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Evaluation of relationship among phenological and morphological traits yield components and seed yield in soybean varieties in Mazandaran Province

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Abstract

In order to evaluation of relationship among phenological and morphological traits, yield components, seed and in soybean varieties , an experiment was laid out in split-plot based on randomized complete block design with four replications at Dashtenaz region of Mazandaran province in 2013. Main plot was seed rates including 55, 70 and 85 kg.ha^{-1} and sub sub plots were six soybean cultivars including Sari (JK), Telar (BP), Caspian (033), Nekador(032), Katol(DPX) and Sehar(Pershing). Results showed that seed rates had significant effects on all the traits. The varieties were different for all the traits. Non-significant interaction effects of seed rates and cultivars for most of the traits except duration of flowering and first pod height from earth indicating that variations of the traits of each cultivar had similar trend in different seed rates. Average seed yield of the genotypes for 55, 70 and 85 kg.ha^{-1} were 2999, 3246 and 2700 kg.ha^{-1}, respectively.The results of correlation analysis showed that duration of flowering was affected by days to flowering and days to maturity. 1000-seed weight had significant positive correlation with days to flowering and duration of flowering, indicating the same directions of variation of these traits. Seed yield had significant positive correlation with yield components including pods per plant, 1000-seed weight, harvest index, indicating these component characters had prime importance role on seed yield.

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Introduction

Oil as a primary source of protein and energy, has an important role in human's nutrition so that today oilseed crops are considered as the second most important source of energy supply (Delka *et al.*, 2005; Khalili, 2005; Sedaghati, 2003). Also vegetable oils are of a better quality compared to animal fats, because of the low amount of saturated fatty acids (Beaver and Johnson, 1981). Oilseeds, are considered as the essential food for human that with different products not only provide a part of the human food needs, but also have industrial and pharmaceutical uses and that is why they are considered as important agricultural products (Bergland, 2002). Past researches indicate that only about 9% of the country's oil needs are domestically produced and the rest that is 91.7 percent should be imported from abroad, and to amend the severe shortage, the researchers found that a lot of work is needed to increase oil production in the country, which is possible to achieve both through an increase in area under cultivation and the increased yield per unit area, among which the second option seems more logical (Zaman and Malik, 2002). The new cultivars have an important role in increasing the yield and tolerance to environmental stresses. In order to increase the efficiency of selection in generations of segregation and selection to understand and analysis characteristics of the study will be inevitable to specify the selection index (Ashraf *et al.*, 2013). The simple correlation factors is often used to study the relationship between of plant characteristics and seed yield are used together, the result is a genes linkage and effects of Pleiotropy (Bartul *et al.*, 1985).From the habit of growth, soybean is divided into three varieties of indeterminate growth, determinate growth, and semi-determinate growth. Indeterminate varieties begin to flower when they have only half the main stem nodes, therefore, development of vegetative and reproductive organs of plants mostly starts with its life cycle .In this varieties, pod and seed formation starts from the lower part of plant, and simultaneously continues upward with the formation of new nodes. But this varieties as well as the other varieties of all beans grows at the same time. In the determinate growth, flowering starts once the end node of the main stem is formed or begins to be formed (Ablett *et al.*, 1991). Soybean cultivation has some advantages. Including symbiotic nitrogen-fixing bacteria in the roots of soybean that fixes the nitrogen in the air, and as a result the plant will require less nitrogen during growth stages. Also some of the fixed nitrogen by symbiotic bacteria remains in the soil and the subsequent crops will require less nitrogen. Soybean cultivation has led to reduced incidence of pests and diseases and weeds in the field (Bharati *et al.*, 1986). Deep planting of seed cultivars that genetically, have a shorter hypocotyl are also not recommended. Deep cultivation of soybean seeds in some cases even increased the risk of soil diseases is the greening seedlings (Jason and Emerson, 2005). Many factors, including weather conditions, planting design, seeding rate, management of farm operations and food can cause a variety of performance and other characteristics of soybean (Dekeeijer *et al.*, 2003). Yield is affected by changes in plant population and row spacing (Akond *et al.*, 2013). Biological yield has been confirmed as one of the best indicators of selection in many studies (Blum, 2011). The researchers concluded that soy density per unit area can reduce the yield per unit area due to increased competition for water and nutrients (Khalili, 2005). In studying the physiological response of soybean varieties to plant densities it was found that in all studied varieties yield of product was higher in high density compared to low density. There is a relationship between the reduction in seed yield at low density and reduced number of pods or seed per unit area (Gan *et al.*, 2002). Yield is the result of increase in the number of pods and seed. Although higher seed rate, provides more functionality, low seed rate causes increase in plant yield. This increase is due to new varieties and higher abilities of cultivars to head higher in low seeding situations, while heading is highly reduced in comparison to seeding rates. The soybean planting in 40cm rows and observed that significant yield increase in contrast to 75cm rows (Walker *et al.*, 2009). In studying the yield and yield components of Soybean, Goli and Olsen have shown that increase in density causes the

decrease in the seed yield in minor branches, pod numbers, and seed yield in a plant (Goli and Olsen, 1983). Density increment can decrease the amount of oil and increase the seed's protean. In this connection, many researchers have reported existence of reverse relationship between protean amount and seed oil as the relation is negative among them (Cober and Voldeng, 2000).The lodging increases as density increases but harvesting soybean with combine harvester has not created much casualty in high densities (Johnson and Major, 1999). Changes in node's numbers in main stem are different as a consequent of density increment proportional to growth mode. In Fykobi varieties (limited Growth), node's rate was not under the influence of density but in varieties 903-52 (semi-limited growth), node decreases as density increases. As density increase, the first pod's height increases from the earth surface consequently. In unlimited varieties, as height increases in high density, the main stem's diameter decreases and causes the increase in lodging. In limited growth, high density does not face lodging (De Bruin and Pederson, 2008). In this study, we investigated the effects of different cultivars on agronomic characteristics and yield of soybean cultivars and also by determining the appropriate values for the cultivars in Mazandaran climate, we determined the effect of seeding rate on yield components, seed and oil yields and specified the correlation rate of traits and the most effective rates on the yield of desired seed cultivars.

Material and methods

This scheme was done in the crop year of 2013 in a region with 36 degrees longitude, 42 minutes east and with 53 degrees latitude, 13 minutes North and a height of 16 meters above sea level, with warm summers and cold and humid winters and the annual rainfall of 560 mm. The experiment is established through designs of in split plots in the form of randomized complete block design with four replications which contains two factors of density (consumed seed rates) and soybean cultivars. The amounts of seeds are 55, 70, 85 kg/ha are considered as the main factor and the soybean cultivars as the sub factor in Sari (JK), Telar (BP), Caspian (033), Nekador (032), Katul (D.P.X), and Sahar (Pershing). Fourteen traits days to flowering, days to the end of flowering, flowering period , plant height in flowering stage, day to maturity, pod's height from surface, pod's numbers in main stem, pod's number in shrub, number of seeds per pod, 1000-seed weight, Harvest Index, seed yield, oil content and oil yield were evaluated.

Experiment site and soil characterization

To determine the soil characteristics (texture and chemical characteristics of the soil) sampling was done prior to testing, for this project the site was sampled at several points at the depth of 0-30 cm(Table 1).

Statistical analysis

Data obtained was analyzed by SAS and MSTAT-C statistical software were compared through the comparisons of Duncan's multi-domain mean. In each group of comparing the mean, the means that have at least one letter in common are not statistically significant.

Characteristics of soybean cultivars

1 - Sari (JK): semi-limited growth mode (Semi-determinate), 2 - Telar (BP): Semi-limited growth mode (Semi-determinate), 3 - Caspian (033): semi-limited growth mode (Semi-determinate), 4- Nekador (032): semi-limited growth mode (Semi-determinate), 5 - Sahar (Pershing): semi-limited growth mode (Semi-determinate), 6 - Katul (DPX): semi-limited growth mode (Semi-determinate).

Research Stages

The field was planted for wheat in the last year. The used herbicide is Trifluralin before planting 2.5 liter per hectare. The disc is used for mixing the poison to the soil. According to soil testing, used fertilizers are 120 kg/ha phosphate triple, 150 kg/ha sulfate potassium, 50 kg/ha urea, 50 kg/ha manganese sulfate, and 20 kg/ha sulfate. The experiment map is implemented after fertilizing and mixing them with soil. When planting, *Rhizobium japonicum* (a

bacterium) is used to inseminate the seed. The planting operations are, according to treatments of consumed seed rates, with four replications in plots. Each replication contains 18 plots; each plot includes 6 rows with 5m longitude at a distance of 40cm. Distances of plants on row planting are different according to seed rates and 1000-seed weight, i.e. about 4cm to 8cm.

Results and discussion

The relations morphological traits, yield components and seed yield of soybean cultivar

Mean squares of seed amount for the characteristics of plant height was significant at the five percent level, which indicates a significant difference of this characteristic in the amount of consumed seed (Table 2). Significance of the mean squares of this characteristic for the studied cultivars has had a significant difference regarding the plant height (Table 2). Also among the studied cultivars, the degree of this characteristic has been variable from 54.6 to 103.2 cm respectively in Telar and Katul cultivars. In this study, the long height cultivars often had high 1000-seed weight, so that the correlation of plant height and 1000-seed weight is shown to be significant and positive (Table 4). Significance of mean squares of the seed amount for the characteristic of Pod's Height from surface at the probability level of one percent indicates significant difference of this characteristic is applicable in the levels of the seed amount (Table 2). The degree of this characteristic on seed levels of 55, 70 and 85 kg/ha have been respectively equal to 11.8, 17.3 and 21.1 cm, which have statistically been classified in three distinct classes. Significance of the mean squares of these characteristics for the studied species also indicate that the studied cultivars have had a significant difference regarding the height of the first pod from ground (Table 2). Considering that the high levels of this characteristic will lead to facilitation in harvest and less waste in the harvest time, therefore the Caspian and Nekador cultivars will have priority having high levels of this characteristic. Negative and significant correlation of this characteristic with the number of pods per shrub indicates that cultivars with high levels of this characteristic have less number of pods per plant (Table 4). Average amount of the seeds used for the characteristic of Pod's Number in Shrub was significant at the one percent level, which indicates a significant difference of this characteristic in the levels of this level of the seeds (Table 2). With increasing the amount of the consumed seed, the number of pods per plant decreased. The amount of this characteristic in the levels of the consumed seed was variable from 50.5 to 64.2 numbers for 55 and 85 kg/ha consumed seed. Also, the degree of this characteristic for the seed amount of 70 and 85 kg per hectare are in a statistical group. The significance of mean squares of this characteristic for the studied cultivars indicates that the studied cultivars have had a significant difference regarding the pods per shrub (Table 2). Positive and significant correlation of this characteristic with the harvest index indicates that the increase in the seed yield have an effective role in increasing the harvesting index. Correlation of this characteristic with the positive seed yield was not significant (Table 4), which indicates that late maturity cultivars mainly have higher seed yield. Significant and positive correlation of this characteristic with 1000-seed Weight also indicates the positive impact of this characteristic was mainly through increased 1000-seed weight.

Table 1. Physical and chemical properties of the soil of the testing place before planting.

Type of the texture	Soil texture			Potassium of the soil (P.P.M)	Soil Phosphor (P.P.M)	Organic carbon (O.C) percentage	Organic material (O.M) percentage	Neutral materials %T.N.V	Electrical Conduction EC×10³	Saturation percentage (S.P)	Soil pH	The depth of the soil (Cm)
	clay	Silica	sand									
Loamy	20	30	50	180	13.6	1.2	2.2	30	0.68	50	7.6	0-30

The relations among phenological traits, yield components and seed yield of soybean cultivars

The correlation of this characteristic was not significant with seed yield (Table 4), which shows that

changes of the characteristic did not have a significant impact on studied cultivars. Positive and significant correlation of this characteristic with days to maturity indicates that cultivars which have high number of days to end of flowering are almost late maturity. Mean squares of seed amount for number of days to end of flowering at one percent probability level is significant, that is indicating the significant difference of this characteristic in different amount of used seed (Table 2).

Table 2. Analysis of variance for Phenological and Morphological Characteristics in soybean cultivars.

Source of Vraiance	df	Mean of Squares(MS)					
		Days to Flowering	Days to end of Flowering	Days to maturity	Plant Height	Pod's Height from surface	Pod's Number in Shrub
Replications	3	103.4 **	5.3	4.3	145.9*	18.7*	533.3*
Seed Rates(a)	2	104.1 **	198.5 **	86.5 **	333.7*	511.7**	1234.3**
Error	6	2.7	1.9	1.8	31.1	3.5	47.9
Cultivar (b)	5	139.9 **	653.8**	773.7 **	4011.6**	75.7**	442.3**
a×b	10	1.5	11.1	2.1	16.6	14.9**	53.4
Error	45	1.4	2.2	4.9	27.7	4.3	35.6
C.V (%)	-	3.5	1.5	1.5	6.7	12.4	10.6

*, ** Significant at p=0.05 and 0.01, respectively.

Table 3. Analysis of variance for Yield components, Oil Content, Seed and oil Yield in Soybean Cultivars.

Source of Vraiance	df	Mean of Squares(MS)					
		Seeds per pod	1000-Seed weight	Seed Yield	HI(%)	Oil Conten (%)	Oil Yield
Replications	3	0.06	31.5	537071*	9.5	0.9	1845
Seed Rates(a)	2	0.04	2183.9**	1795455**	764.6**	71.7**	215416**
Error	6	0.04	23.5	103865	6.5	1.7	6605
Cultivar (b)	5	2.28**	3142.5**	1786088**	221.4**	6.7	122092**
a×b	10	0.03	31.8	114311	5.7	0.1	4827
Error	45	0.06	107.4	108370	4.6	4.2	9201
C.V (%)	-	11.2	5.5	11.1	5.7	9.5	14.9

*, ** Significant at p=0.05 and 0.01, respectively.

Significant difference of the mean squares of this characteristic for the studied cultivars also indicates that the studied cultivars had significant differences from the view of number of days to end of flowering (Table4). The correlation of days to end of flowering characteristic was significant with 1000-seed Weight (Table 4). It indicates that changes in this characteristic in the studies cultivars had significant impact of 1000-seed Weight on seed level. In addition, the significant and positive correlation of this characteristic with days to maturity suggests that cultivars that have higher number of days to the end of flowering, are mainly late maturity. The correlation of this characteristic is positive with seed yield (Table 4), thus increasing this characteristic as one of the important components of seed can also lead to seed yield Among the studied cultivars the amount of this adjective was different from 159.2 to 202 g, respectively for Sahar and Katul cultivars, which shows that 1000-seed weight is a genetic characteristic but also is affected by environmental situation. The correlation of this characteristic with phenological characteristics such as the number of days to start of flowering, days to end of flowering and days to maturity indicates that late maturity cultivars often have higher 1000-seed weight (Table 4). The significant mean squares of this characteristic for the studied cultivars in one percent probability

level is indicating the genetic differences between cultivars under study from the yield seed view(Table 3). The significant and positive correlation indicates of this characteristic with harvest index indicates that increasing seed yield has an effective role in increasing the harvest index.The correlation of this characteristic with 1000-seed weight and seed yield is positive. therefore, the cultivars with potential yield and high yield components have higher oil yield in this study. The significant and positive correlation of this characteristic with the seed yield and oil yield indicates that this characteristic is significantly influenced by both of the main components (Table 4).

Table 4. Correlation coefficient of the traits in soybean cultivars in different planting densities.

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1-Days to flowering	1													
2- Days to end of Flowering	0.89**	1												
3- Flowering Period	0.67**	0.93**	1											
4- Days to maturity	0.77**	0.89**	0.86**	1										
5- Plant Height	0.53*	0.64**	0.63**	0.57*	1									
6- Pod's Height from surface	-0.36	-0.21	-0.07	-0.01	0.19	1								
7- Pod's Number in Main Stem	0.03	0.16	0.23	0.23	0.37	0.52*	1							
8- Pod's Number in Shrub	0.78**	0.59**	0.34	0.53*	0.18	-0.49*	-0.35	1						
9- seeds per pod	-0.57*	-0.43	-0.24	-0.29	-0.24	0.26	-0.06	-0.08	1					
10- 1000-seed Weight	0.63**	0.70**	0.66**	0.81**	0.51*	-0.09	-0.04	0.27	0.23	1				
11- Seed Yield	0.13	0.15	0.14	0.33	-0.02	0.16	-0.24	0.40	0.21	0.56*	1			
12- HI	0.17	0.05	-0.05	0.04	-0.56*	-0.45	-0.45	0.65**	0.26	0.31	0.50**	1		
13- Oil Percentage	0.26	0.16	0.05	0.20	-0.40	0.59**	-0.67**	0.47*	0.14	0.46*	0.54*	0.84*	1	
14- Oil Yield	0.21	0.17	0.13	0.34	-0.16	-0.09	-0.42	0.54*	0.20	0.61**	0.94**	0.60**	0.76**	1

*, ** Significant at p=0.05 and 0.01, respective.

Conclusion

Significance of the mean squares of seed rates shows that Morphological and phenological characteristic, yield components, and seed and oil yield except seed's number in pod are under the influence of significance of seed rates. In this regard, characteristics follow an increment progress such as shrub's height, distance of Pod's Height from surface and pod's number in main stem as the seed rate increases. Therefore, pod's number in shrub and 1000-seed weight fall in reduction. The mean squares are significant for all traits except oil content which in turn shows the difference of genetic varieties except oil percentage. The maximum seed yield is obtained from seed rate in

70 kg/ha field. Among investigated varieties, the Nekador varieties represents the high seed yield because of its seed yield components. In investigating mutual interaction, Nekador varieties high yield is registered in 50 kg/ha seed rate. Correlation is positive between seed yield with traits of pod's number in shrub and 1000-seed weight which shows that these two yield components have an important role in seed yield. The interaction effect of seed rate and varieties is not significant for all traits (characteristics) except for 1st pod's height from surface and pod's number in main stem. Therefore, this shows that changes in most traits follow a similar progress except traits at seed levels.

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