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Effects of Various Agro-climatic Factors on Germination and Growth of Jojoba in Pakistan

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Abstract: Jojoba *Simmondsia chinensis* (Link) Schneider is a dioecious, perennial, evergreen woody shrub. The seed of Jojoba contains 40 to 50% oil which has wide uses in cosmetic, lubricant, pharmaceutical, plastic, printing and other industries. The present research investigations revealed that average temperature from 28.80 to 37.76°C gave 62.22 to 78.88% germination of Jojoba seed. Average maximum plant height 113.59 cm followed by 101.96 cm was recorded on silt + clay and Cholistani sand respectively. The plants gained 102.42, 94.19, 81.66 and 57.16 cm height with brackish water concentrations 1000, 4000, 6000 and 8000 ppm, respectively. Increasing salinity level reduced the growth of Jojoba.

Key words: Jojoba, temperature, soil type, brackish water, germination, growth, Pakistan

Introduction

The Agriculture is the backbone of our economy and contributes 26% GDP, 41% foreign exchange and 51% employs of total labour force (Alizai, 1994). Jojoba *Simmondsia chinensis* (Link) Schneider is a dioecious, perennial, evergreen woody shrub and exotic to Pakistan for new industrial raw material. It is unique wild plant species, widely distributed in semi-arid regions of Arizona, California and Baja California (USA) over an area of 2.6×10^8 km^2 between latitudes 25 and 31°N (Benzioni, 1997; Yermanos, 1979). Jojoba seed contain 40 to 50% oil, which is used in cosmetics e.g. lotions, moisturizers, massage oil, smoothing cream, shampoos, gels, lipsticks and nail polishes. There are many potential uses of Jojoba oil in pharmaceutical, plastic, printing and lubricant industries (Benzioni, 1997).

The germination and growth of Jojoba is controlled by various agro-climatic factors e.g. temperature, soil type, salinity level of the soil, water and methods of sowing. In the past some scientists conducted the research on these aspects. Thomson (1982) recorded that mature seeds germinated readily in alkaline sandy media when daily temperature ranged from 80 to 100°F and seeds did not germinated but died at 100 to 110°F. While Anonymous (1985) reported the best Jojoba planting in late spring or early fall when soil temperature was between 21 to 35°C. The good germination 75 to 78% occurred when temperature exceeds from 21 to 35°C as stated by Kuepper (1981). Mann and Muthana (1982) and other researchers like Harsh *et al.* (1987) recommended the sowing of Jojoba in October or February.

Growth behaviour of Jojoba on various types of soil was studied by Anonymous (1985) stated that Jojoba is restricted to well drained coarse and desert soils. Thomson (1982) recorded that Jojoba is very adaptable in its soil requirement, having properties of well drained, coarse, light or medium textured and complete water penetration. Kuepper (1981) and Dunstone (1986) concluded that Jojoba grown in heavier soils exhibit slow growth and develop root problem, so this soil is unsuitable. Benzioni (1997) and Baxter (1998) investigated that best soil profile for Jojoba therefore has good internal drainage.

Some researchers evaluated the growth of Jojoba at different concentrations of brackish water. Anonymous (1985) concluded that Jojoba could tolerate water of low quality. In California Jojoba plants are growing satisfactory with brackish water having 2000 ppm concentration of salts; seedlings are growing without obvious sign of stress (near Salton Sea) and did not observe the reduction of flowers in one variety at 7000 ppm soil water salinity. Tahir *et al.* (1992) recorded that increasing salinity delayed and reduced the germination of Jojoba seeds. Baxter (1998) in Israel concluded that Jojoba can tolerate brackish water upto 800 mS m^{-1}; however increasing salinity level caused the reduction in vigour, growth and production. Jojoba tolerated salinity water very well and was growing satisfactory in Israel as reported by Tremper (1996).

Research activities were initiated in 1987 on imported seeds of Jojoba from USA in Pakistan. These studies were conducted to find out the effect of agro-climatic factors i.e. temperature, soil and brackish water on germination and growth of Jojoba. This was needed and important to prepare production technology in the light of the scientific investigations in Pakistan.

Materials and Methods

Three experiments were conducted during 1996-98 to investigate the effect of temperature, soil type and brackish water on germination and growth of Jojoba at Jojoba Research Station, Bahawalpur.

- To find out the optimum temperature requirement for the germination of Jojoba seed, a trial was laid out, having 12 treatments with three replications in accordance with CRD design. Ten healthy seeds were sown at the end of 2nd week of each month in polythene bags measuring 22 x 9 cm filled with sand and silt (1:1) ratio. The sown seeds were irrigated with sprinkler daily and meteorological data was collected from was collected from the Meteorological Station, Bahawalpur. The germination data was recorded throughout the study and recorded data was analyzed statistically.
- A study was conducted to find out the effect of different types of soils on the growth of Jojoba. There were four treatments i.e. Cholistani sand, river sand, heavy clay and silt+clay (1:1), having ten plants in each treatment per replication. The trial was laid out in accordance with CRD with three replications. The pits were dug and the soil media according to the treatments were filled and the seeds were sown in spring season. During first three months the irrigation was done with the help of sprinkler and after this flood irrigation method was used for irrigation. The data of plant height was recorded and analyzed statistically for comparison.
- An experiment was conducted to investigate the effect of different levels of brackish water on the growth of Jojoba. There were four treatments i.e. 1000, 4000, 6000, 8000 ppm of brackish water that was applied to three plants in each treatment per replication. The experiment was conducted according to CRD with three replications. Different concentrations of brackish water were prepared with the help of sodium chloride (NaCl). The brackish water was applied through pitcher irrigation method and the pitchers were kept filled with brackish water throughout the study. The mouths of the pitchers were covered with plastic sheet tightly to avoid the addition of impurities in brackish water. The data of the plant height was recorded and analyzed statistically.

Results and Discussion

The results recorded on germination of Jojoba seed, growth of Jojoba on various types of soil and with different levels of brackish water are given in Table 1, 2, 3 and 4.

The results given in Table 1 revealed that maximum germination of Jojoba seeds was 78.88, 72.77 followed by 69.44 and 62.44 at average temperature of 36.15, 28.80, 33.97 and 37.76°C respectively. The Jojoba seeds did not germinate at 21.15 and 43.08° C. The findings of the present research tally with Thomson (1982) and Mann and Muthana (1982) who reported 75 to 85% germination at 26.7 to 37.8°C. These results are also in agreement with Harsh *et al.* (1987) who recommended the sowing of Jojoba in February or October.

Table 1: Average percentage germination of Jojoba seed

Treatments	1996	1997	1998	Average
T1= January	00.00	00.00	00.00	00.00f
T2= February	43.33	45.00	53.33	47.22d
T3= March	75.00	71.67	71.66	72.77ab
T4= April	51.67	53.37	35.00	46.66d
T5= May	16.67	13.33	13.33	14.44e
T6= June	00.00	00.00	00.00	00.00f
T7= July	15.00	15.00	18.33	16.11e
T8= August	63.33	61.67	61.66	62.22c
T9= September	78.33	80.00	78.33	78.88a
T10= October	68.33	75.00	65.00	69.44bc
T11= November	46.66	51.66	51.67	49.99d
T12= December	6.67	3.33	3.33	4.44f

Comparison of means by DMRT at 5% level of significance
Means sharing a letter are not statistically different

Table 2: Height of Jojoba plants on various types of soil

Treatments	1996	1997	1998	Total height (cm)
T1= Cholistani sand	15.30	31.00	55.66	101.96
T2= River sand	13.00	28.00	49.33	90.33
T3= Clay soil	11.00	21.33	35.00	67.33
T4= Silt + clay	17.60	35.66	60.33	113.59

Table 3: Height of Jojoba plants at different levels of Brackish water

Treatments	1996	1997	1998	Total height (cm)
T1= 1000 ppm	14.83	38.26	49.33	102.42a
T2= 4000 ppm	12.33	36.20	45.66	94.19a
T3= 6000 ppm	13.66	29.00	39.00	81.66b
T4= 8000 ppm	9.83	20.00	27.33	57.16c

Cd1=8.51 Cd2=12.9

The data recorded regarding growth of Jojoba on various soils is given in Table 2. The Jojoba plants gained maximum height i.e. 113.59 followed by 101.96 cm on silt + clay and Cholistani sand respectively. These achievements tally with Dunstone (1986), Benzioni (1997), Baxter (1998) who reported that the best soils for Jojoba growth had good internal drainage, medium texture i.e. coarse, sandy or gravel soil. The Jojoba gained 90.33 cm height on river sand and 67.33 cm height on clay soil. These findings tally with Yermanos (1979) and Dunstone (1986) who stated slower growth on heavy soil and concluded unsuitable for Jojoba. Silt + clay were found the best soil followed by Cholistani sand for Jojoba in present study.

The data about effect of various concentrations of brackish water is given in Table 3. The results showed that plants gained maximum height 102.42 followed by 94.91 and 81.66 cm with 1000, 4000 and 6000 ppm brackish water respectively. The minimum plant height 57.16 cm was obtained with 8000 ppm brackish water. The present investigations are in accordance with Anonymous (1985), Tremper (1996), Baxter (1998) who recorded the tolerance

Table 4: Average maximum and minimum temperature (°C)

	1996		1997		1998		Average	
Treatments	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
T1= January	21.49	6.02	20.84	5.62	21.13	5.76	21.15	5.80
T2= February	24.24	8.29	24.26	10.10	25.34	9.55	24.61	9.31
T3= March	30.44	14.26	28.00	12.58	27.96	14.25	28.80	13.69
T4= April	33.34	16.43	31.91	16.93	35.79	18.02	33.68	17.12
T5= May	41.52	24.77	42.04	23.13	40.95	21.78	41.50	23.22
T6= June	43.33	26.59	43.89	27.02	42.40	25.37	43.08	26.32
T7 = July	40.07	27.08	38.01	25.91	41.05	27.82	39.71	26.93
T8= August	38.65	26.35	36.66	25.42	37.99	24.96	37.76	25.57
T9= September	36.71	24.63	34.89	23.95	36.87	23.55	36.15	24.04
T10= October	34.77	18.54	33.61	16.80	33.55	19.79	33.97	18.37
T11= November	30.50	13.60	31.30	13.80	30.13	12.33	30.71	13.24
T12= December	25.45	7.14	24.30	8.03	24.00	8.60	24.58	7.92

of salinity up to 7000 ppm and concluded that increasing salinity reduced the vigour and growth of Jojoba.

It is concluded from the present research that various agro-climatic factors i.e. temperature, types of soil and different concentrations of brackish water affect the germination and growth of Jojoba. The results indicate that the best time of sowing are the months of March, August, September and October in Pakistan. The good soil is clay + silt or Cholistani sand for growth of Jojoba. The Jojoba can tolerate brackish water up to 8000 ppm salinity but increasing level of salinity reduces the growth of this plant.

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