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EFFECTS OF PLANTING DATE AND CULTIVAR ON THE YIELD AND YIELD COMPONENTS OF SOYBEAN IN NORTH OF IRAN

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ABSTRACT

In order to study the effect of planting date and cultivar on yield and yield components of soybean, an experiment was conducted for two seasons (2009-2010) at Kateshal Research Station, Lahijan, northern Iran. Three cultivars, Hill, Sahar and Zan were sown on four sowing dates of April 20, April 30, May 10 and May 20 during the two consecutive crop seasons. The design was a split-plot replicated three times with sowing date as main plots and cultivar as sub-plots. Data were collected on number of pods per plant, seeds number of main stem pods, pod length, maturity period duration, oil percent, protein percent, 1000- seed weight and seed yield. Mean comparison had been done by Duncan's test that showed there were significant differences among means of traits at different planting date treatments. Also, there were significant differences among interaction of date of planting and cultivars for all traits at 1% level. The data were analyzed statistically, which showed that the cultivars with early sowing produced gave higher yield and quality as compared to the late sowing date. The results revealed that higher numbers of pods per plant and seeds number of main stem pods were produced by April 30 and Sahar cultivar. Similarly maximum seed yield (4176.09kg ha^{-1} and 3219.96 kg ha^{-1}) were produced by April 20, Sahar and April 30, Sahar, respectively.

Keywords: planting date, soybean cultivar, seed yield.

INTRODUCTION

Planting delay causes those plantlets face with frost damage before crop maturity in the end season. Generally, the time of planting varies depending on the climatic condition of the region and the variety to be grown. Different varieties of soybean are sensitive to change in environmental conditions where the crop is being grown. Therefore, it is necessary to study the genotype × environment interaction to identify the varieties which are stable in different environments (Calvino *et al*., 2003a). The previous studies showed that the early or late planting significantly reduced the crop yield (Board and Harvills, 1992; Kil *et al.*, 1998 and Rehan, 2002). 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. These include less vegetative growth (Board *et al*., 1992), shorter stems (Boquet, 1990); lower reproductive nodes (Board *et al*., 1999), and shortening of the reproductive phases (Kantolic and Slafer, 2001). 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 (Andriani *et al*., 1991; 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). 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). If seeds are over matured then it will lose its marketability. Like many other vegetables, in order to increase the profitability of vegetable soybean production, sowing at different dates might be a good strategy for maximum profitability. 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). Large pods containing many grains are considered to be of good quality. While variation in soybean planting date is expected to impact the pattern of soybean growth and development, very few reports have been examined in vegetable soybean. The aim of this research was to evaluate the effect of planting dates and genotypes on yield and yield components in north of Iran.

MATERIALS AND METHODS

In order to evaluate the planting dates effects and cultivar on yield and yield components of soybean, a split-plot experiment based on randomize complete block design with three replications was conducted at kateshal research station, Lahijan, northern Iran during two cropping seasons (2009 and 2010). Four planting dates including April 20, April 30, May 10 and May 20 (P1, P2, P3 and p4, respectively) were considered as main plots and the cultivars including Hill, Sahar and Zan (C1, C2 and C3, respectively) were also considered as sub- plots. The soil was classified as a deep loam soil (Typic Xerofluents, USDA classification) contained an average of

280 g clay kg^{-1}, 560 g silt kg^{-1}, 160 g sand kg^{-1}, and 22.4 g organic matter kg^{-1} with a pH of 7.3. Each sub plot was consisted of four rows 6 m long and 50 cm apart. The distance between plants on each row was 10 cm resulting in approximately 240 plants per plot, which were sufficient for statistical analysis. Crop management factors like land preparation, crop rotation, fertilizer, and weed control were followed as recommended for local area. All the plant protection measures were adopted to make the crop free from insects. The data were recorded on ten randomly selected plants of each entry of each replication for number of pods per plant, seeds number of main stem pods, pod length, maturity period duration, 1000- seed weight and seed yield was recorded based on two middle rows of each plot. Oil content was estimated with the help of nuclear magnetic resonance spectrometry (Madson, 1976). Combined analyses of variance of split-plot experiment were done for all the traits (Steel *et al*., 1997). All statistical analyses were carried out using SAS soft ware.

RESULTS AND DISCUSSIONS

Analysis of complete variance showed that there were significant differences between years on number of pods per plant, between years and cultivars on number of pods per plant and between years, planting dates and cultivars on number of pods per plant, pod length and oil percent (Table-1). The most seed yield and yield components were related to 2010 (Table-2). The result of yield rise was the suitable climate condition in 2010. In addition of the drought, climate condition was unsuitable that causes the seed yield becomes 2733.83 kg/ha^{-1} in 2009.

The Analysis of Variance (ANOVA) shows highly significant (P = 0.01) effects of planting date on all traits studied.

Number of pods per plant

The results of analysis of variance (Table-1) revealed that number of pods per plant was significantly affected by planting dates and cultivar. Their interaction had effect on number of pods per plant. Maximum plants (20.62) were recorded in 20 April, which had significantly different with other planting dates. These results confirm the findings of Egli and Bruening (2000), who observed low initial stands of plants in early sowing. In cultivar, maximum number of pods per plants (22.85) was recorded in Sahar. In case of interactions (C x P) was significant and maximum number of pods per plant 22.83 was recorded at (C1 x P1). The probable reason for this might be due to mortality of plants caused by heavy rains.

Seeds number of main stem pods

Planting dates and cultivar had significant effect on seeds number of main stem pods and their interaction had significant effect, too. Maximum seeds number of main stem pods (35.99) was recorded for those plots grown on 30 April. These results are quite similar to the findings of Calvino *et al.* (2003b), who reported higher seeds number of main stem pods in early planting as compared to late planting. In cultivar, maximum seeds number of main stem pods (43.52) was recorded in Sahar. These results are quite in line with the findings of Lee and Hwang (1998), who reported that number of pods per plant was significantly affected by genotype. In case of interactions (C x P) was significant and maximum seeds number of main stem pods 46.86 were recorded at (C2 x P2).

Pod length

The planting dates showed significant effect for pod length. Maximum number (4.49) of pod length was observed in P1 treatment against the minimum number (4.13) of pod length in P3 treatment. This might be due to decrease vegetative growth and increased reproductive growth, which favored the pod length. These results are in support of Weaver *et al.* (1991). However, in case of cultivars the pod length for C2 treatment, C1 treatment and C3 treatment were 4.55, 4.29 and 4.26, respectively which were significantly different from one another. The results are in line with those of Egli and Bruening (2000) in case of soybean, who reported that different planting and cultivar significantly affected the pod length. In case of interactions (C x P) was significant and maximum pod length 4.71 was recorded at (C2 x P2).

Maturity period duration

The results of analysis of variance (Table-1) revealed that maturity period duration was significantly affected by planting dates and cultivar. Their interaction had effect on maturity period duration. Maximum plants (161.99) were recorded in 20 April, which had significantly different with other planting dates. These results confirm the findings of Board and Hall (1984), who observed longer of maturity period duration in early sowing. In cultivar, maximum number of maturity period duration (160.14) was recorded in Hill. In case of interactions (C x P) was significant and maximum maturity period duration 172.33 was recorded at (C1 x P1).

Oil and protein percent

The results of analysis of variance (Table-1) revealed that oil and protein percent were significantly affected by planting dates and cultivar. Their interaction had effect on oil and protein percent. Maximum of 20.74 oil percent was recorded for p1. Nishioka and Okumura (2008) also found similar results and suggested that the increased oil with early sowing. Maximum of 36.25 protein percent was recorded for P2 by 35.92 in P1. In cultivar, maximum oil percent (20.17) was recorded in Zan, wherever, higher protein was recorded in Sahar. In interaction maximum oil percent of 21.74 were recorded at C2P4 and C3P1, while minimum of 18.02 oil percent was recorded for C2P2. Calvino et *al.* (2003a) who found that sowing methods affected the oil percent and maximum oil percent was recorded with early sowing. In interaction maximum number protein percent of 39.90 was recorded

at C2P2, while minimum of 29.96 protein percent was recorded for C3P4. Younas (1993) who found that sowing methods affected the protein percent and negative correlation was recorded between oil and protein.

1000-seed weight

Sowing time treatments showed that P1 (20 April) gave the maximum 1000-seed weight (203.82 g) against the minimum 1000-seed weight (140.37 g) in P4 (20 May). This may be the result of short vegetative period of growth and comparatively long reproductive and grain filling period, which significantly raised 1000-seed weight. These results are supported by that of Pedersen and Lauer (2004b), in case of soybean, who reported that average seed weight from early planting was greater than that from late planting. Similarly, maximum 1000-seed weight (224.4 g) was recorded in Zan cultivar against the minimum 1000-seed weight (148.22 g) in Sahar. These results are in line to the findings of Pedersen and Lauer (2004a), who viewed that planting dates and cultivar have a significant influence on 1000-grain weight. In case of interactions (C x P) was significant and maximum 1000-seed weight 306.33 was recorded at (C3 x P2).

Seed yield

Seed yield was significantly affected by different sowing dates, cultivar and their interactions (Table-1). The maximum seed yield and yield components belonged to the first (3439 kg/ha^{-1}) planting date, April 20 (Table-2). For these plants there was more time for plant growth in suitable temperature and moisture, so seed yield increasing is rational. With planting delay the growth period becomes short, while high temperature during flowering decreases the seed yield and yield components of soybeans planted early. Also in other studies, the planting delay decreased the yield (Kane *et al*., 1997; Kantolic and Slafer, 2001; Egli and Bruening, 2000; Board *et al*., 1999). The probable reason for this might be heavy rains, which adversely affected the soybean production. Maximum seed yield of 3301 kg/ha^{-1} was recorded in Sahar cultivar. These results are in accordance with the results of Evans (1996), who found that genotypes had significant effect on seed yield. In case of interactions (C x P) was significant and maximum seed yield of 4176.09 kg/ha^{-1} were recorded at (C2 x P1). Minimum seed yield of 1696 kg/ha^{-1} was recorded at (C3P3).

Table-1. Mean squares of evaluated characteristics of soybean cultivars with different planting dates during two years.

		Number of pods per plants	**Seeds number of main stem pods**	**Pod length** (cm)	**Maturity period duration**	**Oil** (%)	**Protein** (%)	**1000-seed weight** (gr)	**Seed yield** (kg/ha^{-1})
S.O.V	df	M.S							
Year (Y)	1	7.25*	5.68	0.075	13.69	1.01	2.05	30.58	18.96
Error a	4	2.75	3.26	0.065	7.12	0.81	1.32	20.56	9.23
P (Planting date)	3	86.96**	23.94**	0.55**	74.74**	7.74**	28.92**	89.36**	190.00**
P×Y	3	25.01**	4.36	0.32*	6.23	1.23	2.02	55.01*	20.36
Error b	12	1.95	2.95	0.042	4.17	0.75	1.42	25.01	10.84
C (Cultivar)	2	42.5*	21.14*	0.75*	185.33**	13.76**	40.69**	208.55*	199.9**
C×Y	2	6.05*	2.37	0.021	7.56	0.10	0.25	37.25	18.00
C×P	6	6.01*	39.62**	0.12**	29.07**	0.34*	0.48*	65.9*	36.31*
C×P×Y	6	5.02*	3.06	0.14**	8.02	0.38*	0.30	25.13	15.31
Error c	32	1.95	2.08	0.025	4.01	0.12	0.19	16.73	9.32
C.V%		10.31	7.35	4.30	8.70	9.40	7.60	6.25	8.20

* and ** significant at 5% and 1% level of probability, respectability
Y: year P: planting date C: cultivar

Table-2. Mean characteristics of soybean cultivars during two years together mean main effects (planting date and cultivar) and interaction effect (planting date ×cultivar) on characteristics during two years.

	Number of pods per plants	**Seeds number of main stem pods**	**Pod length** (cm)	**Maturity period duration**	**Oil** (%)	**Protein** (%)	**1000-seed weight** (gr)	**Seed yield** (kg/ha^{-1})
Year								
2009	16.95b	30.77a	4.37a	152.50a	19.74a	34.12a	174a	2733.83a
2010	19.02a	32.25a	4.53a	147.50a	20.12a	36.00a	177a	2859.63a
Planting date (P)								
20Apr (P1)	20.62a	34.97a	4.49a	161.99a	20.74a	35.92a	203.82a	3439.56a
30Apr (P2)	18.42b	35.99a	4.50a	155.77b	19.00c	36.25a	202.32a	2686.51b
10May (P3)	14.66c	26.49b	4.13b	150.33c	19.30bc	33.17b	160.15b	2411.65c
20May (P4)	14.09c	25.62b	4.35ab	140.22d	19.91b	31.98c	140.37c	2397.58c
Cultivar (C)								
Hill (C1)	17.02b	31.11b	4.29b	160.14a	19.54b	34.59b	157.30b	2705.66b
Sahar (C2)	22.85a	43.52a	4.55a	158.49a	19.48b	36.12a	148.22b	3301.55a
Zan (C3)	10.98c	17.68c	4.26b	137.58b	20.17a	32.31c	224.48a	2194.32c
Treatment (P×C)								
C1P1	22.83a	37.20bc	4.36bcd	172.33a	20.85b	35.81abc	193.41c	3000.52bc
C1P2	18.10cd	32.00cd	4.30bcd	165.66ab	19.94cd	35.62abcd	141.63e	2738.34bcd
C1P3	14.06de	29.73de	4.00d	157.66cd	18.97e	35.33abcd	152.21de	2606.36bcde
C1P4	13.10ef	25.53de	4.53abc	145.01ef	18.41f	31.63cde	141.96e	2477.43cdef
C2P1	24.81a	45.61a	4.83a	169.66ab	19.63d	37.33a	141.96e	4176.09a
C2P2	25.33a	46.86a	4.71ab	162.01bcd	18.02f	39.90a	159.00d	3219.96b
C2P3	20.53bc	39.6ab	4.16cd	155.33d	18.55ef	32.81a	140.81e	2932.56bc
C2P4	20.73bc	42.03ab	4.51abc	147.02e	21.74a	34.36abcd	151.13de	2877.41bc
C3P1	14.23de	22.13e	4.34bcd	144.03ef	21.74a	34.63abcd	276.1b	3142.09bc
C3P2	11.83ef	29.13de	4.51abc	139.66ef	19.04e	33.26abcd	306.33a	2101.24def
C3P3	9.40f	10.16f	4.23cd	138.04f	20.40bc	31.42de	187.46c	1696.05f
C3P4	8.45g	9.3f	4.03d	128.66g	19.59d	29.96e	128.03f	1837.92ef

Means with the same letters in each column do not have significant difference at the 5% level of probability according to Duncan test.

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