

Effect of different sowing dates on growth, yield and quality of soybean varieties

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Abstract

Soybean (*Glycine max* L.) is one of the important food, oil and protein crop. The early days to nodule formation was observed in variety NARC-I under the sowing dates of 15th May and 1st June, and late days to nodule formation was observed in variety NARC-II under the sowing date of 30th June. The maximum days to leghae moglobium in nodules were observed in varieties NARC-I and NARC-II under the sowing date of 30th June and minimum in variety NARC-II under the sowing date of 30th June. The maximum days to due disappearance leghae moglobium in nodule were observed in Bragg and Bossier varieties under sowing of 15th June and minimum days to due disappearance leghae moglobium in nodule were recorded in NARC-I and NARC-II under sowing dates of 30th June and 15th May respectively. The maximum number of nodules plant⁻¹ were recorded in variety Bossier under the sowing date of 30th June and minimum number of nodules plant⁻¹ were recorded in variety NARC-II under the sowing date of 15th June and minimum number of nodules plant⁻¹ were recorded in variety NARC-II under the sowing date of 15th June and minimum number of nodules plant⁻¹ were recorded in variety NARC-II under the sowing date of 15th June respectively.

The maximum plant height was recorded in variety Bossier under the sowing date of 30th June and minimum were sown on 15th May in variety Bragg. The early days to flowering were achieved (39.70 sown on 15th May in variety Bragg. The early days to maturity at were recorded under sowing date of 15th May in variety Bragg and late days to maturity were obtained in variety Bossier under sowing date of 30th June. The maximum number of branches plant⁻¹ were observed in variety NARC-I and lowest number of branches plant⁻¹ were obtained in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were observed in variety Bragg and minimum number of pods plant⁻¹ were recorded in variety Bossier under sowing date of 15th May.

The highest seed index were observed in Bossier variety under sowing date of 15th May and lowest seed index was observed in variety NARC-II under sowing date of 15th May. The maximum seed yield in variety Bossier under sowing date of 15th May and minimum seed yield were achieved in variety NARC-II under sowing date of 30th June respectively. The highest oil content were obtained in variety Bragg under sowing date of 30th June, and minimum oil content was observed in variety Bossier sowing date of 15th May respectively.

The highest leaf area index were recorded in variety Bragg under sowing date of 1st June and lowest in variety NARC-I under sowing date of 30st June and 15th June respectively. The maximum crop growth rate was observed in variety Bragg under sowing date of 30th June and minimum crop growth rate in variety NARC-I under sowing date of 15th May. The maximum net assimilation rate was observed in variety Bossier under sowing date of 1st June and minimum net assimilation rate was observed in varieties NARC-I under sowing date of 30th June. The highest leaf area was observed in variety Bossier under sowing date of 30th June. The highest leaf area was observed in variety Bossier under sowing date of 1th June, followed by in varieties Bragg and Bossier under sowing dates of 1st June and 15th May and lowest leaf area was achieved in variety NARC-II under sowing date of 15th June and 15th May and lowest leaf area was achieved in variety NARC-II under sowing date of 15th June and 15th May and lowest leaf area was achieved in variety NARC-II under sowing date of 15th June respectively.

Key words: Soybean, sowing dates, growth, yield, oil content

INTRODUCTION

Soybean was domesticated in China, which has the first written records of soybean (Singh, 2010), dating to about 3100 years ago (Hymowitz, 2005). The earliest recorded introductions of soybean to the U.S. were by Samuel Bowen, a sailor, in 1765 from China (Hymowitz, 2005), and by Benjamin Franklin in 1770 from France (Singh, 2010). Originally introduced as a forage crop, soybean is now used for food, livestock feed, industrial processes, bio-fuel, and in pharmaceuticals (Singh, 2010).

The soybean belongs to the family Leguminosae, subfamily Papilionoideae and genus Glycine, L. The cultivated form called *Glycine max* (L.) Merrill, grows as a summer annual. However, some related species are perennial in nature (Mullen, 2003).

Soybean (*Glycine max* L.) is one of the important oil and protein crop of the world and is grown under a wide range of environmental conditions, where climatic factors such as temperature, photoperiod and moisture stress, exerts a detrimental effect on plant growth and metabolism(Khan *et al.*, 2007). Planting date and plant population are the important factors affecting soybean growth and development, seed yield (Zhang *et al.*, 2010) and seed quality (Rahman *et al.*, 2005). Planting date can effect on soybean agronomic traits via air temperature. The effect of temperature on soybean seed yield and quality also depends on growing stages. Khan *et al.*, (2011) found that increase in mean air temperature from 23 to 30 °C during soybean growth stages led to varied effects on seed quality and vigor. One of the most important agronomic characteristics of soybeans is that it can take nitrogen from the air and convert it to a form usable by the soybean plant (ASA, 2003).

Soybean seed contains high amount of protein (45-50%), oil (20%), and rich in vitamin B, C, E and minerals (NGLRP, 2011). It can be used as a good supplemental food especially in the underdeveloped countries where majority of population suffers from malnutrition. Soybean has a very diverse utilization such as seeds can be used to prepare baby food and food for diabetic patients, green pods can be used as green vegetables and dry seeds can be eaten roasted or fried. Soybean cake and meal are utilized for preparing various livestock and poultry feeds. Demand for soybean is in current increase with increase in poultry business and majority of soybean meal is imported from India (Shrama, 2012).

Environmental conditions can change the yield in the same sowing date in different years; therefore, just one field experiment cannot bring conclusive results for choosing the best sowing date (Egli and Cornelius, 2009). This problem can be solved by the use of historical climatic series applied to crop models for estimating yield in such a way that the choice of the best sowing date is based on a probabilistic level. Similar method has been used by several authors to define sowing dates for different crops and places (Farias *et al.*, 2001; Anapalli *et al.*, 2005; Soler *et al.*, 2010; Battisti *et al.*, 2013). Sowing dates influence soybean growth stages, due to variation in photoperiod (Han *et al.*, 2006; Kumudini *et al.*, 2007), air temperature (Chen and Wiatrak, 2010), and rainfall distribution and amount during the crop cycle (Hu and Wiatrak, 2012). In São Domingos, SC, Meotti *et al.* (2012) observed that 77% of soybean yield variability was associated with the climate conditions induced by the sowing dates.

MATERIALS AND METHODS

The research experiment was conducted at Agriculture Research Institute Tando Jam, Sindh, Pakistan during two consequent years 2007-08 and 2008-09 in randomized complete block design with three replications. The experiment consists four varieties of soybean viz. Bragg, Bossier, NARC-I and NARC-II along with four sowing dates 15^{th} May, 1^{th} June, 15^{th} June and 30th June, plot size was $3 \times 5 m^2 = 15 m^2$.

Land preparation: The land was prepared by two dry plowings with tractor followed by surface leveling. The land preparation operations were carried out for equal distribution of irrigation and fertilizers.

Cultural practices: The crop was kept clean, and periodical weed control practices were carried out to avoid any possible constraint against the experimental process by weeds as unwanted plants. Thus all cultural practices were performed uniform in all plots, keeping in view the crop requirements.

Sowing method: Drilling was done in straight lines through single coulter with hand manual for different experiments.

Seed rates: Different sowing dates were used in the experimental plots as per schedule.

Sowing time: The experiments were planted 15th May, 1st, 15th and 30th June and harvested 10th, 25th August, 10th and 24th September during 2007-08 and 2008-09.

Fertilizer applied: Nitrogen, phosphorus and potash were applied in the form of urea, di-ammonium phosphate (DAP) and sulphate of potash. All phosphorus and potash were applied at sowing time, while nitrogen was applied in split application during 1st and 3rd irrigation.

Irrigations: The irrigations were applied to the crop with an interval of 25-32, 46-50, 68-76, 88-92 and 102-112 days after sowing.

Weed management: Weeds are the major cause for low yield in soybean crop. Weeding and interculturing operations were performed as required during early growth and development stages.

Plant protection: The crop was kept free from weeds, insect pests, and diseases. Plant protection measures were adopted whenever it was required.

Seed germination (%): Germination percentage was evaluated in each plot after 15 days of sowing.

Days to nodule formation: Nodule formation can be seen within a week of emergence, but active fixation usually begins within 10-14 days later, around V2-V3 growth stages, at which point they can supply most of the plant's N requirements. An individual nodule remains active for 5-6 weeks before beginning to break down.

Days to leghae moglobium in nodules: When appearance in the root red color nodules.

Days to due disappearance leghae moglobium in nodule: When nodules color change in the color green.

Number of nodules plant⁻¹: After maturity the number of nodes in the mainstem was counted five plants randomly selected in each treatment (InfoStat, 2000).

Plant height (cm): Plant height (cm) was measured at physiological maturity. Five representative plants were selected in each experimental unit and the height measured from ground level to the tip of the plant.

Days to flowing (Days): Number of days was counted from date of sowing up to date of flowering from each plot randomly in each treatment.

Days to maturity (Days): Days to maturity were counted when complete loss of green colour occurred.

Number of branches plant⁻¹: Number of branches was recorded from each plant from five plants randomly selected plants in each treatment.

Number of pods plant⁻¹: Number of pods was recorded from each plant randomly five plant were selected from each treatment.

Seed index (g): Seed weight was measured after sun drying using top loading digital balance.

Seed yield (kg ha⁻¹): Seed yield was recorded from the weight of threshed seeds of soybean harvested from the area of one square meter, and computed as kg ha⁻¹.

Biological yield (kg ha⁻¹): Biological yield was obtained from the weight of threshed straw of soybean harvested from the area of one square meter and computed kg ha⁻¹.

Oil content (%): Oil was extracted from standardized Soxtec machine method (Anderson, 2004)

Leaf area index (cm⁻²): Leaf area index was evaluated through leaf area meter (Licor model 3100). According to the method as out lined by hunt (1978). LAI = Leaf area / Ground area

Crop growth rate (g⁻² day⁻¹: A sample was taken from each plot and oven dried at 80^oC for 24 hours to record dry weight. The crop growth rate was calculated by the formula suggested by hunt (1978). CGR = $(W_2 - W_1) / (t_2 - t_1) x$ (area)

Whereas, CGR = Crop growth rate, W_1 and W_2 are the total dry weight, t_1 and t_2 are the time.

Net assimilation rate ($g^{-2} day^{-1}$): The mean net assimilation rate was estimated as method suggested by hunt (1978). NAR = TDM / LAD

 $LAD = [(LAI_1 + LAI_2) \times (t_2 - t_1)]/2$

Where, LAD = Total leaf area duration, LAI_1 = Leaf area index at initial developmental growth stage, LAI_2 = Leaf area index at final growth (maturation) stage. t_1 = Time corresponding to initial developmental stage, t_2 = Time corresponding to maturation stage, TDM = Total dry matter. NAR = $W_2 - W_1 / (t_2 - t_1) \ge 1 / \text{leaf area}$.

Crop growth rate: Crop growth rate was determined according to following formula as reported by Hunt (1978).

 $CGR = (W_2 - W_1) / (t_2 - t_1)$

Net assimilation rate:

The net assimilation rate was estimated as suggested by Hunt (1978). $[I_AI_1 + I_AI_2] \times (t_1 - t_2)]$

$$LAD = \frac{2}{2}$$

Dry weight (g) plant⁻¹at maturity: Dry weight (DW) per plant was recorded from five randomly selected plants from each treatment. The samples was chopped into small pieces and put in muslin cloth bags and was oven dried at 80 °C for 90 hours and weighed on digital top loading balance, then average dry weight per plant was calculated.

Statistical analysis:

The experimental data were recorded and subjected to factorial design of analysis of variance (ANOVA) under linear models of statistics to observe statistical differences among different traits of soybean by using computer program, Student Edition of Statistix (SWX), Version 8.1 (Analytical Software, 2005). Further least significant difference (LSD) test was also applied to test the level of significance among different combination means (Gomez and Gomez, 1984).

Results

The statistical analysis of variance indicated that days to nodule formation, days to leghae moglobium in nodules, number of nodules plant⁻¹ were highly significant, while seed germination and days to due disappearance leghae moglobium in nodule were non-significant at 5% probability level and data are presented Table 1a. The early days to nodule formation was observed (34.67 and 34.33 days) in variety NARC-I under the sowing dates of 15th May and 1st June, followed by (36.50 and 37.00 days) in varieties Bossier and NARC-I under sowing date of 15th June. The late days to nodule formation was observed (41.50 days) in variety NARC-II under the sowing date of 30th June. The maximum days to leghae moglobium in nodules were observed (52.50 and 51.67 days) in varieties NARC-I and NARC-II under the sowing date of 30th June, followed by (48.33, 48.50 and 46.00 days) under the sowing date of 15th June in Bragg, Bossier and NARC-I varieties and minimum days to leghae moglobium in nodules (41.67 days) in variety NARC-II under the sowing date of 30th June. The maximum days to due disappearance leghae moglobium in nodule were observed (75.67 and 75.17 days) in Bragg and Bossier varieties under sowing of 15th June and minimum days to due disappearance leghae moglobium in nodule were recorded (71.50 and 70.50 days) in NARC-I and NARC-II under sowing dates of 30th June and 15th May respectively. The maximum number of nodules plant⁻¹ were recorded at par (6.77 and 6.69) in varieties Bossier and NARC-1 under the sowing date of 30th June, followed by (5.96 and 5.42) with sowing dates of 15th June in varieties Bossier and NARC-I and minimum number of nodules plant⁻¹ were recorded (3.61) in variety NARC-II under the sowing date of 15th June respectively.

Varieties	Sowing	Seed	Days to	Days to	Days to due	Number of
	dates	germination	nodule	leghae	disappearance	nodules
		(%)	formation	moglobium	leghae	plant ⁻¹
				in nodules	moglobium in	
Duese	15th Mary	96.92	24 67 ad	11 C7 h	nodule 71.82 a. a	2 (0 ad
вгадд	15 th May	80.83	34.07 cu	44.07 D	/1.85 a-c	3.69 Cu
	1 st June	85.83	35.17 b-d	47.00 a-c	73.00 ab	4.47 c
	15 th June	85.00	36.50 a-c	48.33 а-с	75.67 a	5.39 b
	30 th June	84.67	40.67 a	51.33 a	71.33 a-c	6.71 a
Bossier	15 th May	87.17	35.67 b-d	42.67 bc	71.50 a-c	3.73 cd
	1 st June	85.50	36.00 bc	44.83 b	72.83 ab	4.34 c
	15 th June	84.67	36.50 a-c	48.50 a-c	75.17 a	5.96 ab
	30 th June	85.17	43.83 a	52.17 a	73.00 ab	6.69 a
NARC-I	15 th May	87.33	34.67 cd	41.67 b-d	71.17 a-c	3.69 cd
	1 st June	85.17	34.33 cd	44.33 b	72.83 a-c	4.38 c
	15 th June	85.00	37.00 ab	46.00 ab	75.00 a	5.42 b
	30 th June	84.50	40.50 a	52.50 a	71.50 a-c	6.77 a
NARC-II	15 th May	86.50	36.67 a-c	42.17 bc	70.50 a-d	3.61 cd
	1 st June	85.17	35.50 b-d	44.50 b	73.33 ab	4.46 c
	15 th June	84.33	37.00 ab	46.50 ab	75.33 a	5.35 b
	30 th June	83.17	41.50 a	51.67 a	72.33 а-с	6.74 a
SE		73.07	0.7726	0.8426	0.8961	0.2074
LSD (5%)		-	1.185	1.293	-	0.3182

Table 1a. Effect of different sowing dates on growth parameters of soybean varieties

The statistical analysis of variance indicated that days to flowering was highly significant, while plant height, days to maturity, number of number of branches plant⁻¹ and number of pods plant⁻¹ were nonsignificant at 5% probability level and data are presented Table 1b. The maximum plant height was recorded (50.67 and 50.52 cm) in varieties Bossier and Bragg under the sowing date of 30th June and minimum (42.31 and 42.02) were sown on 15th May in varieties Bragg and NARC-I. The early days to flowering were achieved at par (39.70 and 39.67 days) sown on 15th May in varieties Bragg and NARC-I and late days to flowering were observed (50.09, 50.39 and 50.13 days) in varieties NARC-II, NARC-I and Bragg under sowing date of 30th June. The early days to maturity at were recorded par (111.50 and 111.67 days) under sowing date of 15th May in varieties Bragg and NARC-II and late days to maturity were obtained at par (120.83 and 120.67 days) in varieties Bossier and NARC-II under

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sowing date of 30th June. The maximum number of branches plant⁻¹ were observed at par (7.13 and 7.19) in varieties NARC-I and NARC-II under sowing date of 15th May and lowest number of branches plant⁻¹ were obtained at par (3.59 and 3.72) in varieties Bossier and NARC-I and NARC-II under sowing date of 15th May. The maximum number of pods plant⁻¹ were observed at par (85.79, 85.32, 85.15 and 85.78) in varieties Bragg, Bossier, NARC-I and NARC-II under sowing date of 15th May and minimum number of pods plant⁻¹ were recorded at par (51.55, 51.28 and 51.12) in varieties Bossier and NARC-II under sowing date of 15th May.

The maximum plant height was recorded (50.67 and 50.52 cm) in varieties Bossier and Bragg under the sowing date of 30th June and minimum (42.31 and 42.02) were sown on 15th May in varieties Bragg and NARC-I. The early days to flowering were achieved at par (39.70 and 39.67 days) sown on 15th May in varieties Bragg and NARC-I and late days to flowering were observed (50.09, 50.39 and 50.13 days) in varieties NARC-II, NARC-I and Bragg under sowing date of 30th June. The early days to maturity at were recorded at par (111.50 and 111.67 days) under sowing date of 15th May in varieties Bragg and NARC-I and late days to maturity were obtained at par (120.83 and 120.67 days) in varieties Bossier and NARC-II under sowing date of 30th June. The maximum number of branches plant⁻¹ were observed at par (7.13 and 7.19) in varieties NARC-I and NARC-II under sowing date of 15th May and lowest number of branches plant⁻¹ were obtained at par (3.59 and 3.72) in varieties Bossier and NARC-I under sowing date of 15th May. The maximum number of pods plant⁻¹ were observed at par (85.79, 85.32, 85.15 and 85.78) in varieties Bragg, Bossier, NARC-I and NARC-II under sowing date of 15th May and minimum number of pods plant⁻¹ were recorded at par (51.55, 51.28 and 51.12) in varieties Bossier and NARC-II under sowing date of 15th May.

Varieties	Sowing dates	Plant height	Days to	Days to	Number of	Number of
		(cm)	flowing	maturity	branches	pods plant-1
			(Days)	(Days)	plant ⁻¹	
Bragg	15 th May	42.31	39.70 c	111.50	3.75	51.55
	1 st June	47.22	47.64 a-c	114.00	4.83	63.05
	15 th June	48.57	48.69 ab	116.33	5.67	69.10
	30 th June	50.30	50.13 a	120.00	7.12	85.59
Bossier	15 th May	43.27	43.49 bc	110.83	3.84	49.87
	1 st June	47.31	46.88 b	113.33	4.80	63.25
	15 th June	48.82	48.79 ab	115.33	5.76	71.60
	30 th June	50.52	49.98 a	120.83	7.09	85.32
NARC-I	15 th May	42.02	39.67 c	111.50	3.59	51.28
	1 st June	47.03	47.76 a-c	113.33	4.83	62.71

Table 1b. Effect of different sowing dates on growth parameters of soybean varieties

	15 th June	48.10	49.13 ab	116.00	5.75	70.70
	30 th June	50.38	50.39 a	121.33	7.19	85.15
NARC-II	15 th May	42.87	39.68 c	111.67	3.72	51.12
	1 st June	46.96	46.94 b	113.83	4.48	63.26
	15 th June	48.93	48.46a b	116.33	5.54	71.27
	30 th June	50.67	50.09 a	120.67	7.13	85.78
SE		0.8905	1.3111	1.1331	0.3225	2.072
LSD (5%)		-	2.012	-	-	-

The statistical analysis of variance indicated that seed yield, biological yield were highly significant and seed index, oil content, days to flowering Biological yield were non-significant at 5% probability level and data are presented Table 1c. The highest seed index at par (117.40 and 116.35 g) were observed in Bossier and Bragg varieties under sowing date of 15th May and lowest seed index was observed (111.38 g) in variety NARC-II under sowing date of 15th May. The maximum seed yield was observed (4145.00 kg ha⁻¹) in variety Bossier under sowing date of 15th May, followed by (3955.00, 3970.00 and 3925 kg ha⁻¹) in variety Bragg and Bossier varieties under sowing date of 15th May, followed by (3955.00, 3970.00 and 3925 kg ha⁻¹) in variety Bragg and Bossier varieties under sowing date of 15th May, followed by (3955.00, 3970.00 and 3925 kg ha⁻¹) in variety Bragg and Bossier varieties under sowing date of 15th May, followed by (3955.00, 3970.00 and 3925 kg ha⁻¹) in variety Bragg and Bossier varieties under sowing date of 15th May, followed by (3955.00, 3970.00 and 3925 kg ha⁻¹) in variety Bragg and Bossier varieties under sowing date of 15th May, followed by (3955.00, 3970.00 and 24.28 %) were observed in varieties Bragg, NARC-I and NARC-II under sowing date of 30th May, followed by at par (21.48 and 21.57 %) in varieties Bragg and NARC-II were sown under sowing dates of 30th June and minimum oil content were noted (16.85 and 16.71 %) in varieties Bossier and NARC-II under sowing date of 15th May respectively.

Varieties	Sowing dates	Seed index	Biological yield	Seed yield	Oil content
		(g)	$(kg ha^{-1})$	$(kg ha^{-1})$	(%)
Bragg	15 th May	116.30	9050.00 ab	3955.00 ab	17.66
	1 st June	116.08	8925.00 ab	3825.00 ab	18.77
	15 th June	115.33	8810.00 ab	3775.00 а-с	21.48
	30 th June	114.28	8633.33 b	3700.00 a-c	24.17
Bossier	15 th May	117.40	9671.67 a	4145.00 a	16.85
	1 st June	116.35	9263.33 a	3970.00 ab	17.71
	15 th June	115.70	9158.33 a	3925.00 ab	20.93
	30 th June	115.33	8901.67 ab	3815.00 ab	23.67
NARC-I	15 th May	115.47	8540.00 b	3660.00 b	17.48
	1 st June	114.41	8761.67 b	3755.00 bc	18.69
	15 th June	113.32	8621.67 b	3695.00 b	21.57

Table 1c. Effect of different sowing dates on growth and quality parameters of soybean varieties

	30 th June	112.40	8505.00 b	3645.00 b	24.19
NARC-II	15 th May	114.27	8446.67 bc	3620.00 b	16.71
	1 st June	113.28	8505.00 a-d	3645.00 b	17.78
	15 th June	112.36	8458.33 a-d	3625.00 b	20.92
	30 th June	111.38	8306.67 a-d	3560.00 bc	24.28
SE		0.2213	119.2787	26.004	0.7739
LSD (5%)		-	183.0	39.90	-

The statistical analysis of variance indicated that leaf area index (cm⁻²), net assimilation rate (gm⁻² dav⁻¹). drv weight plant⁻¹(g) and leaf area (cm⁻²) were highly significant, while crop growth rate (gm⁻² day⁻¹) was non-significant at 5% probability level and data are presented Table 1d. The highest leaf area index were recorded at par (0.350 and 0.336 cm²) in varieties Bragg and Bossier under sowing date of 1st June, followed by (0.318 and 0.305 cm²) in varieties Bragg and Bossier under sowing date of 15th May 15th June and lowest (0.197 and 0.179 cm²) in varieties NARC-I and NARC-II under sowing date of 30st June and 15th June respectively. The maximum crop growth rate was observed at par (0.116 and 0.113 gm⁻² day⁻¹) in varieties Bragg and NARC-II under sowing date of 30th June and minimum crop growth rate at par (0.052 and 0.058 gm⁻² day⁻¹) in variety NARC-I under sowing date of 15th May and 1st June. The maximum net assimilation rate was observed (23.64 and 21.16 gm⁻² day ¹) in variety Bossier under sowing date of 1st and 15th June, followed by (20.49 and 19.11 gm⁻² day⁻¹) in varieties NARC-I and Bragg under sowing dates of 1st and 15th June and minimum net assimilation rate was observed (9.91 and 9.11gm⁻² day⁻¹) in varieties NARC-I and NARC-II under sowing date of 30^{th} June. The maximum dry weight plant⁻¹ (14.15 g) in variety Bossier under sowing date of 15^{th} May, followed by (13.17 and 13.30 g) in varieties Bragg and Bossier under sowing dates of 15th May and 1st June, and minimum dry weight plant-1 at par (10.34 and 10.27 g) in varieties NARC-I and NARC-II under sowing date of 15th June. The highest leaf area was observed (210.17 cm²) in variety Bossier under sowing date of 1th June, followed by (201.50 and 201.67 cm²) in varieties Bragg and Bossier under sowing dates of 1st June and 15th May and lowest leaf area was observed (107.33 and 103.33 cm²) in variety NARC-II under sowing date of 15th and 30th June respectively.

Varieties	Sowing dates	Leaf area	Crop growth	Net	Dry weight	Leaf area
		index (cm ⁻²)	rate	assimilation	plant ⁻¹ (g)	(cm ⁻²)
			$(gm^{-2} day^{-1})$	rate		
				$(gm^{-2} day^{-1})$		
Bragg	15 th May	0.305 ab	0.060	14.51 cd	13.17 ab	182.83 ab
	1 st June	0.336 a	0.073	21.21 a	12.18 a-c	201.50 a
	15 th June	0.284 b	0.087	19.11 a-c	11.26 c	170.50 ab
	30 th June	0.229 b-d	0.116	10.41 d	11.25 c	137.33 b-d
Bossier	15 th May	0.336 a	0.059	15.77 с	14.15 a	201.67 a
	1 st June	0.350 a	0.070	23.64 a	13.30 ab	210.17 a
	15 th June	0.318 ab	0.089	21.16 a	12.07 a-c	190.83 ab
	30 th June	0.236 a-c	0.103	11.61 с-е	11.61 c	141.83 bc
NARC-I	15 th May	0.243 a-c	0.053	13.18 cd	11.71b c	146.17 bc
	1 st June	0.259 bc	0.062	20.49 ab	11.53 c	155.50 b

Table 1d. Effect of different sowing dates on physiological parameters of soybean varieties

	15 th June	0.210 c	0.083	18.13 b	11.40 c	126.17 c
	30 th June	0.197 cd	0.113	9.91 b-e	10.34 d	118.50 d
NARC-II	15 th May	0.226 b-d	0.052	12.11 cd	11.44 c	135.83 b-d
	1 st June	0.245 bc	0.058	21.30 a	10.83 d	147.00 bc
	15 th June	0.179 b-d	0.080	17.51 b	10.63 d	107.33 e
	30 th June	0.172c	0.104	9.11de	10.27 d	103.33 f
SE		0.0011	0.0106	0.1049	0.5291	0.8216
LSD (5%)		0.0015	-	0.1609	0.8119	1.261

Discussion

Oil seed production in the world play vital role for fulfillment of food requirement for humankind. The worlds increasing population is a major constrain so it is need of time to produce more edible food agriculture produce for fulfilling the food requirement. Oil seed crops specially soybean produce more percentage of edible oil in Pakistan soybean cultivated at very small scale due to lack of knowledge and proper production technology for growers in this study almost all aspects related to soybean covered including "sowing times, seed rates, deed depth, spacing's, nutrients fertilizers, irrigations, seed storage etc. This study is helpful for future edible oil production specially soybean oil production and also helpful for solving edible oil production shortage in the country and saving of foreign exchange at large scale.

Planting date is an important factor influencing soybean growth and yield (Samia et al., 2013). Later plantings is likely to incur significant reductions in yield all aspects of soybean development including length of vegetative growth, timing of flowering, and maturity date are greatly influenced by photoperiod and temperature (Wiebold, 2002). The growth and yield responses of soybean to planting date depend on the environment, variety and production practice. If planted too early, soybean may have poor emergence or limited growth because of hot temperature when soybeans are exposed to day shorter than critical length, they progress rapidly to maturing. If this occurs before the plant reaches an adequate size, the soybean is stunted and give low yield, Boquet and Clawson (2007, Purcell et al., 2002). Sowing dates play vital role to crop response for its growth and yield. It seems that different soybean traits vary to sowing dates. In sowing dates connection the agronomic, physiological and nutrients traits showed variations. It is also seems that higher NPK content in plants was found at 15th May of crop sowing. Similarly Samia et al. (2013) worked on soybean sowing dates in Sudan the results of season 2010/11 showed significant differences for number of pods plant-1, number of seeds pods-1 and highly significant difference was obtained in weight of pods plant-1, weight of seeds plant⁻¹, seed index (1000 seed wt. g) yield and harvest index. The S3 (16th June) mid-June, obtained the highest values and S5 (30th June) gave the lowest values of the above parameters. Salem (2004) pointed out that sowing date plays an important role in soybean productivity.

In this study agronomic traits showed significant differences among traits and soybean seed production also vary between varieties clearly observed the variability of agronomic traits among soybean genotypes observed in this study corroborate with those reported by Malik et al. (2006).

It seems that that vary for their agronomic traits similarly researchers worked on agronomic traits which our results are in close conformity to those of previous investigators who also found plant height, number of leaves per plant (Malik et al., 2007), number of pods and seeds (Liu et al., 2005; Arshad et al., 2006) to be the most important plant agronomic traits contributing to improved varietals economic yield in soybean crop and hence suggested that these traits should be given more information about cultivars furthermore, it was also observed by Liu et al. (2005) that harvest index had no relationship with seed yield among varieties and plant height also had no direct influence on final seed yield even tall statured soybean varieties produced larger number of leaves which in turn supplied greater amounts of assimilates for seed growth resulting in higher seed yield finally the findings of above researchers showed variation in traits variety to variety. Physiological and nutrients traits significantly affected among varieties. Some soybean traits showed non-significant response to verities.

The response of varieties and sowing dates showed significant response for various soybean traits. Among various traits and their interaction variety Bossier perform better at 15th May, 1st June and 15th July and 30th June sowing traits but increased seed yield was found at 15th May sowing 4145 kg ha-1 in variety Bossier our findings confirmed by Samia et al. (2013) it can be reported that the two soybean cultivars can be planted during early to mid-June to avoid drastic reduction in yields. Similarly our observations confirmed results also illustrated by Ibrahim (2012, Billore et al., 2009, Kumar et al., 2005,) who reported the importance of early sowing for maximizing the yield potential of irrigated soybean. Also Zhang, et al. (2002) proved that the optimum sowing date for irrigated soybean is mid-June. Varieties reduce yield and yield components due to late sowing of crop our these findings confirmed by Samia et al. (2013) late sowing dates (30th June) may lead to a lack of sufficient vegetative growth, low number of pods plant⁻¹ and reduced seed weight and ultimately lower seed yields. Genotypes of soybean do differ in seed yields (Veni et al., 2003; Billore et al., 2009; De Bruin and Pedersen, 2008). The results were in agreement with (Arshad, 2006).

Conclusion

The early days to nodule formation was observed in variety NARC-I under the sowing dates of 15th May, days to leghae moglobium in nodules in varieties NARC-I under the sowing date of 30th June, more days to due disappearance leghae moglobium in nodule in Bragg variety under sowing of 15th June and highest numbers of nodules plant-1 were recorded in variety Bossier under the sowing date of 30th June. The maximum plant height was recorded in variety Bossier under the sowing date of 30th June, early days to flowering sown on 15th May in variety Bragg and early days to maturity under sowing date of 15th May in variety Bragg. The maximum numbers of branches plant-1 in variety NARC-I under sowing date of 15th May and maximum number of pods plant⁻¹ were observed in variety Bragg under sowing date of 15th May. The highest seed index was observed in Bossier under sowing date of 15th May, seed yield in variety Bossier under sowing date of 15th May and highest oil content was observed in variety Bragg under sowing date of 1st June, crop growth rate in variety Bragg under sowing date of 30th June, net assimilation rate in variety Bossier under sowing date of 1st June, dry weight plant⁻¹ in variety Bossier under sowing date of 1st June, dry weight plant⁻¹ in variety Bossier under sowing date of 1st June.

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Design and treatments

The experiment was laid out in split plot design with three replications. The sowing dates (15th March, 25th March and 04th April) were considered as main factors and soybean varieties (Malakand-96 and Kharif-93) as sub factors. The net plot size was 6.0 m x 1.8 m.

Crop husbandry

Seed bed Preparation

Seed bed was prepared by applying soaking irrigation (rouni). After that the field was cultivated two times with the help of cultivator followed by the same number of planking.

Sowing date and Seed rate

The crop was sown at respective dates each of 10 days interval with the help of hand drill at 30 cm spaced rows with seed rate of 100 kg ha-1.

Fertilizer application

Fertilizer was applied at the rate of 25 kg N, 50 kg P and 50 kg K ha-1. All nutrients were applied at the time of sowing in the form of urea, diammonium phosphate and sulfate of potash respectively. *Irrigation*

Total six irrigations were applied during the whole growth period of crop till maturity. 1st irrigation was applied 7 days after emergence, 2nd at three to four leaf stages, 3rd after thinning, 4th during flower initiation, 5th during pod formation and 6th during seed development.

Intercultural practices

Hoeing was done by manual method. Two hoeing were given to ensure optimum control of weeds in crop 20 and 40 days after sowing.

Harvesting

Harvesting was done manually with the help of sickle.

Harvested crop was tied into bundles and allowed to dry in the field for 10 days to lower the moisture level up to 12%.

Data collection

In this experiment, the parameters of seed yield and its components, the qualitative parameters such as seed protein and oil contents were recorded.

At the end of growth season, ten randomly sampled plants were taken from the central rows of each plot and measured yield attributes and morphological characteristics. The weight of 100 seeds was recorded as the average of three 100-seed samples and calculated 1000-seeds weight by unit method. Also, to determine biological yield, whole plant dry weight was considered as biological yield. Harvest index was calculated by following formula; *Harvest index=Grain YieldBiological YieldX* 100

Oil content was determined by Soxhlet Fat Extraction method (A.O.A.C., 1990).Percent oil content was calculated using the following equation; *Oil Contents* (%)=*Weight of flask+oil-Weight of flask+oil-Weight of flaskX*100

Protein in seed was determined according to Kjeldhal method (Bremner, 1964). Percent crude protein was calculated using the formula; (*Crude Protein*%)=(V1-V2)N100 WX 14X 6.25X 100

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