.0	4.185	232.2
Sandy loam soil, depth 60 cm	248.2	195.7	195.0	208.0	165.8	143.8	58.09	17.3	3.980	230.1
Loamy soil, depth 60 cm	238.0	218.0	200.3	216.0	164.2	154.6	60.57	20.0	4.787	240.0
Clayey soil, depth 30 cm	212.2	211.3	180.2	210.7	174.2	152.9	61.92	27.7	6.788	245.5
Clayey soil, depth 60 cm	252.2	205.2	187.0	230.8	178.3	162.5	59.25	20.7	5.242	254.1
Clayey soil, depth 90 cm	232.3	196.0	185.0	206.4	158.3	132.5	59.98	12.0	3.158	263.2
Clayey soil, depth 120 cm	227.5	203.9	196.2	216.9	157.1	133.8	58.01	16.0	3.888	243.2
Mixture of Clayey soil (50%) and river sand (50%), depth 60 cm	210.3	197.6	183.2	215.0	168.5	147.1	59.73	22.7	5.343	236.1
Mixture of Clayey soil (75 %) and river sand (25%), depth 60 cm	235.0	194.6	181.5	226.5	162.5	150.8	58.87	16.7	3.855	231.5
Weathered rock (murrum)	228.7	179.1	193.2	230.5	160.0	127.1	57.75	15.3	3.596	234.9
CD (P=0.05)	24.6	19.3	NS	12.08	NS	19.4	2.45	6.63*	1.53	4.24*

*Significant at 0.01 level; **growth observation after uniform training and pruning to shape up the plants during summer season; ***re-growth after cutting of the plants at ground level during October 2010 due to infestation of bacterial blight disease

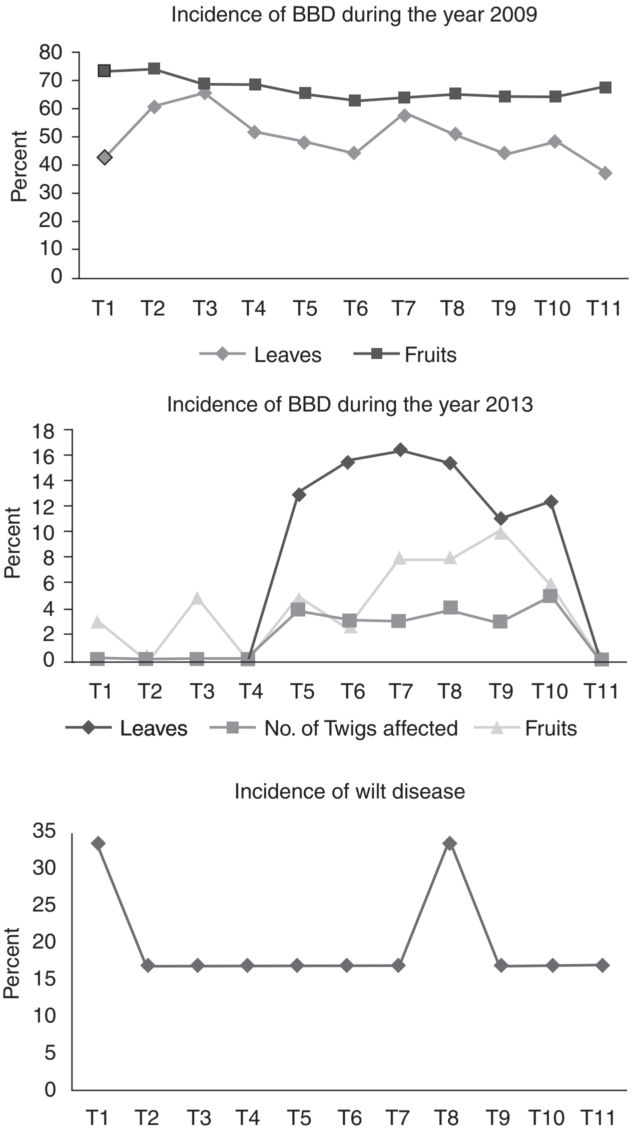

Fig 1 Incidence of bacterial blight (BBD) and wilt disease on pomegranate plants grown under different soils

was highest in the plants grown on black clayey soil up to 90 cm depth. Lower number of fruits with higher plant canopy in this treatment might have resulted in better fruit weight.

Most of the parameters related to quality of fruits revealed non-significant variations except fruit juice recovery, total soluble solids (TSS) and TSS/acid ratio (Data not shown). In general, it was observed that better quality fruits were produced in light soils compared to heavy texture soils.

Disease incidence

During the year 2009, incidence of bacterial blight disease (BBD) occurred on leaves and fruits of all the plants under experimentation. Incidence of BBD on leaves was significantly low in case of the plants grown on weathered rock followed by gravelly soils having depth of 30 cm while it was non-significant in case of fruits. During the year 2013, fruits of the plants grown under most of the treatments were affected with the disease. The leaves of the plants grown on clayey soils as a sole or mixed with sand got infected with the disease (Fig 1). In general, it was observed that the plants grown on heavy soil are more prone to this disease compared to light soils. Very high water holding capacity of these soils might have led to high humidity in the microclimate of the plants which resulted into increased severity of the disease. Incidence of wilt disease was observed in all treatments but no fixed trend was observed. It is reported that wilt, the widespread and destructive disease of pomegranate has been found in mild to severe form in many orchards of all the major pomegranate states of India (Sharma *et al*. 2010).

On the basis of the results of the investigation, it can be concluded that, pomegranate can be successfully grown on extremely shallow, rocky soils by digging wide size pits and re-filling it with clay textured soil, provided the filling depth doesn't exceed 60 cm. The performance was equally well on loamy (generally pond soil) soil. If the filling material is of clay texture, then care should be taken towards the supply of sufficient quantity of micro-nutrient, while in case of light soils, application of macro-nutrients should be monitored. For improvement of drainage conditions in clayey soils, use of river sand to the extent of 25 percent is preferred, above which there was drastic reduction in nutrient availability and uptake by the plants, adversely affecting the growth and yield of pomegranate. Incidence and severity of wilt and bacterial blight disease was higher in the plants grown on clayey soils compared to light soils.

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