Soybean qualities parameters, seed yield and its components response to planting dates and density in the north of Iran

Homa Taghavi[1], Hamid Reza Mobasser[1], Elyas Rahimi Petroudi[1], Salman Dastan[2]

[1.] Department Department of Agronomy, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran.
[2.] Department of Agriculture, Payam Nour University, Mazandaran, Iran.
sdastan@srbiau.ac.ir

Abstract: In order to evaluation of soybean (*Glycin max* L.), qualities parameters, seed yield and its dependents components response to planting dates and plant density, an experiment was carried out at the Islamic Azad University of Qaemshahr Agronomy farm, Mazandaran, Iran in 2012. This experiment was done as split plot in randomized complete blocks design based three replications. Planting dates were chosen as main plots including: May 14, July 5 and August 15, and plant density as sub plots including: 20, 40, 60 and 80 plant per m^2. The results showed that planting date on May 14 had the most number of days from planting to flowering, number of days from flowering to filling pod, first pod height from ground surface, number of pod per plant, number of seed per plant, due to highest seed yield (420.3 g/m^2) was produced for this planting date, but the maximum oil percentage was observed on August 15 and the most 100-seed weight and protein percentage were obtained on July 5. The maximum number of pod per plant had observed with 20 plants per square, but highest seed yield was produced with 80 plants per square. As the most oil and protein percentage were observed with 20 and 80 plants per square. The maximum seed yield (581.1 g/m^2) was conducted for interaction planting date on May 14 with 80 plants per square, because of increase number of seed per pod.

[Taghavi H, Mobasser H.R, Rahimi Petroudi E, Dastan S. **Soybean qualities parameters, seed yield and its components response to planting dates and density in the north of Iran**. *Life Sci J* 2012;9(4):4719-4726] (ISSN:1097-8135). http://www.lifesciencesite.com. 709

Keywords: Density; oil percentage; planting date; seed yield; soybean

1. Introduction

Soybean is one of the important oilseed crops and major source of high quality protein for human daily diet and livestock feed in the world (Lei et al., 2006). Soybean is grown on an area of 84.084 ha with an annual production of 207.476 tones given an average yield of 2467 kg/ha in Iran (FAOSTAT, 2009). The optimum soybean (*Glycine max*) planting date is determined by a combination of calendar date and climatic conditions. Soybean seed can germinate in soil temperatures as low as 45°F, but temperatures near 50°F provide better and more consistent germination. Optimum soil temperatures for rapid germination and emergence are above 60°F. Sowing date is the variable with the largest effect on crop yield (Calvino et al., 2003a, b). Fine-tune management of soybean by sowing date is a good approach to enhance both crop yield and economic benefit. Effects of planting date on soybean yield and other traits varied at locations (Hoeft et al., 2000; Naeve et al., 2004). Environmental conditions associated with late sowing affect crop features related to the capture of radiation and portioning of crop resources. In spring-sown single crops of soybean, yield is most susceptible to nutritional and water deficits during late flowering and grain filling, and grain number is the main yield component involved in this response (Calvino and Sadras, 1999). Delayed sowing generally shifts reproductive growth into less favorable conditions with shorter days and lower radiation and temperature (Egli and Bruening, 2000). Unlike grain soybean, the taste of the grain and the pod traits of vegetable soybean at harvest are extremely important (Takao, 2004). The yielding ability of green soybean may be affected by its sowing time due to adverse weather conditions and the number of pods set; the green soybean yield decreased with delay in the sowing time (Nishioka and Okumura, 2008; Zhang et al., 2008).

Adjusting planting density is an important tool to optimize crop growth and the time required for canopy closure, and to achieve maximum biomass and grain yield (Ball et al., 2000; Turgut et al., 2005; Svecnjak et al., 2006; Haddadchi and Gerivani, 2009). High populations provide a way to optimize grain yields in short-season production systems (Liu et al., 2007). Bilal Ahmad et al., (2009) stated that the optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions. Ismail and Hall, (2002) stated a decrease in grain yield of cowpea with increased spacing. Bing et al, (2010) reported grain yield and numbers pod per plant were declined with increasing density. Yield potential of soybean is affected by the number of pod per plant, number of seed per pod, and seed weight (Desclaux et al., 2000;

Ohashi and Nakayama, 2009). Liu et al., (2008) stated that Adjusting planting density is an important tool to optimize crop growth and the time required for canopy closure, and to achieve maximum biomass and grain yield. Ball et al, (2000) reported that increasing plants population reduced yield of individual plants but increased yield per unit of area. Plant population can be used as a tool to manage crop growth, maximize biomass, the time required for canopy closure and yield (Akunda, 2001). Information on the effects of component densities of maize and sorghum on the yield of soybean are available (Muoneke et al., 2007). The objective of our study was evaluation of soybean qualities parameters, seed yield and its dependents components response to planting dates and plant density.

2. Material and Methods

In order to evaluation of soybean (*Glycin max* L.), qualities parameters, seed yield and its dependents components response to planting dates and plant density, an experiment was carried out at the Islamic Azad University of Qaemshahr Agronomy farm, Mazandaran, Iran in 2012. The experimental farm is geographically situated at 28°, 56' N latitude and 28°, 36' E longitude at an altitude of 14.5 m above mean sea level. The soil was analyzed and the soil of field was clay-loam (Table 1), weather conditions were also measured in vegetation period (Table 2). This experiment was conducted as split plot in randomized complete blocks design based three replications. Planting dates were chosen as main plots including: May 14 (spring planting date), July 5 (summer planting date) and August 15 (summer delay planting date), and plant density as sub plots including: 20, 40, 60 and 80 plant per m^2, with planting arrangement in order 50×10 cm^2, 50×5 cm^2, 40×4.16 cm^2 and 30×4.16 cm^2, respectively. Plots were planted with a grain drill. According to soil results Urea and potassium (K_2O) were applied 200 and 150 kg/h sequentially, all operations like weeds control, plant illnesses controlling, pests controlling were done during the growth process with chemical components, as manual weeding was applied during the growing season. The number of days from sowing to flowering, number of days from flowering to initial pod filling and number of days from sowing to maturity was recorded. During the growth time, following characteristics was measured randomly from each plot (Plant height, first pod height from ground surface, number of pod per plant, number of grain per pod, 1000-seed weight and seed yield). Oil and protein percentage was measured in lab. Data analyzed by SAS statistical software and Averages comparison were calculated by Duncan's multiple range tests in a 5% probability level.

3. Results and Discussion

Number of days from planting to flowering had significant effect under planting date in 1% probability level (Table 3). Planting date on May 14 (55.17 days) had more flowering duration compare to planting date on July 5 March (45.75 days) and August 15 (33.92 days) (Figure 1). The maximum number days from planting to flowering was obtained at interaction of spring planting date under 20, 40, 60 and 80 plant per square equivalent to 55.33, 55.33, 54.67 and 55.33 days, respectively. The minimum number days from planting to flowering had observed at interaction of summer delay planting date with 20, 40, 60 and 80 plant per square equivalent to 33.67, 34, 34.33 and 33.67 days, respectively (Table 4). All physiological process is under effect of day length, temperature degree and other environmental factors (planting date) and consequently it affects on yield and yield components (Rameeh, 2006). Pedersen and Lauer (2003, 2004a, 2004b) conducted one of the few detailed studies on the effects of early (3–6 May) vs. late (23–27 May) planting dates by examining soybean growth, development, and yield in a 4-yr experiment located in Wisconsin. They observed that the start of each reproductive stage from R_1 (begin flower) to R_5 (begin seed) was delayed by the 3-wk delay in planting date.

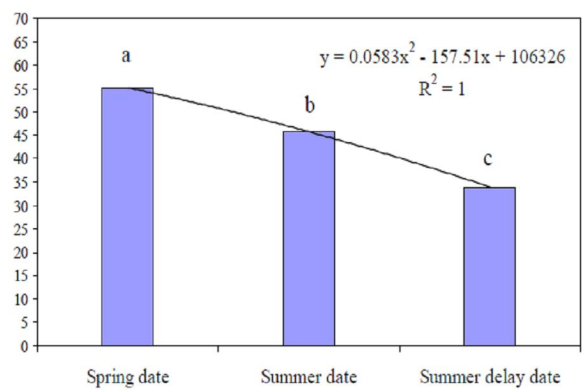

Figure 1. Effect of planting dates on number of days from planting to flowering.

Number of days from flowering to pod filling had significant effect under planting date in 5 % and 1% probability level sequentially (Table 3). Planting date on May 14 (12.67 days) had more pod filling duration compare to planting date on July 5 (9.33 days) and August 15 (9.25 days) (Figure 2). The most number of days from flowering to pod filling was observed at interaction of 14 May with 20, 60 and 80 plant per square (12.67, 12.67 and 13 days), and the least number of day from flowering to pod filling was obtained at interaction of July 5 with 40 and 80 plant per square (8 and 9.33 days) and interaction of August 15 with 20, 60 and 80 plant per square equivalent to 9.33, 8.67 and 9.33 days (Table 4). Late planting date caused to decrease flowering duration and plant maturity. Pedersen and Lauer (2003, 2004a, 2004b) conducted one of the few detailed studies on the effects of early (3–6 May) vs. late (23–27 May) planting dates by examining soybean growth, development, and yield in a 4-yr experiment located in Wisconsin. They observed that the start of each reproductive stage from R_1 (begin flower) to R_5 (begin seed) was delayed by the 3-wk delay in planting date.

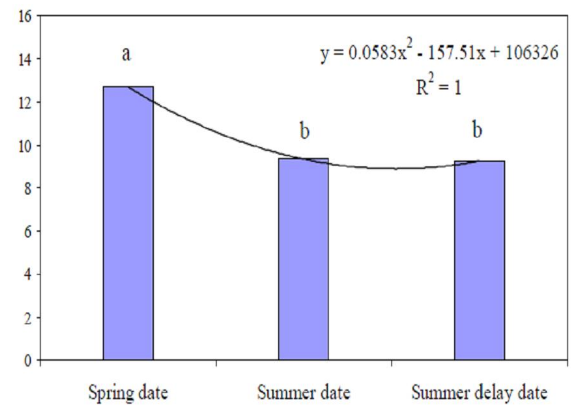

Figure 2. Effect of planting dates on number of days from flowering to filling pod.

Number of days from planting to maturity had significant effect under planting date in 1% probability level (Table 3). Planting date on July 5 (151 days) had more growth duration compared to planting date on May 14 (111.6 days) and August 15 (130 days) (Figure 3). The maximum growth duration had observed at interaction of July 5 with 20, 40, 60 and 80 plant per square equivalent to 150.7, 151.7, 150.7 and 151 days, respectively and the minimum number of days from planting to maturity had obtained at interaction of May 14 with 20, 40, 60 and 80 plant per square equivalent to 111.7, 111.7, 111.3 and 111.7 (Table 4). Late planting date caused to decrease growth duration because growth degree day is low in last planting dates. Pedersen and Lauer (2003, 2004a, 2004b) conducted one of the few detailed studies on the effects of early (3–6 May) vs. late (23–27 May) planting dates by examining soybean growth, development, and yield in a 4-yr experiment located in Wisconsin. They observed that the start of each reproductive stage from R_1 (begin flower) to R_5 (begin seed) was delayed by the 3-wk delay in planting date.

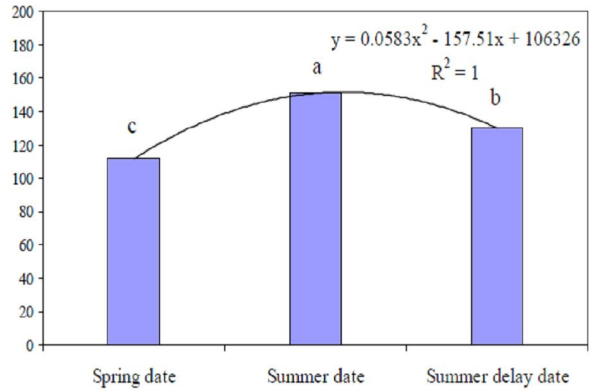

Figure 3. Effect of planting dates on number of days from planting to maturity.

Plant height had significant effect under plant density in 1% probability level (Table 3). The least plant height (62.09 cm) was observed for 20 plants per square and minimum of that was observed for other plant density that equivalent to 70.81, 71.46 and 74.94 cm for 40, 60 and 80 plant per square, respectively (Figure 4). The maximum plant height (84.50 cm) was obtained for interaction of summer planting date with 80 plants per square and the minimum plant height (56.77 cm) had obtained at interaction of summer delay planting date with 20 plants per square (Table 4). Early planting date caused to increase plant height because it has more time to growth that can increase flower and pod. Taller stems can increase photosynthesis if they don't have lodging problem. Pedersen and Lauer (2004a) also used data they collected at 20-d intervals to examine seasonal patterns in plant height and node appearance. At 64 d after emergence, plants in the late May planting were 35 cm shorter than plants in the early May planting, but at R6, plants in both planting dates were nearly equal in height.

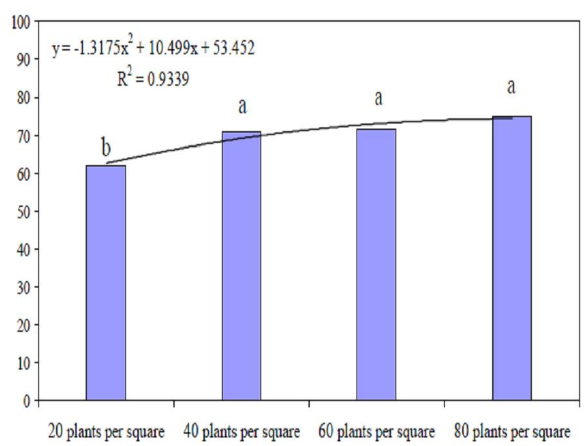

Figure 4. Effect of plant density on plant height.

First pod height from ground surface had significant effect under planting date in 5% and plant density in 1% probability level (Table 3). The most pod height from ground surface (26.01 cm) was produced for planting date on May 14 and minimum of that (17.68 cm) was obtained for planting date on July 5 (Figure 5). The lowest pod height from ground surface (17 cm) was observed for 20 plants per square and the highest of this trait was obtained for 40, 60 and 80 plants per square equivalent to 22.62, 22.52 and 23.79 cm, respectively (Figure 6). The most pod height from ground surface (30.97 cm) was produced at interaction of May 14 with 80 plants per square and the least of that (14.23 cm) had observed at interaction of July 5 with 5 plants per square (Table 3). In late planting dates, plant faced to low temperature in early growth stage, so it has low growth and has not suitable growth before entering in reproductive stage, therefore it often faced with high temperature compare to early planting dates in flowering time, hence first pod couldn't have evolution consequently they are less than early planting dates.

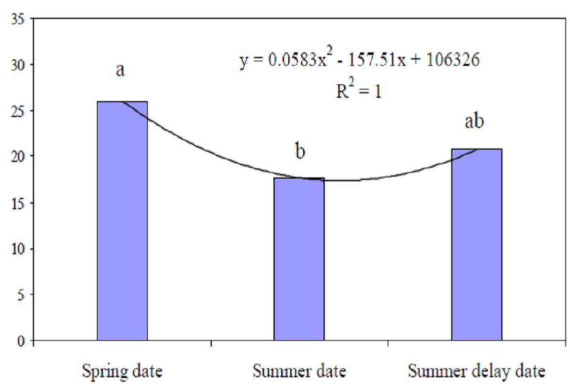

Figure 5. Effect of planting dates on first pod height from ground surface.

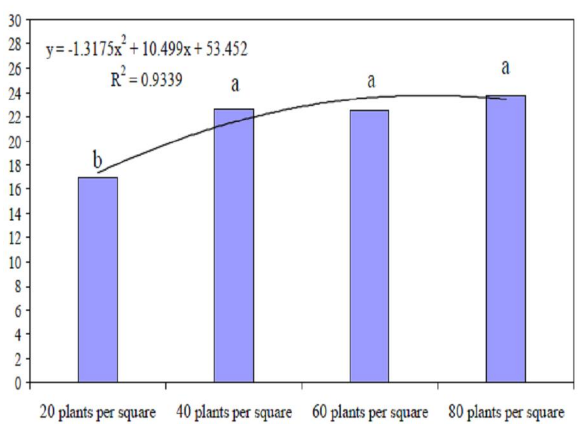

Figure 6. Effect of plant density on first pod height from ground surface.

Number of pod per plant had significant effect under planting date in 5% and plant density in 1% probability level (Table 5). The maximum number of pod per plant (66.75 pods) was produced for planting date on May 14 and minimum of that (48.42 and 37.85 pods) was obtained for planting date on July 5 and August 15. The most number of pods per plant (69.97 pods) was observed in 20 plants per square and least of that had produced for 40, 60 and 80 plants per square equivalent to 51.82, 42.06 and 40.20 pods, respectively (Table 6). The maximum number of pods per plant (93.30 pods) was observed at interaction of spring planting date with 20 plants per square and the minimum of that was obtained at interaction of summer delay planting date with 60 and 80 plants per square equivalent to 28.43 and 30.10 pods (Table 7). Results showed that early planting dates had suitable environmental factors so plant produce more pod. Late planting dates decreased to produce pod because of high temperature in flowering time and beginning of pod produce, so decrease in pod cause to reduce of grain yield. Plant with strong seed dormancy and enough leaf in winter before entering to reproductive stage can have more photosynthesis material for re-growth that it can to keep more flowers and turn to pod. Ozer, (2003) reported that differences in product yield in different planting dates caused to change in pod number in plant. Pedersen and Lauer (2003, 2004a, 2004b) conducted seed number and pod number were greater, but seed per pod was lower, in the early May planting date. However, these yield component differences were small, offering little explanation for the difference in 4-yr seed yield means between 4.23 Mg ha^{-1} recorded in the early May plantings and 3.85 Mg ha^{-1} in the late May plantings.

Number of seed per pod had significant effect under planting date in 1% probability level (Table 5). The maximum number of seed per pod (2.7 seeds) was obtained for planting date on May 14 and the minimum of that (2.45 and 2.50 seeds) was obtained for planting date on July 5 and August 15 (Figure 7). The most number of seed per pod (2.77 seeds) was observed at interaction of spring planting date with 80 plants per square and the least number of seed per pod (2.28 seeds) had produced at interaction of summer planting date with 80 plants per square (Table 7). Angadi *et al.* (2000) have shown that high temperature can caused to decrease grain number per pod. Pedersen and Lauer (2003, 2004a, 2004b) conducted seed number and pod number were greater, but seed per pod was lower, in the early May planting date. However, these yield component differences were small, offering little explanation for the difference in 4-yr seed yield means between 4.23 Mg ha^{-1} recorded in the early May plantings and 3.85 Mg ha^{-1} in the late May plantings.

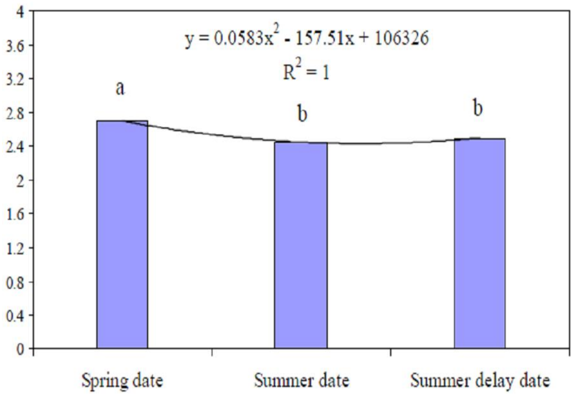

Figure 7. Effect of planting dates on number of seed per pod.

1000-seed weight had significant effect under planting date in 1% probability level (Table 5). The maximum 1000-seed weight (23.47 g) was produced for planting date on July 5 and the minimum of that (19.05 g) was obtained for planting date on August 15 (Figure 8). The most 1000-seed weight had observed at interaction of July 5 with 20, 40, 60 and 80 plants per square equivalent to 23.27, 23.97, 23.70 and 22.93 g and the least 1000-seed weight (17.83 g) was produced at interaction of summer delay planting date with 40 plants per square (Table 7). The plant can't use environmental conditions for photosynthesis and sap production in late planting date, so grain filling reduced because of high temperature consequently stored metabolic material reduced with more respiration, therefore plant produced pods with small grains and less 1000-seed weight (Abadian *et al.,* 2008). Angadi *et al.* (2000) reported that 1000-seed weight decreased with high temperature and unsuitable planting date.

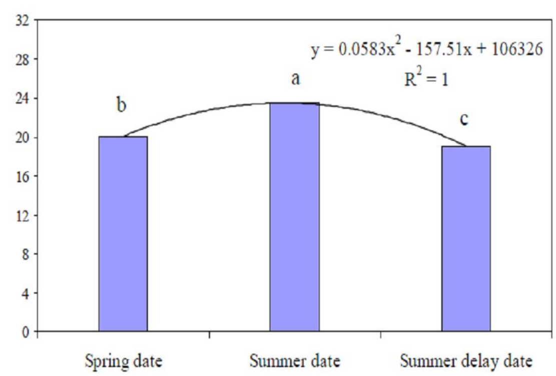

Figure 8. Effect of planting dates on 1000-seed weight.

Seed yield had significant effect under planting date in 5% and plant density in 1% probability level (Table 5). The maximum seed yield was produced for planting date on May 14 and July 5 (420.3 and 382.8 g/m^2) and the minimum of that (279.6 g/m^2) was obtained for planting date on August 15. The most seed yield (508.1 g/m^2) was observed for 80 plants per square and the least seed yield had produced for 20 and 40 plants per square equivalent to 282.4 and 264.6 g/m^2 (Table 6). The maximum seed yield (581.1 g/m^2) was conducted for interaction planting date on spring with 80 plants per square, because of increase number of seed per pod and the minimum of that was produced at interaction of summer delay planting date with 20 and 40 plants per square equivalent to 164.9 and 190.13 g/m^2 (Table 7). Main reason of increase seed yield in early planting dates was favorable temperature degree in growth season, so the plant had more time for growth consequently rapeseed could have use environmental conditions to increase yield with more yield components compare to other planting dates. Duration of Plant vegetative growth was short in planting date on August and plant rapidly went to reproductive stage under environmental conditions and temperature degree, so it caused to intense drop in yield. Morrison and Stewart, (2002) have shown high temperature in end of the season decrease yield and flowering limited with temperature more than 27 $^{\circ}$c. Delayed sowing generally shifts reproductive growth into less favorable conditions with shorter days and lower radiation and temperature (Egli and Bruening, 2000). In a simulation study, Egli and Bruening (1992) found that reduced radiation and temperature accounted for most of the reduction in yield associated with late sowing in well watered soybean crops reaching maturity in late October or early November. Unlike grain soybean, the taste of the grain and the pod traits of vegetable soybean at harvest are extremely important (Takao, 2004). The yielding ability of green soybean may be affected by its sowing time due to adverse weather conditions and the number of pods set; the green soybean yield decreased with delay in the sowing time (Nishioka and Okumura, 2008; Zhang et al., 2008).

Oil percentage had significant effect under planting date and plant density in 1% probability level (Table 5). The maximum oil percentage (24.04 %) was obtained for planting date on August 15 and the minimum of that (22.67 and 22.63 %) was produced for planting date on May 14 and July 5. The most oil percentage (37.75 and 37.74 %) was produced for 20 and 80 plants per square and minimum of that (37 %) was obtained for 60 plants per square (Table 6). The maximum oil percentage (24.75 %) was obtained at interaction planting date on summer delay planting date with 80 plants per square and the minimum of that was observed at interaction of planting date on May 14 with 60 plants per square and July 5 with 60 plants per square (Table 7). Rameeh (2006) and Omidi (2006) have shown in different varieties late planting date caused to decrease oil percentage in rapeseed. Early planting date caused to face pod filling period with moderate temperature and it increases lipids metabolism, fatty acids and oil percentage (Hamrouni *et al.,* 2001).

Table 1. Selected soil properties for composite samples at experimental site.

Soil texture	K (ppm)	P (ppm)	N (%)	OM (%)	pH	EC (μmohs/cm)	Depth (cm)
Clay loamy	228	12	0.22	1.8	7.1	0.26	0-30

Table 2. Weather condition in experiment site in rice growth stages.

Variable	January	February	March	April	May	June	July	August	September	October	November
Minimum tem.	8	6	10	12	14	19	22	25	18	15	14
Maximum tem.	12	8	18	20	24	30	34	34	28	18	16
Evaporation (mm)	45	42	52	58	75	110	128	156	121	85	82
Precipitation (mm)	53	45	36	85	32	28	9.2	12.2	48	82	95

Table 3. Mean square of planting dates and plant density on phonological and morphological traits.

S.O.V.	DF	Number of days from planting to flowering	Number of days from flowering to pod filling	Number of days from planting to maturity	Plant height	First pod height from ground surface
Replication	2	1.86	1.58	0.19	185.06	30.23
Planting dates (A)	2	1360.52**	45.58**	4667.69**	298.73	212.99*
Error	4	5.78	1.67	0.44	137.81	28.53
Plant density (B)	3	0.63	0.99	1.07	268.04**	83.35**
A×B	6	0.82	1.32	0.18	39.71	7.37
Error	18	0.83	2.49	0.86	19.15	7.28
C.V. (%)	-	2.54	15.15	0.69	6.27	12.56

** and * respectively significant in 1% and 5% level.

Table 4. Interaction of planting dates and plant density on phonological and morphological traits.

Interaction	Number of days from planting to flowering	Number of days from flowering to pod filling	Number of days from planting to maturity	Plant height (cm)	First pod height from ground surface (cm)
S_1P_1	55.33 a	12.67 a	111.7 c	66.37 cde	20.40 cd
S_1P_2	55.33 a	12.33 ab	111.7 c	71.30 b-e	26.40 ab
S_1P_3	54.67 a	12.67 a	111.3 c	74.47 bc	26.29 ab
S_1P_4	55.33 a	13.00 a	111.7 c	73.00 bcd	30.97 a
S_2P_1	44.67 b	10.33 abc	150.7 a	63.13 ef	14.23 e
S_2P_2	46.00 b	8.00 c	151.7 a	75.57 b	19.00 cde
S_2P_3	46.00 b	9.67 bc	150.7 a	72.43 bcd	18.93 cde
S_2P_4	46.33 b	9.33 c	151.0 a	84.50 a	18.57 cde
S_3P_1	33.67 c	9.33 c	129.7 b	56.77 f	16.37 de
S_3P_2	34.00 c	9.67 bc	130.7 b	65.57 de	22.47 bc
S_3P_3	34.33 c	8.67 c	129.7 b	67.47 b-e	22.33 bc
S_3P_4	33.67 c	9.33 c	130.0 b	67.23 b-e	21.83 bc

Values within a column followed by same letter are not significantly different at Duncan ($P \leq 0.05$).
S_1, S_2 and S_3: Sowing dates May 14, July 5 and August 15, respectively.
P_1, P_2, P_3 and P_4: Plant density 20, 40, 60 and 80 plant per m^2, respectively.

Table 5. Mean square of planting dates and plant density on qualities parameters, seed yield and its dependents components.

S.O.V.	DF	Number of pod per plant	Number of seed per pod	1000-seed weight	Seed yield	Oil percentage	Protein percentage
Replication	2	485.44	0.02	0.72	2816.57	0.38	0.09
Planting dates (A)	2	2566.48*	0.21**	64.28**	63705.96*	7.72**	20.2599
Error	4	245.21	0.02	0.41	7954.10	0.16	0.22
Plant density (B)	3	1671.13**	0.02	0.44	113622.85**	1.34**	1.31*
A×B	6	113.54	0.03	1.58	6114.10	0.42	0.22
Error	18	136.31	0.02	0.81	6032.09	0.30	0.35
C.V. (%)	-	22.89	5.17	4.32	21.52	2.37	1.58

** and * respectively significant in 1% and 5% level.

Table 6. Mean comparison of planting dates and plant density on qualities parameters, seed yield and its dependents components.

Treatments	Number of pod per plant	Seed yield (g.m^{-2})	Oil percentage	Protein percentage
Planting dates				
May 14	66.75 a	420.3 a	22.67 b	36.55 b
July 5	48.42 b	382.8 a	22.63 b	38.99 a
August 15	37.85 b	279.6 b	24.04 a	37.05 b
Plant density				
20 plants per m^2	69.97 a	282.4 c	23.46 a	37.75 a
40 plants per m^2	51.82 b	264.6 c	22.92 ab	37.56 ab
60 plants per m^2	42.06 b	388.5 b	22.67 b	37.00 b
80 plants per m^2	40.20 b	508.1 a	22.41 a	37.74 a

Values within a column followed by same letter are not significantly different at Duncan ($P \leq 0.05$).

Table 7. Interaction of planting dates and plant density on qualities parameters, seed yield and its dependents components.

Interaction	Number of pod per plant	Number of seed per pod	1000-seed weight (g)	Seed yield (g.m^{-2})	Oil percentage	Protein percentage
S_1P_1	93.30 a	2.73 ab	19.90 b	391.14 bc	23.13 cde	36.66 bcd
S_1P_2	68.52 b	2.65 abc	20.13 b	304.9 cd	22.93 cde	36.58 bcd
S_1P_3	58.57 bcd	2.65 abc	19.97 b	403.9 bc	22.19 e	36.19 cd
S_1P_4	46.63 b-e	2.77 a	20.23 b	581.1 a	22.46 de	36.77 bcd
S_2P_1	62.40 bc	2.50 bcd	23.27 a	291.0 cd	22.89 cde	39.20 a
S_2P_2	48.27 b-e	2.55 abc	23.97 a	298.5 cd	22.41 de	39.05 a
S_2P_3	39.17 de	2.48 bcd	23.70 a	458.4 ab	22.21 e	38.70 a
S_2P_4	43.87 cde	2.28 d	22.93 a	483.3 ab	22.03 cde	38.91 a
S_3P_1	54.20 bcd	2.60 abc	19.00 bc	164.9 d	24.38 ab	37.30 bc
S_3P_2	38.67 de	2.42 cd	17.83 c	190.13 d	23.42 bcd	37.04 bcd
S_3P_3	28.43 e	2.55 abc	19.13 bc	303.3 cd	22.62 bc	36.10 d
S_3P_4	30.10 e	2.43 cd	20.23 b	460.0 ab	24.75 a	37.55 b

Values within a column followed by same letter are not significantly different at Duncan ($P \leq 0.05$).

S_1, S_2 and S_3: Sowing dates May 14, July 5 and August 15, respectively.

P_1, P_2, P_3 and P_4: Plant density 20, 40, 60 and 80 plant per m^2, respectively.

Protein percentage had significant effect under plant density in 5% probability level (Table 5). The maximum protein percentage had obtained for July 5 (38.99 %) and the minimum of that had observed for May 14 and August 15 (36.55 and 37.05 %). The most protein percentage had observed for 20 and 80 plants per square equivalent to 37.75 and 37.74 %) and the least protein percentage was obtained in 60 plants per square (37 %) (Table 6). The maximum protein percentage was produced at interaction of July 5 with 20, 40, 60 and 80 plants per square equivalent to 39.20, 39.05, 38.70 and 38.91 %, and the minimum of that (36.10 %) had obtained at interaction of summer delay planting date with 60 plants per square (Table 7).

Corresponding Author:
Dr. Salman Dastan
Department of Agriculture
Science and Research Branch, Islamic Azad University
Mazandaran, Iran
E-mail: sdastan@srbiau.ac.ir

References

1. Abadian, H., Latifi, N., Kamkar, B., & Bagheri, V. M. (2008). Consider effect of late planting time, density on quantitative, qualitative characteristics in Canola at Gorgan. *Agricultural Science and Natural Resources in Gorgan Journal*. 5:15.
2. Akunda, E. M. (2001). Intercropping and population density effects on yield component, seed quality and photosynthesis of sorghum and soybean. *J. Food Tech. (Africa)*. 6: 170-172
3. Angadi, S. V., Cutforth, H. W., Miller, P. R., McConkey, B. G., Entz, M. H., Brant, S. A., & Volkmar, K. M. (2000). Response of three Brassica species to high temperature stress during reproductive growth. *Can. J. Plant Sci*. 80: 693-701.
4. Ball, R. A., Purcell, L. C., & Vories, E. D. (2000). Optimizing soybean plant population for a short-season production system in the Southern USA. *Crop Sci*. 40: 757-764.
5. Bilal Ahmad, L., Badrul, H., Amarjeet, S., Haq, S. A., & Sofi. N. R. (2009). *ARPN Journal of Agricultural and Biological Science*. 4(2):19-25.
6. Bing, L., Liu, X., Wang, C., Jin, J., Herbert, S. J., & Hashemi, M. (2010). *Int. J. Plant Prod*. 4(1): 1-10.

7. Calvino, P.A., & Sadras, V. O. (1999). Interannual variation in soybean yield: interaction among rainfall, soil depth and crop management. *Field Crops Res.* 63: 237-246.
8. Calvino, P. A., Sadras, V. O., & Andrade, F. H. (2003a). Quantification of environmental and management effects on the yield of late-sown soybean. *Field Crops Res.* 83: 67-77.
9. Calvino, P. A., Sadras, V. O., & Andrade, F. H. (2003b). Development, growth and yield of late-sown soybean in the southern Pampas. *Europ. J. Agro.* 19: 265-275.
10. Desclaux, D., Huynh, T. T., & Roumet, P. (2000). *Crop Sci.* 40: 716-722.
11. Egli, D. B., & Bruening, W. P. (1992). Planting date and soybean yield: evaluation of environmental effects with a crop simulation model: *SOYGRO. Agric. Meteorol*. 62: 19-29.
12. Egli, D. B., & Bruening, W. P. (2000). Potential of early-maturing soybean cultivars in late plantings. *Agro. J*. 62: 19-29.
13. FAOSTAT, (2009). Online at http://faostat.fao.org/site/339/default.aspx.CA Francis,1986, MacMillan, L., Publishing Co. New York.
14. Haddadchi, G. R., & Gerivani, Z. (2009). Effects of phenolic extracts of canola (*Brassica napuse* L.) on germination and physiological responses of soybean (*Glycin max* L.) seedlings. International Journal of Plant Production, 3(1): 63-74.
15. Hamrouni, I., Hammadi, B. S., & Marzouk, B. 2001. Effect of water deficit on lipids of safflower aerial parts. Phyto-chemistry. 58: 277-280.
16. Hoeft, R. G, Nafziger, E. D., Johnson, R. R., & Aldrich, S. R. (2000). Modern corn and soybean production. *MCSP Publications, Champaign, LJ*.
17. Ismail, A. M., & Hall, A. E. (2002). *Crop Sci.* 40: 1618-1624.
18. Lei, W., Tong, Z., & Shengyan, D. (2006). *Acta Ecologica Sinica*. 26(7): 2073-2078.
19. Liu, X. B., Herbert, S. J., Zhang, Q. Y., & Hashemi, M. (2007). Yield-density relation of glyphosate-resistant soya beans and their responses to light enrichment in north-eastern USA. *J. Agron. Crop Sci.* 193: 55-62.
20. Liu, X. B., Jin, J., Wang, G. H., & Herbert, S. J. (2008). *Field Crops Res.* 105: 157-171.
21. Morrison, M.J., & D.W. Stewart. 2002. Heat stress during flowering in summer brassica. *Crop Sci.* 42: 797-803.
22. Muoneke, C. O., Ogwuche, M. A. O., & Kalu, B. A. (2007). Effect of maize planting density on the performance of maize/soybean intercropping system in a guinea savanna agro ecosystem. *Afr. J. Agric. Res.* 2: 667-677.
23. Naeve, S. L, Potter, B. D., Quiring, S. R., O'Neil, T. A., & Kurle, J. E. (2004). Influence of soybean plant population and row spacing on development and yield across planting dates in Minnesota. Available at www.soybeans.umn.edu/pdfs/2004asaposter-1-spacing planting-screen.pdf(verified 11Dec.2007). Univ. of Minnesota, Minneapolis.
24. Nishioka, H., & Okumura, T. (2008). Influence of sowing time and nitrogen topdressing at the flowering stage on the yield and pod character of green soybean (*Glycine max* (L.) Merril). *Plant Prod. Sci.* 11(4): 507-513.
25. Ohashi, Y., & Nakayama, N. (2009). *Acta Physiol Plant*. 31: 271-277.
26. Omidi, H. (2006). Effect of planting date and harvesting time on grain shattering of Canola cultivar. 9th Congress of agronomical science and plant breeding, Tehran, Iran.
27. Ozer, H. (2003). Sowing date and nitrogen rate effects on growth, yield and yield component of two summer rapeseed cultivars. *Europ J. Agron*. 19: 453-463.
28. Pedersen, P., & Lauer, J. G. (2003). Soybean agronomic response to management systems in the Upper Midwest. *Agron. J.* 95:1146–1151.
29. Pedersen, P., & Lauer. J. G. (2004a). Soybean growth and development in various management systems and planting dates. *Crop Sci*. 44:508–515.
30. Pedersen, P., & Lauer, J. G. (2004b). Response of soybean yield components to management system and planting date. *Agron. J*. 96:1372–1381.
31. Rameeh, V. (2006). Consider effect of different planting times on yield and other agronomical traits in canola. 9th Congress of agronomical science and plant breeding, Tehran, Iran.
32. Svecnjak, Z., Varga, B., & Butorac, J. (2006). Yield components of apical and sub apical ear contributing to the grain yield responses of prolific maize at high and low plant populations. *J. Agron. Crop Sci.* 192: 37-42.
33. Takao, Y. (2004). Vegetable Horticulture Encyclopedia. Second edition Vol. 8. Rural Culture Association. Tokyo, pp. 397-399.
34. Turgut, L., Duman, A., Bilgili, U., & Acikgoz, E. (2005). Alternate row spacing and plant density effects inforage and dry matter yield of corn hybrids (*Zea mays* L.). *J. Agron. Crop Sci*. 191: 140-151.
35. Zhang, Q. Y., Herbert, S. J., & Pan, X. W. (2008). Field performance of vegetable soybean varieties (lines) in Northeast USA. *Soybean Sci.* 27(3): 409-413.

9/14/2012