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Evaluation of different seed rates effects on yield components, seed and oil yields in soybean varieties conditions in Mazandaran province

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Abstract

In order to evaluation of different seed rates on yield components, seed and oil yields of 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), Katul(DPX) and Sehar(Pershing). Results showed that seed rates had significant effects on all the traits except seeds per pod. The varieties were different for all the traits. Non-significant interaction effects of seed rates and cultivars for most of the traits indicating that variations of the traits of each cultivar had similar trend in different seed rates. The varieties including Sari and Nekador with high mean values of seed number had high mean values of seed yield. Average seed yield of the genotypes for 55, 70 and 85 kg.ha^{-1} were 2999, 3246 and 2700 kg.ha^{-1} , respectively. Among the genotypes, the cultivar of Nekador performs a better the highest seed yield due to its seed yield components. The seed yield amount of this value in three seed levels in 55, 70, and 85 kg/ha are respectively 3766, 3643, and 3496 kg/ha which its value was in the same class for 55 and 70 kg/ha seed rates. Seed rates had not significant effects on days to maturity. Sahar and Katul with 135.3 and 156.9 days to maturity, respectively which were considered as early and late maturity genotypes. Significant positive correlation of seed yield with the characteristics including pods per plant and 1000-seed weight, indicating the important role of these two yield components for seed yield increasing.

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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). 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). With increasing density, light intensity on vegetation was reduced and it reduced the number of tributaries and biomass. His research showed that absorbing photo-synthetically active radiation to achieve maximum performance was influenced by morphological and physiological characteristics (Wells, 1993). 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). Optimum plant density of soybean cultivars changes according to varieties and geographic location (Goli and Olsen, 1983). 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. New cultivars can better compensate lower plant population through producing more seed on the branches than older cultivars (Shure and Davis, 2008). 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). Researchers have said that extra density increase causes decrease in yield; and factors such as varieties, lodging, prematurity, and bad environmental conditions have influence on yield (Wright *et al.*, 1984). 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.

Experimental Section

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.

Soil properties of the testing site

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 shows the results of soil samples prior to the plant.

Treatments of the test and the statistical characteristics of the design

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).

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.

Sampling method for the studied traits.

Number of seeds per pod

In 10 randomly selected plants, the numbers of seeds per pod on main stem were counted and the average was calculated for each pod.

1000-seed weight

Five hundred seeds from each plot was weighed and then doubled, so the weight of 1000 seeds was measured in grams.

Harvest Index

The harvest index for each plot is obtained through obtaining economic yield and biological yield and through the following equation.

$$HI = \frac{Agricultural\ yield}{Plant\ total\ dry\ matter} \times 100$$

Seed yield

The marginal effect was calculated on a kg scale with respect to weighing the seed of each plot in 4.8 square meters after correction with 12% moisture per kg and then was extended to kilograms per hectare.

Oil Content

By soxhlet was measured by the oil content. In this context the mill to 5 grams of The samples, solvent extraction using petroleum ether with a boiling range of 40 to 60 ° C was performed. After extraction, solvent oil was isolated by vacuum evaporation. After measuring the sample weight and oil content was calculated.

Oil Yield

Multiplying the oil content and seed yield for each treatment was calculated as kilograms per hectare.

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.

Results and discussion

The effects of different seed rates on yield components of soybean varieties

mean comparison of number of seeds per pod characteristic shows that (Table 2)(Fig 1) with increasing the used seed amount number of seeds per pod does not follow a specific process and amount of this for all 3 levels of seed in places in one statistical group, and indicates that number of seeds per pod was influenced by genetic factors and environmental factors do not have a significant impact on it. 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. (Table 2)(Fig 1) indicates that with increasing the used seeding rate, 1000-seed weight decreased, which indicates increasing plant density and increasing competition between plants, eventually lead to the reduction of grain weight. 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 effects of different seed rates on seed and oil yields of soybean varieties

The results of mean comparison shows that (Table 2)(Fig 1), with increasing the amount of used seed, the seed yield has increased and then decreased that obtained yield for 55 and 70 kg seed per hectare is placed in one statistical group. 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 seed yield 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 (Table 4) Also positive and significant correlation with 1000-seed weight suggests that in studied cultivars these characteristics have more effective role in increasing the seed yield. Significant mean squares of seed reats for oil content characteristic, indicates the significant effect of used seed level on this characteristic (Table 2)(Fig 1) it seems that with increasing plant density and lower light penetration into the canopy of vegetation leads to lower oil content and amount of this characteristic in studied cultivars has not been significant which shows that there is not a significant difference between the studied cultivars from the view of oil content. The correlation of this characteristic with 1000-seed weight and seed yield is positive (Table 4), therefore, the cultivars with potential yield and high yield components have higher oil yield in this study. Oil yield was significantly affected by the amount of the consumed seed which is resulted from the genetic difference of the seed yield of the consumed cultivars (Table 2)(Fig 1).

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

Table 2. Mean comparison of the effect of seed rates, soybean cultivars and their interaction effects on Yield Components and Seed and Oil Yields.

Main Factor	Traits					
	Seeds per pod	1000-seed Weight (gr)	Seed Yield (Kg.ha)	HI (%)	Oil content (%)	Oil Yield (Kg.ha)
55 kg.ha	2.22a	196.1a	2999ab	43.4a	23.08	694.7a
70 kg.ha	2.27a	187.2b	3246a	36.9b	21.5b	698.2a
85 kg.ha	2.19a	177.0c	2700b	32.2c	19.36c	532.4b
			Sub Factor			
Sari(JK)	1.62d	185.8bc	3024bc	40.4b	21.52b	658.9b
Telar(BP)	2.86a	178.3c	2855bcd	43.4a	21.79b	621.2bc
Caspian(033)	2.41b	196.0ab	3141b	36.7c	20.63b	648.7b
Nekador(032)	2.42b	199.3a	3626a	39.0bc	22.68a	822.6a
Katul(DPX)	2.13c	202.0a	2690cd	31.7d	20.79b	564.9bc
Sahar(Pershing)	1.93c	159.2d	2536d	33.8d	20.03b	534.5c

In each group of average comparison, those averages that have at least one trait in common do not have significant difference.

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).

The results of the analysis based on the split-plot design indicated that the effect of the seed rates was significant in all characteristics. The cultivars have had significant difference regarding all the studied characteristics except for the oil content which indicates genetic differences in all the studied cultivars (Table2)(Fig1). Insignificance of the interaction between the seed rates and cultivar for the studied characteristics indicated that changes in the characteristics in the studied cultivars at all seed rates have a similar trend (Table3).

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 Content (%)	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.

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.

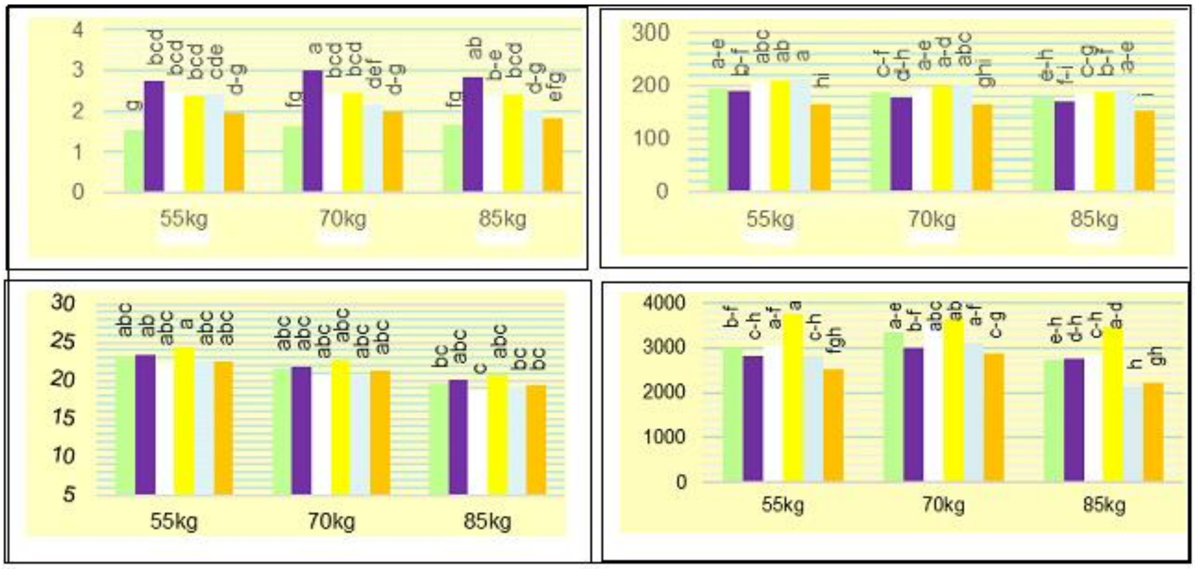

Fig. 1.

Conclusion

Generally, this study contains the following Significance of the mean squares of seed rates shows that phenological characteristic, yield components, and seed and oil yield except seeds per 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.

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