CROP WEATHER RELATIONSHIP OF SOYBEAN VARIETIES UNDER DIFFERENT DATES OF SOWING IN CHHATTISGARH PLAIN ZONE

Deepanshu Mukherjee*, R. Singh, R. Lakpale and J.L. Chaudhary

College of Agriculture, IGKV, Raipur (C.G.) 492012

Received-12.10.2015, Revised-20.10.2015

Abstract: Soybean (*Glycine max* (L) Merril.) is one of the leguminous oilseed crops in tropical and sub-tropical regions of India and is one of the classical short day plants and most of its genotypes respond as quantitative short day plant. Soybean varieties "JS-93-05", JS-9752, and JS-335 were grown as a test crop and recommended dose of nitrogen, phosphorus and potassium *i.e.,* 20:60:40 kg ha-1, respectively. The crop was shown on 10 June, 20 June and 30 June 2014 after the onset of monsoon maintaining spacing of 30 cmX10 cm using a certified seed rate of 75 kg ha-1. At 25 DAS, significantly higher dry matter observed under D1 (10 June) which was found at par to D3 (30 June). Maximum crop growth rate was found in 10 June and the lowest crop growth rate was observed in 20 June. Highest accumulated growing degree day, Accumulated Photo thermal units (PTU), Accumulated Helio thermal units (HTU) and heat use efficiency was observed under 10th June sown variety JS-9752 at maturity stage (2057.2) and the lowest GDD recorded with variety JS- 335 under D3 (30 June) (1615.8).

Keyword: Soybean varieties, Oil seed crops, Weather

INTRODUCTION

Soybean (*Glycine max* (L) Merril.) is one of the leguminous oilseed crops in tropical and sub-tropical regions of India. It is a short duration and thermosensitive crop and its response to yield varies with variety and temperature. This crop is successfully grown in *Kharif* as well as in rabbi/summer, where adequate irrigation facilities are available. India has made impressive progress in agriculture during the last three decades, culminating in self-sufficiency in cereals and made good efforts in increasing the production and productivity of pulses and oilseeds crops. Soybean (*Glycine max* L.) ranks first amongst oilseed crops in the world and is also known as the wonder crop of the twentieth century. It contributes nearly 25 per cent of the world's total oil and fat production. Soybean is a World's first rank crop as a source of vegetable oil and the cheapest source of vegetable oil and protein having 40 per cent protein well balanced in essential amino acids, 20 per cent oil rich with poly unsaturated fatty acids specially Omega 6 and Omega 3 fatty acids, 6 to 7 per cent total mineral and 5-6 per cent crude fibre (Chauhan *et al.,* 1988). The protein quality of soybean is equivalent to that of meat, milk products and eggs. It is generally grown as a rainy season crop under rainfed situation predominantly in *Vertisols* and associated soils. In India, soybean occupies an area of 12.2 m ha with production potential of 11.95 million tonnes and average productivity of 979.3 kg ha-1 (Anonymous, 2013a). The productivity of soybean is less in India as compared to world average (2484.1 kg ha-1). Global area and production of soybean is 111.27 m ha and 276.4 million tonnes respectively (Anonymous, 2013b). The major soybean producing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh and Karnataka (Anonymous, 2013). In Chhattisgarh, agriculture is mainly based on rain water, therefore most of the crops are grown as rainfed in *kharif* season. Soybean occupies 159.59 thousand ha area with a yield of 1150 kg ha-1 (Anonymous, 2015) growing in districts like Rajnandgaon, Durg, Mungeli, Bemetara and Kabirdham. Optimum temperature for germination of soybean is approximately 30^{o}C with base temperature of 10^{o}C (Ghadekar, 2001). Soybean is one of the classical short day plants and most of its genotypes respond as quantitative short day plant. The variation of photo period sensitivity among soybean genotypes allows the crop to grow successfully across a wide range of latitudes. Photo period influences the rate of development during pre and post flowering stages. Changes, in photoperiod and temperature are reported to alter the happening of growth stages, the growth and partitioning of dry matter of this photoperiod and thermosensitive short day C3 crop (Lawn, 1989).

MATERIAL AND METHOD

The field experiment was carried out in FRBD with three replications at Research and Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur situated in Eastern Central part of Chhattisgarh at latitude of 21^{0}16' N, longitude 81^{0}36' E and altitude 289.5 m above mean sea level. The general climatic condition of Raipur is classified as sub humid with mean annual rainfall of about 1175 mm out of which 87 per cent (1023.0 mm) received during monsoon (June to September). During *Rabi*, (December to

*Corresponding Author

February) only 33.8 mm of rainfall is received and hence, rice is mostly grown under rainfed conditions. Maximum and minimum temperatures range between 24.4^{0}C and 42.6^{0}C and 10.0^{0}C and 27.5^{0}C (1 SMW and 22 SMW). Atmospheric humidity is normally higher during June to September and thereafter, decreases during *Rabi* with increased sunshine hours. Atmospheric humidity is normally higher during June to September and thereafter, decreases during *Rabi* with increased sunshine hours. The soil of the experimental field was silty clay loam in texture, neutral in reaction (pH 6.9), low in available N (242 kg/ha), medium in available P (13.6kg/ha) and high in K (250 kg/ha) (Subbiah and Asija, 1956; Jackson, 1967; Olsen *et al*., 1954 and Black, 1965.). Soybean varieties JS-93-05, JS-97 52, and JS-335, JS-97-52 and JS-335 were grown as a test crop. Recommended dose of nitrogen, phosphorus and potassium *i.e.*, 20:60:40 kg ha-1, respectively were applied through urea, single super phosphate and muriate of potash as basal in rows and fertilizer were drilled in furrow. The crop was shown on 10 June, 20 June and 30 June 2014 after the onset of monsoon. The row and plant spacing was 30 cm X 10 cm using a certified seed rate of 75 kg ha-1. Plant height at an interval of 15 days after sowing (DAS) and dry matter accumulation plant^{-1} at 15 days after sowing (DAS) up to harvest. Number of pods plant^{-1}, Number of seeds pod^{-1}, Test weight (100-seed weight), Seed yield (kg ha^{-1}), Stover yield (kg ha^{-1}) , Leaf area and leaf area index (LAI) (Tandaleand Ubale, 2007), Crop growth rate (g plant -1 day-1), Relative growth rate (g plant^{-1} day^{-1}) (Leopold and Kridemann, 1975), Heat units like Growing degree days, Photothermal Unit (PTU), Heliothermal Unit (HTU), Heat Use Efficiency (HUE), Radiation Use Efficiency (RUE), statistical analysis as per the procedure laid down by Panse and Sukhatme, (1967).

RESULT AND DISCUSSION

Dry matter accumulation and LAI

Dry matter accumulation of soybean was observed at 25, 65 and 95 DAS and the same was presented in Table 1. In general, dry matter accumulation increased throughout the crop growth period. At 25 DAS, significantly higher dry matter observed under D1 (10 June) which was found at par to D3 (30 June) and minimum dry matter accumulation observed under treatment D2 (20 June) as compared to other dates of sowing. As regard to varieties, significantly the maximum dry matter accumulation observed under V3 (JS- 335), however, it was found comparable to V1 (JS- 9752). At 35 DAS, dry matter accumulation of soybean was found unaffected due to date of sowing and as regard to varieties, maximum dry matter accumulation observed in variety V1(JS- 9752), however, it was found comparable to variety V3 (JS- 335). At 50 DAS, significantly maximum dry matter observed under D1 (10 June) which was found at par to D2 (20 June) with minimum dry matter accumulation under treatment D3 (30 June) and same trend was observed leaf area index (Kumar *et al.*,2008a). The varieties JS-9752 yielded maximum under D1 (10 June)

Crop growth rate (g plant-1 day-1)

The data presented in Table 1 showed crop growth rate of different varieties and the values of crop growth rate were fluctuating during different stages. At 25 DAS, significantly maximum crop growth rate was found in 10 June and the lowest crop growth rate was observed in 20 June. At 20-35 DAS, crop growth rate was significantly highest in 20 June and the lowest found in 10 June. At 35-50 DAS, crop growth rate is highest in 10 June and lowest found in 30 June. At 50-65 DAS, the result was found non-significant. At 65-80 DAS, crop growth rate was significantly higher in 20 June and lowest value found in 30 June. At 80- 95 DAS, the crop growth rate was maximum in 10 June which is comparable with 30 June and the lowest value was found in 20 June. Among the different varieties at 0-25 DAS, the highest crop growth rate was found in V3- JS 335 which was found comparable with V1- JS 9752 and the lowest value was found in V2- JS 9305. The same trend was also found in 20-35 DAS. At 35-50 DAS, the highest crop growth rate was found in V1 (JS 9752) which was significantly superior over V2 (JS 9305) and V3 (JS 335). At 50-65 DAS, 65-80 DAS and 80-95 DAS, the crop growth rate was found non-significant.

Relative growth rate (g plant-1 day-1)

The values of relative growth rate were higher for the varieties sowing on 10th June as compared to the crop sown on 20th June and 30th June Table 1. In 10 June the relative growth rate was highest up to 0-25 DAS, then after decrease in 50-65 DAS and it was slightly decreased in 80-95 DAS and then after RGR value was found negligible in remaining all period of observation. In 20th June the crop growth rate was showed fluctuated during in different growth stages the RGR was maximum in between 50-65 DAS and similar trend also found in 30th June. Among the different varieties, maximum relative growth rate was found during 0-25 DAS under the variety V1 (JS-9752) and lowest found in V2 (JS-9305). The similar trend also found in rest of the period then after the relative growth rate was no significant differences.

Yield attributes and yield

Pods plant^{-1}, Seed Pod^{-1} and test weight were observed at harvest of crop and the same is presented in Table 2. Significantly maximum pods plant^{-1} was observed under D1 (10th June) which was found at par to D2 (20 June) as compared to other sowing date. As regard to varieties, significantly higher seed pod^{-1} observed under V1 (JS-9752) followed by V2

(JS-9305) and V3 (JS- 335). Higher test weight of soybean seed was recorded under JS-9752 (9.97g) as compared to the test weight of JS-9305 (9.76g) whereas, JS-335 (8.94g) recorded inferior test weight among all the varieties. Among the different sowing dates significantly higher test weight was found under 10th June sowing (9.93g) and was found comparable over 20th June sowing (9.44g) and both were superior over 30th June sowing (9.28g). Similar results were obtained by Ahmad *et al.* (2010). Number of seed per pod is an objective which is depended on genotype and it is independent of environmental factors by Yari *et al.* (2013). Similar results were also obtained by Deokar *et al.* (2009). Zargar *et al.* (2011) who concluded that delayed planting dates can accelerate flowering, shorten vegetative and reproductive growth, reduce grain yield and oil content of soybean (Sadeghi *et al.*, 2013). Also in other studies, the planting delay decreased the yield. Interaction effect of date of sowing and varieties revealed that varieties JS-9752 yielded maximum under D1 (10 June), however it was found comparable with D2 (20 June) and JS-9305 with D1 (10 June) and D2 (20 June). Significantly minimum seed yield obtained with variety JS-335 under D3 (30 June) (Table 2). Higher seed yield of soybean with the crop sown up to 10 June were also reported by Jasani *et al.* (1993), Singh *et al.* (2007) and Kumar *et al.* (2008b), Yari *et al.*, (2013a) reported that planting date is one of the most effective non-economic factors on the optimal operation of the plant cultivated. Due to the short duration of grain effecting period, seed reserve amount is also reduced, which will result in reduced 1000 seed temperatures during the days can also lead to the decrease of reserve and as result, in the cases mentioned above are reason for the reduced ultimately seed yield. Yari *et al.*, (2013b) reported that seems to be due to a delay in planting date because reduced. V1 (JS 9752) varieties planted on 10 May that was able to grow very well and be able to have more grain number and had grain with weight more than those with other cultivars that may increase the yield of the cultivars in this variety V1 (JS-9752) (Baisakh and Dash, 1992). Significantly maximum stover yield (kg ha^{-1}) observed under D1 (10 June) which was found at par to D2 (20 June) and minimum under treatment D3 (30 June) as compared to other date of sowing. As regard to varieties, significantly maximum stover yield (kg ha^{-1}) observed under V1 (JS-9752). However, it was found comparable to V2 (JS-9305) and minimum stover yield (kg ha-1) observed under treatment V3-(JS- 335). Harvest Index was found significantly differed as in yield and yield attributing characters.

Effects of heat units

Accumulated Growing degree days (GDD)

Different soybean varieties responded differently in terms of accumulated GDD at the time of maturity. Highest accumulated growing degree day was observed under 10th June sown variety JS-9752 at maturity stage (2057.2) and the lowest GDD recorded with variety JS- 335 under D3 (30 June) (1615.8). In case of JS- 9752 highest accumulated growing degree day was noticed under 10th June sowing (2057.2) followed by 20th June sowing (1726.3) and 30th June sowing (1652.5). Similarly in JS-9305 higher accumulated growing degree day was observed at maturity under 10th June sowing (1982) followed by 20th June (1652.5) and 30th June sowing (1615.8). Among the variety (JS-335) was found that the highest accumulated growing degree day under 10th June sowing (1928.1) followed by 20th June sowing (1615.8). In general, the accumulated growing degree day values decreased when the sowing was delayed from 10th June, due to early maturity of crops under delayed sowing condition because of higher temperature at maturity. These results are in general agreement with the findings of Kumar *et al.* (2008b). Almost same trend was observed at different stages of observations i.e. emergence, 50% flowering, 100% flowering and pod formation.

Accumulated Photo thermal units (PTU)

Different varieties responded differently in terms of accumulated photo thermal units at the time of maturity. Highest accumulated photo thermal unit was observed under 10th June sowing of all varieties Table 3. The highest accumulated photo thermal unit value was observed by JS-9752 under 10th June sowing (26566) followed by 20th June sowing (22258) and 30th June sowing (21147). Among the variety, by JS- 9305 maximum accumulated photo thermal unit was observed under 10th June sowing (25641) followed by 20th June sowing (21351) and 30th June sowing (21133). Similarly accumulated photo thermal unit value was observed by JS- 335 under 10th June sowing (24978) followed by 20th June sowing (21823) then 30th June sowing (21133). It can be interpreted that from different sowing dates that higher PTU values were recorded with the crop sown on 10th June which decreased gradually with a delay in sowing (Sharma *et al.*, 1991).

Accumulated Helio thermal units (HTU)

The data pertaining to accumulated helio thermal unit due to different dates of sowing varieties of soybean are presented in Table 3. Helio thermal unit (HTU) of soybean varieties under different sowing dates varied considerably at maturity variety JS-9752 recorded that highest accumulated helio thermal unit observed under 10th June sowing (16978.3) followed by 20th June sowing (14373.2) then 30th June sowing (13774.6) similar result obtained by Barik and Sahoo (1989). Among the varieties JS- 9305 observed highest accumulated helio thermal unit

under 10th June (16250), followed by 20th June sowing (13866.9) and 30th June sowing (13794.3) at maturity. Similarly the variety (JS-335) observed maximum accumulated helio thermal unit under 10th June sowing (15942.7), followed by 20th June sowing (14135.7), then 30th June sowing (13794.3) at maturity (Ramesh and Gopalaswamy, 1992)

Heat use efficiency (g m-2 day-1)

Heat use efficiency (HUE) for three soybean varieties under different dates of sowing are presented in Table 4.13. Higher heat use efficiency was observed that is variety JS-9752 under 10th June sowing (0.19g m-2 day-1) closely followed by 20th June sowing (0.14g m-2 day-1) followed by 30th June sowing (0.10g m-2 day-1). Similarly JS- 9305 variety recovered maximum heat unit efficiency observed in 10th June sowing (0.15g m-2 day-1) followed by 20th June (0.14g m-2 day-1) and 30th June sowing (0.09g m-2 day-1). Variety JS-335 recovered maximum heat unit efficiency was found for 10th June sowing (0.17g m-2 day-1) followed by 20th June sowing (0.15g m-2 day-1) and 30th June sowing (0.10g m-2day-1). Maximum heat unit efficiency was found with variety JS- 9752 for D1-10th June (0.19g m-2 day-1). Similar results were also reported by Singh *et al.* (2007).

Radiation use efficiency (g MJ-1)

Radiation use efficiency (RUE) of different soybean genotypes under different dates of sowing varied considerably and was shown in Table 3. The data revealed that (JS- 9752) exhibited higher radiation use efficiency under 10th June sowing (0.87gMJ-1) followed by 20th June sowing (0.73 gMJ-1) and 30th June sowing (0.56 gMJ-1). Similarly among the varieties JS-9305 recovered the highest radiation use efficiency which has been observed in 10th June sowing (0.69 gMJ-1) followed by 20th June (0.69 gMJ-1) and 30th June (0.51 gMJ-1). Among the genotypes JS- 335 gave maximum radiation use efficiency which was found in 10th June sowing (0.76 gMJ-1), followed by 20th June sowing (0.75 gMJ-1) and 30th June sowing (0.54 gMJ-1). Highest radiation use efficiency was observed under 10th June sowing by all the varieties. Higher radiation use efficiency in 10th June sowing might be due to better conversion of light in to dry matter, better yield component and harvest index in 10th June. Similar results were reported by Singh *et al.* (2007) and Kumar *et al.* (2008b). The RUE value decreased due to delay in sowing (Kumar, 2008). Similar results have been recorded to Souza *et al.* (2009). The duration for emergence, 50 per cent flowering, 100 per cent flowering, pod formation and physiological maturity of three soybean varieties was investigated and different Dates of sowings.

Table 1. Dry matter accumulation (g plant -1) of soybean varieties at different interval under different sowing dates

Treatments	Dry matter accumulation (g plant -1)			Leaf area Index			Crop Growth Rate (g plant -1 day -1)			Relative Growth Rate (g plant -1 day -1)		
	25 DAS	65 DAS	95 DAS	25 DAS	65 DAS	95 DAS	0-25 DAS	50-65 DAS	80-95 DAS	0-25 DAS	50-65 DAS	80-95 DAS
Date of sowing												
D1 – 10 June	2.58	7.21	9.55	0.275	0.774	0.554	0.129	0.067	0.078	0.020	0.004	0.004
D2 – 20 June	2.00	5.91	8.85	0.291	0.758	0.555	0.100	0.049	0.047	0.015	0.004	0.002
D3 – 30 June	2.04	5.18	6.58	0.295	0.541	0.528	0.102	0.040	0.061	0.015	0.004	0.004
SEm±	**0.062**	**0.121**	**0.088**	**0.012**	**0.010**	**0.015**	**0.003**	**0.010**	**0.008**	**0.001**	**0.001**	**0.000**
CD(P=0.05)	**0.186**	**0.361**	**0.264**	**0.035**	**0.031**	**NS**	**0.009**	**NS**	**0.023**	**0.002**	**NS**	**0.001**
Varieties												
V1 – JS – 9752	2.28	6.75	8.87	0.26	0.70	0.55	0.11	0.04	0.05	0.02	0.02	0.00
V2 – JS – 9305	1.96	5.51	7.74	0.32	0.67	0.53	0.10	0.05	0.06	0.01	0.01	0
V3 – JS – 335	2.38	6.05	8.39	0.29	0.70	0.55	0.12	0.06	0.07	0.02	0	0.01
SEm±	**0.062**	**0.121**	**0.088**	**0.012**	**0.010**	**0.015**	**0.003**	**0.010**	**0.008**	**0.001**	**0.001**	**0.000**
CD(P=0.05)	**0.186**	**0.361**	**0.264**	**0.035**	**NS**	**NS**	**0.009**	**NS**	**NS**	**0.002**	**NS**	**NS**

Table 2. Yield and yield attributes of soybean varieties as influenced under different sowing dates

Treatments	Yield attributes of soybean			Yield of soybean		
	Pods plant -1 (no.)	Seed pod -1 (no.)	Test weight (g)	Seed yield (kg ha -1)	Stover yield (kg ha -1)	Harvest Index (%)
Date of sowing						
D1 – 10 June	74.22	2.67	9.93	2079	2655	43.96
D2 – 20 June	49.97	2.47	9.44	2019	2580	43.93

D3 – 30 June	39.97	2.22	9.28	1451	1848	44.01
SEm±	**1.050**	**0.030**	**0.319**	**69.99**	**90.29**	**0.034**
CD(P=0.05)	**3.149**	**0.089**	**NS**	**209.8**	**270.70**	**NS**
Varieties						
V1 – JS – 9752	79.09	2.72	9.97	2204	2826	43.82
V2 – JS – 9305	52.13	2.47	9.76	2139	2729	43.95
V3 – JS – 335	32.96	2.22	8.94	1209	1528	44.15
SEm±	**1.050**	**0.030**	**0.319**	**69.99**	**90.29**	**0.037**
CD(P=0.05)	**3.149**	**0.089**	**NS**	**209.8**	**270.70**	**0.101**

Table 3. Accumulated Photo thermal Units (PTU) and Accumulated Helio thermal Units (HTU) at different growth stages of soybean varieties under different sowing dates

Treatments	Accumulated Photo thermal Units (PTU)					Accumulated Helio thermal Units (HTU)				
	Emergence	50 % flowering	100 % flowering	Pod formation	Physiological maturity	Emergence	50 % flowering	100 % flowering	Pod formation	Physiological maturity
V1 – JS - 9752										
D1 – 10 June	1389	14454	15978	18339	26566	693.7	8817.7	9788.1	11237.9	16978.3
D2 – 20 June	1016	17104	11798	12909	22258	607	10571	11798.9	12909.5	14373.2
D3 – 30 June	1235	10792	12469	13642	21147	708	6595.2	7672.7	8266.1	13774.6
V2 –JS - 9305										
D1 – 10 June	1389	12394	13528	15048	25641	693.7	7584.7	8181.5	9251.1	16250.5
D2 – 20 June	1016	16558	17814	19824	21351	607	10024.4	11128.9	12745.6	13866.9
D3 – 30 June	1235	10108	11249	12469	21133	708	6222.9	6902.6	7672.7	13794.3
V3 –JS - 9305										
D1 – 10 June	1389	13052	14454	15978	24978	693.7	7902.2	8817.7	9788.1	15942.7
D2 – 20 June	1016	15658	16608	18828	21823	607	9665.9	10214.5	11969.6	14135.7
D3 – 30 June	1235	9637	11249	12469	21133	708	6003	6902.6	7672.7	13794.3

REFERENCES

Ahmad, M., Anwar, M., Rahman, M. and Alam, M. (2010). Yield and yield components of soybean varieties as affected by different sowing dates.American- Euresian Journal of Agronomy. 3 (1):25-29.

Anonymous (2009). Crop Survey conducted by SOPA (The Soybean Processors Association Indore. (M.P.) of India. September 16 to 24.

Anonymous (2010). All India Coordinated Research Projects on Soybean. Directorate of Soybean Research, ICAR, Indore.9-10.

Anonymous (2013). The Soybean Processors Association of India (SOPA). www.sopa.org.

Anonymous (2013a) **and Anonymous** (2013b). Food and Agriculture Organization (FAO) of the United Nations. www.faostat.org.

Anonymous (2015). Krishi Darshika, I.G.K.V., Raipur (C.G.). pp 4. Anonymous 2010. Mention wheather it is from Annual reportor from status report. Directors Report and summary tables of experiments on soybean.15.

Baisakh, B. and Dash, G. B. (1992). Performance of promising genotype of Soybean in hilly region of Orissa. Indian J. Agric. Sci. 62 (5):335-336.

Barik, T. and Sahoo, K.C. (1989). Response of Soybean to date of sowing and spacing. Indian J. Agron.34 (4):464-466.

Benati, R., Danuso, F., Amuduci, M. T. and Venturi, G. (1988). Effects of sowing date on yield and yield components of Soybeans. Rivistadi Agronomia. 22 (1):3-12.

Black, C.A. (1965). Method of soil analysis. Amar. Agron. Inc. Madeson, Wisconsin, USA. pp. 131-137.

Chauhan, G.S., Verma, N.S. and Bains, G.S. (1988). Effect of extrusion processing on the nutritional quality of protein in rice legumeblends. Nahrung 32:43.

Deokar, P., Guhey, A. and Patil, S. (2009). Physiological basis of seed yield variation in soybean (*Glycine max* (L.)Merill.). International J. Plant Sciences 4 (2):596-598.

Ghadekar, S.R. (2001). Crop Climatology, Meteorology (Ed. S.R. Ghadekar). Agromet Publishers Nagpur 186-193. Isoda, A., Mori, M., Matsumoto, S., Li, Zhiyuan, Wang, Peiwu 2006. High yielding performance of soybean in Northern Xinjiang, China, Plant-Production- Science. 9 (4):401-407.

Jackson, M.L. (1967). Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi. Jasani, K.P., Patel, M.P. and Patel, H.P. 1993.Growth and yield of soybean as influenced by sowing period and seed rate. Indian J. Agron. 38 (4):670- 672

Kumar, A., Pandey, V., Shekh, A.M. and Kumar, M. (2008). Radiation use efficiency and weather parameter influence during life cycle of soybean (*Glycine max.* [L] mirrll) production as well accumulation of dry matter, American- Eurasian Journal of Agronomy 1(2): 41-44.

Kumar, A., Pandey, V., Shekh, A.M. and Kumar, M. (2008a). Radiation Use efficiency and weather parameter influence during life cycle of Soybean (*Glycine max.* [L] Merrill) production as well accumulation of dry matter .American Eurasian Journal of Agronomy 1 (2):41-44.

Kumar, A., Pandey, V., Shekh, A.M. and Kumar, M. (2008b). Growth and yield response of soybean (*Glycinemax* L.) in relation to temperature, photoperiod and sunshine duration at Anand, Gujrat India American- Eurasian Journal of Agronomy1(2):45-50.

Kumar, A., Pandey, V., Shekh, A.M. and Kumar, M. (2008c). Correlation study in soybean with response to prevailing weather parameter, agrometeorological indices to seed and stover yield at Anand. American-Eurasian Journal of Agronomy 1(2):31-33.

Kumar, M. and Singh, D. (2007). Agroclimatic models for growth and yield of soybean (*Glycine max* (L.) Merill.) Annals of Biology.23 (2):173-16.

Lawn, R.J. (1989). Agronomic and physiological constraints to the productivity of tropical grain legumes and prospects for improvement. Exptl. Agric, 25 (2):509-528.

Olsen, S. R., Cole, C.V., Watanable, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United State Department of Agriculture, CIRC, Washington D. C.

Panse, V.G. and Sukhatme P.V. (1967). Statistical method for Agricultural workers. Second Edition Indian Council of Agricultural Research, New Delhi.

Ramesh, P. and Gopalaswamy, N. (1992). Effect of planting date and irrigation regime on growth, yield attributes and yield of Soybean. Indian J. Agron. 37 (1):126-129.

Sadeghi, M.S., and Niyaki, N.A.S., (2013). Effects of planting date and cultivar on the yield and yield components of soybean in north of iran. ARPN J. of agricultural and biological science, asian research publishing network (ARPN). 8(1): 81-85.

Sharma, J.K., Namdeo. K.N. and Nakhtore, C.L. (1991). Influence of sowing dates and cultivars on growth and yield of soybean .Research and Development Reporter 8 (2):102-106.

Singh, A., Rao, V.U.M., Singh, D. and Singh, R. (2007). Study on agrometeorological indices for soybean crop under different growing environments. Journal of Agrometeorology, 9 (1):81-85.

Singh, B. and Singh, G. (1991). Effect of dates of sowing on grain yield of soybean under Nagal and condition.Legume Res. 14 (4):185-186. Singh, K.P. and Bajpai, R.P. 1992. Effects of sowing date on yield of rainfed soybean Indian J. Agron. 37 (1):149.

Souza, P., Ribeeiro, A., Rocha, E., Falarias, J., Loureiro, R.,Bispo, L. (2009). Solar radiation use efficiency by soybean under field condition in the Amazonregion. Pesquisa. Agropecuattia Brasilereira. 44 (10):1211-1218.

Subbiah, B.V. and Asija, G.L. (1956). A rapid method for estimation of nitrogen in soil. Current Science 26 : 259-260.

Tandale, M. and Ubale, S. (2007). Evaluation of effect of growth parameter. Leaf area index (LAI), Leaf area Duration (LAD), Crop growth rate (CGR) on seed yield of soybean during *Kharif* season. International J. Agri. Sci.3 (1):119-123.

Yari, V., Frnia, A., Maleki, A., Moradi, M., Naseri, R., Ghasemi , M., and Lotfi, A., (2013a). Yield and yield components of soybean cultivars as affected by planting date, bulletin of environment pharmacology and life science 2(7): 85- 90

Yari, V., Frnia, A., Maleki, A., Moradi, M., Naseri, R., Ghasemi , M., and Lotfi, A., (2013b). Yield and yield components of soybean cultivars as affected by planting date, bulletin of environment pharmacology and life science 2(7): 85- 90.

Yari, V., Frnia, A., Maleki, A., Moradi, M., Naseri, R., Ghasemi , M., and Lotfi, A., (2013c). Yield and yield components of soybean cultivars as affected by planting date, bulletin of environment pharmacology and life science 2(7): 85- 90.

Yari, V., Frnia, A., Maleki, A., Moradi, M., Naseri, R., Ghasemi , M., and Lotfi, A., (2013d). Yield and yield components of soybean cultivars as affected by planting date, bulletin of environment pharmacology and life science 2(7): 85- 90.

Zargar, M., Mafakheri, S., and Shakouri, J.M., 2011. Response of soybean varieties to different planting dates, middle- east journal of scientific research 8(1): 161-164