Agric Res J **59** (6) : 1159-1163, *December* 2022
DOI No. 10.5958/2395-146X.2022.00161.2

EFFECT OF DIFFERENT ENVIRONMENTS ON YIELD AND YIELD ATTRIBUTES OF SOYBEAN IN PUNJAB

Sumandeep Kaur[1], K K Gill[2*], S K Mishra[3] and S S Sandhu[1]

[1]Department of Climate Change and Agricultural Meteorology,
[2]Communication Centre, Punjab Agricultural University, Ludhiana-141004, Punjab
[3]Regional Research Station, Faridkot - 151203, Punjab

Soybean (*Glycine max* L.) is commonly called as "Golden bean" of 20th century. It is a unique pulse cum oilseed crop but is mostly grown as an oilseed crop in India. It was introduced in India in 1960s and had a great success. Soybean becomes a major crop in very short period in rainfed area. It is world's most important seed legume, which contributes 25 per cent to the global vegetable oil production, about two thirds of the world's protein concentrate for livestock feeding and is a valuable ingredient in formulated feeds for poultry and fish (FAOSTAT, 2013). Commercial utilization of soybean in India is just four decades old. During present time, soybean cultivation as a rainy season crop in rainfed agroecosystem of central and peninsular India has become popular (Aggarwal *et al.,* 2013). In Punjab, soybean crop–emerged as a replacement of rice, and offers a diversifying option (Arora *et al.,* 2011). Diversification of 0.5 million hectare areas under rice by soybean would result in saving of 77500 ha-m of water (Hira *et al.,* 2009).Crop yield is the interaction of crop growth and its microclimate. The radiation interception over the canopy or penetration below the canopy would influence the abortion of reproductive structures in soybean. Wiebold *et al.* (1981) reported that abscission is greatest within the shaded portion of the canopy. Temperature above 40°C causes severe pod abortion in soybean (Mann and Jaworski, 1970). Soil temperature is an important influencing factor for crop production. Planting arrangement and mulching influence the soil and canopy temperature through modifying incoming solar radiation. The effect of planting arrangements of soybean on its micro environments are not reported yet. Therefore, the present piece of work was undertaken with a view to evaluate the change in microclimate due to adoption of different planting methods and mulch.

The field experiment was conducted at the research farm of Department of Climate Change and Agricultural Meteorology, PAU Ludhiana (30° 54′ N latitude and 74° 48′ E longitude and altitude of 247 m above the mean sea level) and research farm of Regional Research Station, Faridkot (30° 40' N and 74°44' E with an elevation of 247m above mean sea level during *kharif* 2018.The cultivar SL 958 was sown under four sowing dates (15th May, 30th May, 15th June and 30th June), mulch application (no mulch and straw mulch) and planting methods (Unidirectional planting (E-W) and bidirectional planting (NS-EW). The treatments were allocated in Split Plot Design in three replications in which dates of sowing and mulch treatment were kept in main plot and planting methods were kept in sub plot. The gross plot size was 5.85m x 2.70 m and the net plot size was 4.85m x 1.70m used for harvest of final yield. The growth parameters (plant height and dry matter) were recorded at 40 days after sowing at 15 days interval. Whereas yield and yield attributes were recorded at harvest time.

Plant height (cm)

The plant height of soybean under different environments at Ludhiana and Faridkot is presented in Table 1.The plant height was significantly affected by treatment like sowing date and mulch application but planting methods showed non-significant effect on plant height of soybean at both locations. The rate of increase in height was rapid during the early growth stages, whereas, it declined as the crop proceeded towards maturity. The plant height under crop sown on 15th May (D1) was maximum at all stages at Ludhiana and Faridkot. However, delay in sowing reduced the plant height.

Plant dry matter (g/m^2)

The dry matter accumulation of soybean under different environments at Ludhiana and Faridkot is presented in Table 2.Crop sown on 15th May produced higher dry matter followed by crop sown on 30th May, which was at par with each other but significantly higher than other sowing dates. Straw mulching also had a significant effect on dry matter. Sowing of soybean on 15thMay produced higher dry matter accumulationand lowest dry matter was recorded when crop sown on 30thJune.

Mulch application was significantly affected the dry matter and it was significantly higher under straw mulch than without mulch at both locations. It might be due to

*Corresponding author : kkgill@pau.edu
Date of receipt: 02.05.2022, Date of acceptance: 31.12.2022

Table 1. Periodic plant height (cm) of soybean under different environments at Ludhiana and Faridkot during *kharif* 2018

Treatment	40 DAS		55 DAS		70 DAS		85DAS		100 DAS		115 DAS		At harvest	
	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK
Date of sowing														
15th May	23.2	24.7	37.2	38.1	62.8	63.7	70.4	70.9	77.1	77.6	79.4	81.4	79.6	81.8
30th May	22.3	24.3	36.9	37.3	60.9	62.8	69.6	69.6	75.9	76.4	78.5	79.8	79.0	80.0
15th June	18.6	18.8	31.9	32.6	50.6	51.9	58.2	58.9	61.9	61.9	62.9	64.9	63.6	65.5
30th June	16.6	17.9	27.1	28.6	46.4	47.5	50.5	52.9	54.9	55.7	58.3	58.2	59.4	59.2
LSD (p=0.05)	2.4	2.1	2.5	2.5	1.9	1.7	2.6	2.4	3	3.1	3	1.7	3.2	1.8
Mulching														
Mulch	21.1	22.3	34.7	35.9	57.8	57.4	63.3	63.9	68.7	68.6	70.8	72.5	71.5	73.1
Non mulch	19.3	20.5	31.8	32.4	52.6	55.6	61	61.8	66.2	67.2	68.7	69.7	69.2	70.3
LSD (p=0.05)	1.7	1.49	1.7	1.8	1.4	1.2	1.8	1.7	2.1	NS	2.12	1.2	2.2	1.3
Planting method														
Unidirectional	19.8	21.5	32.9	33.8	54.9	56.4	61.7	62.5	67.3	67.9	69.5	71.1	70.4	71.8
Bidirectional	20.5	21.4	33.7	34.4	55.5	56.6	62.6	63.1	67.7	67.8	70	71.2	70.3	71.6
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

more plant population, less soil temperature and good moisture content, which favored the development of plant height, and establishment of crop. Planting direction affects the dry matter accumulation significantly after 40 days of sowing. Dry matter production in bidirectional sowing was significantly higher as compared to unidirectional sowing at both locations. Kumar (2005) also observed the same results.

Number of pods per plant

Number of pods per plant is a direct component that contributes to seed yield. Different sowings and mulch treatment at both locations significantly affected the number of pods per plant as shown in Table 3. Highest pod per plant was obtained when crop sown on 15th June followed by crop sown on 30th May being statistically at par with each other at both locations.

Table 2. Periodic dry matter (g m^{-2}) of soybean under different environments at Ludhiana and Faridkot during *kharif* 2018

Treatment	40 DAS		55 DAS		70 DAS		85DAS		100 DAS		115 DAS		At harvest	
	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK
Date of sowing														
15th May	260.8	269.5	417.3	426.0	630.3	652.0	1095.4	1143.2	1673.5	1738.8	1882.2	1917.0	1956.1	2008.3
30th May	252.2	256.4	404.2	412.9	617.2	639.0	1065.0	1121.5	1577.9	1617.0	1843.1	1877.9	1917.0	1969.2
15th June	191.6	195.6	304.2	312.9	508.6	556.4	991.1	1025.8	1477.9	1486.6	1730.1	1756.1	1790.9	1838.8
30th June	178.2	173.9	286.9	295.5	482.5	499.9	904.1	938.9	1425.8	1447.5	1599.6	1638.8	1673.5	1730.1
LSD (p=0.05)	39.1	30.4	56.5	73.8	36.9	32.1	99.9	95.6	65.2	73.8	104.3	82.5	121.7	134.7
Mulch Application														
Mulch	234.7	239.1	378.2	386.8	591.1	612.9	1051.9	1095.4	1595.3	1625.7	1821.3	1851.8	1903.9	1904.0
Non mulch	208.6	204.3	326.0	334.7	530.3	560.7	973.7	1017.2	1482.3	1517.1	1708.3	1743.1	1764.8	1817.0
LSD (p=0.05)	26.1	21.7	39.1	52.1	26.1	22.6	69.5	66.5	47.8	52.1	73.8	60.8	82.5	95.6
Planting Methods														
Unidirectional	213.0	213.0	330.4	334.7	534.6	560.7	978.0	1017.2	1499.7	1534.4	1712.7	1747.4	1773.5	1825.7
Bidirectional	230.4	234.7	378.2	386.8	586.8	608.5	1051.9	1095.4	1577.9	1612.7	1817.0	1838.7	1890.9	1925.7
LSD (p=0.05)	NS	NS	26.1	34.3	30.4	24.7	60.8	40.8	34.7	47.8	60.8	52.1	95.6	91.2

Yield attributing characters

Number of pods per plant was lesser in crop sown on 15th May that may be due to the heavy rainfall at time of flowering at Ludhiana and whereas, lowest number of pod per plant was obtained in crop sown on 30th June (D4) at Faridkot due to delay in sowing. Rahman (2006) also found reduction in number of pods with delay in sowing. Straw mulch significantly improved the number of pods per plant as compared to without mulch that might be due to moisture conservation. However, planting method non significantly affected the number of pods per plant. Ravinder *et al.* (1997) reported mulching significantly improved the pods per plant.

Number of branches per plant

The data of number of branches under different treatments is presented in the Table 3. Date of sowing significantly affected the number of branches per plant. Significantly highest number of branches per pod was recorded when crop was sown on 15th May. Significantly lower branches per plant were recorded when crop was sown 30th June. Branches per plant decreased significantly with delayed sowing at both locations and comparatively higher number of branches was recorded at Faridkot than at Ludhiana under all sowing dates that might be due to prevailing weather conditions. However, mulch application and planting methods showed non-significant effect on the number of branches per plant at both locations.

Number of seed per pod

Date of sowing and mulch application had a significant effect on seed number per pod. Highest seed number per pod was observed when crop was sown on 15th May followed by 30th May which were statistically at par with each other. Lowest seeds per pod were recorded under the crop sown on 30th June. The seed number per pod decreased with delay in sowing that may be due to prevailing weather conditions during seed development. Straw mulch also significantly improved the number of seed per pod at both locations as it might counters the moisture stress during pod filling stage as compared to without mulch. Planting methods had non significant effect on seed number per pod (Singh *et al.*, 2014).

Hundred grain weight (g)

The 100 grain weight was significantly affected by dates of sowing at both locations. Highest 100 grain weight was obtained from the crop sown on 15th May at both locations that might be due to optimum environmental conditions. The early sown crop recorded highest grain weight due to longer duration and sufficient time for the growth and end pod stage, which enabled the plant to produce bold seeds. Late sowings decreased the effective rate of pod filling and shortened the effective duration of pod filling compared to earlier sown crop. Yari *et al.* (2013) also reported reduction in grain weight under delayed sowing. Straw had non-significant effect on 100 grain weight and increase in 100 grain weight was observed under straw mulch as compared to without mulch. Planting methods showed non-significant effect on 100 grain weight.

Table 3. Yield attributes of soybean crop under different date of sowing, mulching treatment and planting methods at Ludhiana and Faridkot

Treatment	Number of pod per plant		Number of branches per plant		Number of grains per pod		100 grain weight(g)	
	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK
				Date of sowing				
15th May	49.6	64.1	7.5	7.8	2.51	2.51	11.0	11.3
30th May	64.7	72.7	5.3	6.5	2.49	2.48	10.9	11.3
15th June	69.3	74.6	5.2	6.0	2.44	2.49	10.1	10.9
30th June	52.8	59.1	4.0	5.4	2.40	2.36	9.9	10.0
LSD (p=0.05)	4.1	6.5	1.7	1.2	0.07	0.04	0.9	0.7
				Mulch Application				
Straw Mulch	63.4	70.0	5.7	6.5	2.49	2.48	10.5	10.8
no mulch	54.8	65.2	5.3	6.3	2.43	2.44	10.4	10.9
LSD (p=0.05	2.9	4.6	NS	NS	0.05	0.03	NS	NS
				Planting methods				
Unidirectional	59.2	69.7	5.7	6.1	2.46	2.47	10.8	10.7
Bidirectional	58.9	65.5	5.3	6.7	2.46	2.45	10.2	11.1
LSD (p=0.05	NS	NS	NS	NS	NS	NS	NS	NS

Biological yield

The data revealed that biological yield was significantly affected by the sowing time, mulch treatment and planting methods at both locations (Table 4). The maximum biological yield was recorded under the crop sown on 30th May at both locations. At both locations, biological yield was significantly decreased with delay in sowing. Lowest biological yield was obtained when crop was sown on 30th June. Nath *et al.* (2017) also reported decrease in biological yield with delay in sowing time. Higher plant height, plant population, dry matter, number of branches were positively correlated with the biological yield. Amongst the locations, maximum biological yield was recorded at Faridkot that might be due to prevailing weather conditions which was favorable for the crop growth. Crop sown with straw mulch produced higher biological yield as compared to without mulch at both locations. Sandhu *et al.* (2011) also observed the increase in biological yield with use of mulch. Under planting methods, bidirectional planting produced significantly higher yield than uni directional planting.

Straw yield

The data of straw yield are presented in Table 4. The data revealed that straw yield was significantly influenced by different treatments at Ludhiana and Faridkot. The sowing dates significantly affected the straw yield. Highest straw yield was obtained when crop was shown on 15th May and 30thMay at Ludhiana and Faridkot, respectively. This might be due higher vegetative growth and number of branches. However, crops sown on 15th May, 30th May and 15th June were statistically at par with each other at both locations. Late sown crop (30th June) produced significantly lowest yield at both locations.

Rajput and Shrivastava (1999) also showed decrease in straw yield with delay in sowing. Straw mulch significantly increased the straw yield than without mulch at both locations .Straw yield was affected by growth parameters like plant height, dry matter that are improved by mulching through lowering of soil temperature and conservation of soil moisture. Unidirectional planting produced significantly lower yield than bidirectional planting at both locations.

Grain yield

The grain yield of soybean was significantly affected by the sowing dates, mulch application and was non-significantly affected by the planting methods. The grain yield recorded under different treatments at Ludhiana and Faridkot has been presented in the Table 4. The significantly highest yield was obtained at Ludhiana when crop was sown on 15th June and lowest yield was recorded in crop sown on 30th June. Grain yield under early sowing was decreased as the flowering period coincided with heavy rainfall that significantly reduced the seed yield. However, highest grain yield at Faridkot was obtained when crop was sown on 30th May followed by the crop sown on 15thJune both being statistically at

Table 4. Biological yield, straw yield, grain yield and harvest index of soybean crop under different treatments at Ludhiana and Faridkot during *Kharif* 2018

Treatment	Biological yield (q/ha)		Straw yield (q/ha)		Seed yield (q/ha)		Harvest index (Per cent)	
	LDH	FDK	LDH	FDK	LDH	FDK	LDH	FDK
Date of sowing								
15th May	47.1	55.4	36.7	37.4	10.4	16.6	22.7	33.9
30th May	48.6	56.8	35.8	35.3	12.7	18.0	26.2	36.4
15th June	46.5	54.5	31.4	34.4	15.1	19.8	32.7	36.6
30th June	29.9	34.2	20.8	19.5	9.2	14.7	30.7	44.4
LSD(p=0.05)	4.4	8.2	5.0	8.0	1.7	2.6	5	6
Mulching								
Straw mulch	46.4	55.5	33.7	35.9	12.8	18.5	27.8	36.7
Non mulch	39.6	44.5	28.8	27.4	10.9	16.1	28.4	38.9
LSD(p=0.05)	3.1	5.8	3.6	5.6	1.2	1.8	NS	NS
Planting methods								
Unidirectional	40.8	44.9	29.4	26.8	11.5	17.1	28.7	40.1
Bidirectional	45.2	55.3	32.9	36.5	12.2	17.5	27.5	35.6
LSD(p=0.05)	1.9	5.7	2.5	5.8	NS	NS	NS	NS

par with each other.

Bhatia *et al.* (2000) also found the decrease in grain yield by delay in sowing time. It decreased due to lack of sufficient vegetative growth, lower number of pods per plant, grain weight, seed number per pod (Jasani *et al. ,*1994), which ultimately resulted in lower seed yield. Highest yield was obtained at Faridkot than Ludhiana that might be due to the normal weather conditions at Faridkot during *kharif* 2018. Mulch application significantly increased the grain yield at both locations by increasing number of pods per plant and higher plant population contributed to higher seed yield.

Harvest index

Harvest index under different treatments at both locations was calculated and is presented in Table 4. The harvest index was significantly affected by the sowing dates whereas, mulch application and planting methods had a non significant effect on harvest index. Highest harvest index was obtained when crop was sown on 15th June followed by 30th June both being statistically at par with each other. At Faridkot, higher harvest index was obtained when crop was sown on 30th June. Harvest index improved with delay in sowing which might be due to better source sink relationship (Singh *et al.*, 2014).

Authors' contribution

Conceptualization of research work and designing of experiments (KKG); Execution of field/ lab experiments and data collection (SK);Analysis of data and interpretation (SKM, SSS);Preparation of manuscript (SK, KKG)

LITERATURE CITED

Agarwal D K, Billore S D, Sharma A N, Dupare B U and Srivastava S K (2013) Soybean Introduction, improvement and utilization in India – problems and prospects. *Agric Res* **2(4):** 293-300

Arora V K, Singh C B, Sidhu A S and Thind S S 2011 Irrigation, tillage and mulching effects on soybean yield and water productivity in relation to soil texture. *Agric Water Manage* **98:** 563-68

Bhatia V S ,Tiwar S P and Joshi A P 2000 Yield and its attributes as affected by planting dates in soybean *(Glycine max)* varieties. *Ind J Agric Sci* **69 (10):** 296-99.

Hira G S 2009 Water management in northern states and food security of India. *J Crop Improvement* **23:** 136-57.

Jasani K P, Patel M P and Patel H S 1994 Response of soybean to date of sowing and seed rate on yield and qualities. *Gujarat Agril Univ Res J.***19:** 108-10

Kumar N 2005 *A study on radiation and thermal use efficiency in barley genotypes (Hordeumvulgare L) under two row orientations* M.Sc. Thesis CCS Haryana Agricultural University, Hisar

Rahman M M, Rahman M M and Hussain M M 2013 Effect of sowing date on germination and vigour of soybean (*Glycine max*) seeds. *The Agriculturists* **11(1):** 67-75

Yari V, Frnia A, Maleki A, Moradi M, Naseri R, Ghasemi M and Lotfi A 2013 Yield and yield componentsof soybean cultivars as affected by planting date. *Bull Env Pharmacol Life Sci* **2(7):** 85-90.

Ravinder K, Srivastava B K and Kumar R 1997)influence of different mulch material on flowering and fruit setting of winter tomato. *Crop Res Hisar* **15 (2-3):**196-98.

Rajput R L and Shrivastava U K 1999 Influence of varieties sowing date and seed rate on physiological parameters and grain yieldof soybean *[Glycine max (L.)* Merrill]. *Legume Res* **22 (7)**: 117-20.

Guriqbal Singh, Harpreet kaur ,and K K Gill 2014 Influence of diverse environments on the growth and productivity of soybean genotypes in Northern India. *Soybean Res* **12**: 60-66.

Mann J D and Jaworski E G 1970 Comparison of stresses which may limit soybean yields. *Crop Sci* **10**: 620-24.

Wiebold W J, Ashley D A and Boerma H R 1981 Reproductive abscission levels and patterns for eleven determinate soybean cultivars. *Agron J* **73**: 43-46.