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Effect Of Seeding Rate On Grain Yield And Some Agronomic Characteristics Of Rapeseed In Spring Planting In Dryland Conditions

Masoud Eskandari Torbaghan[1] , Mehrnoush Eskandari Torbaghan[2]

1Academic Member of Agricultural and Natural Resources Research Center of Khorasan Razavi

2 Lecturer of Khorasan Razavi Agricultural Education center
Lecturer of Khorasan Razavi Agricultural Education center, Shahid Kalantari Highway,
Khorasan Razavi, Iran Between Television Sq. and Jahad Sq., Mashhad,

Abstract

Rapeseed is one of the most important oilseed crops that has major role in edible oil supply. In order to determine the best cultivar and seed rate for dryland rapeseed and mustard, this experiment was conducted a factorial design based on RCBD with four replications during 2004-06 at North of Khorasan Dryland Research Station (Shirvan). The treatments of trial were: two canola cultivars (Bard 1 and Hyola 401) and five seed rates (2, 3.5, 5, 6.5 and 8 Kg/ha). The traits stand and cold damage, days to flowering, plant height, days to maturity, number of pods per plant, number of seeds per pod, thousand kernel weight and grain yield were recorded. Two years combined analysis results showed that, the effect of cultivar on all traits was significant (P < 0.01). Seeding rate had significant effect on days to maturity, days to flowering and stand (P < 0.01). The cultivar Bard-1 with 814 Kg/ha, had higher grain yield than Hyola 401 (736 kg/ha). The highest seed yield (821 Kg/ha) was obtained from 6.5 Kg/ha. According to the results of this experiment and special climatic conditions of this region, seed rate 6.5 Kg/ha and also early maturity cultivar "Bard-1" is suggested for cold rain fed of Iran.

Key words: Mustard oilseed crop, Seeding rate, Cold rainfed conditions, Plant density.

1. Introduction

In recent years, oil consumption has increased due to population growth and increase in consumption per capita in Iran. Currently, less than 10% of the oil consumed by country produce inside the country and while the country has the potential to reach the optimal production of oilseed crops (Khademi et al., 1999).

Canola has the third rank in the edible oil production after soybean and oil palm (Khademi et al., 1999). With the right choice of agronomic factors such as crop rotation, planting date, plant desired increase in plant density leads to recovery of the loss of branches and plant yield components via the number of plants increase (Fathi et al., 2002).Higher amount of grain yield, thousand kernel weight and greater number of pods per plant have been reported by researchers in the narrow row spacing (Bagheri,.1995; Yazdifar et al., 2006;).

Previous studies show that the dry grain weight per plant has a declining trend with an increase in plant density more than suitable density because the increase in plant density creates the dense canopy, competition among the bushes rising, nutrients availability uptake increase and also the ability of plants to use of environmental conditions such as light for photosynthesis decreases. As a result, plant faces at the same time with some kind of stresses such as drought stress, radiation stress, nutrients deficiency and etc. and plant increases grain filling rate to reduce stress effects and creation balance in photosynthesis, respiration and nutrients storage, which leads a reduction in the number of seeds per pod, the density and etc., can be increased quality and quantity of plant yield. Suitable plant density selection in spring canola led to better plant stand and higher grain yield achievement due to climatic conditions and soil properties (Bilgili et al., 2003). Szczygielski and Owczarek (1987) reported that increase in plant density led to a reduction in the number of branches per plant, so a less number of pods per plant produced. They also showed that different plant densities in new cultivars of rapeseed can cause different changes in structure, size, and resistance to cold temperatures and grain yield. Based on the obtained results by these two researchers, rapeseed cultivars show different responses to various plant densities (80-240 plant per square meter), so that this matter causes a variation in plant height, stem diameter, number of branches per plant, number of pods per branch in cultivars. According to the existing reports, increase in plant density causes a reduction in grain yield per plant via the number of branches, number of pods per plant, number of seeds per pod and grain weight per plant reducing. But the of pods per plant, number of seeds per pod and seed yield increased with a reduction in the row spacing. Row spacing of 12 cm and 36 cm with 4626 kg/ha and 2879 kg/ha yield produced maximum and minimum grain yield respectively. In the another study by Faraji (2006) was observed that however that the number of plants per square meter increased due to seeding rate increasing, but seeding rate did not have a significant effect on grain yield because of the increasing plant lodging and reducing the number of pods per plant.

In a study on the effect of plant density and turnip row spacing in *Tobin* cultivar to control of rye weed by Donovan (1994), he concluded that density about 200 plants per square meter can be significantly reduced weeds damage on crop yield and also reduced the weed seed production and weed biomass. In the Shrief et al. (1990) research, the effect of row spacing on grain yield and quality characteristics of rapeseed was only significant in the year without suitable weather condition, and the most amount of oil was decline duration of grain filling and so that the decrease in thousand kernel weight (Zang and Sedum, 1995). Bilgili et al. (2003) and Lythgoe et al. (2001) suggested that different rapeseed cultivars had lower yields in lower plant densities than to higher densities; rapeseed cultivars were also effective in the reduction of weeds in the higher densities. Researches of Christensen and Drabble (1984) in Canada showed that *Brassica rapa* and *B. napus* had higher yield in narrower rows (7.5 cm) compare to wider rows (15 and 25 cm) and the seeding rate (7-14 kg/ha) had no significant effect on yield. Yazdifar et al. (2006) on study in three space rows 12, 18 and 24 cm, and two seed rates, 4 and 6 kg/ha on three cultivars RGS003, Hyola 60 and Hyola 401 observed that the grain yield decreased with increase in rows spacing so that highest yield produced in the 12 cm treatment of row spacing. In the study by Faraji (2004) on three seeding rates of 6, 8 and 10 kg/ha and three rows spacing of 12, 24 and 36 cm on the *Quantum* rapeseed cultivar in Gonbad city concluded that the number compensatory effects in the wider rows (Potter et al., 2002). In dryland planting of rapeseed, optimum seed rate and the best row spacing was recommended 6 to 8 kg/ha and 36 cm respectively for ease of agricultural operations (Ranjbar, 2006).

Due to agronomic characteristics of *Brassica nappus* L. such as the limited water requirement, encouraging the development of beekeeping, increasing the wheat yield following rapeseed harvesting, weeds control and reduction of pathogens in the next crop and also necessarily determination of appropriate cultivar and the best seeding rate of rapeseed for spring planting in cold rain-fed conditions, this study was carried out on the two cultivars of rapeseed and mustard.

2. Materials and Methods

A hybrid rapeseed cultivar and mustard cultivar called Hyola 401 and Bard1 respectively, were planted during 2004-2006 as a factorial design based on RCBD with four replications at North of Khorasan Dryland Research Station (Shirvan) in a clay loam soil texture. Bard 1 is a species of

obtained from highest plant density. Study by Angadi et al. (2003) on the effect of plant density on rapeseed plant in semi-arid regions showed that environmental conditions have a great effect on the effectiveness of rapeseed. In 2000, with normal rainfall during the growing season, grain yield was almost similar in the range of 20 to 80 plants per square meter, whereas in 2001, with less precipitation than normal, grain yield was significantly decreased with a decrease in the plant density less than 40 plants per square meter, but none significant difference in yield was observed between 40 and 80 plants per square meter while the plants distributed very well. Potter et al. (2002) with study the effect of row spacing and seed rate on rapeseed cultivars observed that the row spacing was only significant in the low rainfall region and the row spacing of 15 cm had a significant advantage compare to the 30 cm row spacing. Researchers expressed that this result is due to a reduction of planting time to flowering stage in the early cultivars in lower rainfall regions because it causes a decline in plant increases, cultivation was done by hand at a depth of 2 cm when the soil moisture arrived to the filed capacity on 3 March. Each plot consisted of 6 rows with 6 m length along with of 25 cm row spacing. Metasystox and diazinon were used respectively to combat with chaetocnema tibialis beet and epicometis hirta damage in the early growth stages of the plant in 2:1000 that the spraying was carried out with back tractor sprayer. During the growth period and then some characteristics including: stand, days to flowering, plant height, days to maturity, number of pods per plant, number of seeds per pod, thousand kernel weight and grain yield were recorded. Determination of seed oil carried out with NMR method in the chemistry analysis laboratory in oil seeds crops research department in the Seed and Plant Improvement Karaj Institute. Results of experiment were analyzed with MSTAT-C and EXCEL software's as an analysis of variance. Means comparison was done with Duncan's multiple range tests at five percent level for each mustard (*Brassica juncea* L.) that compares to rapeseed cultivars (*Brassica napus* L.) goes into the flowering stage earlier and is also more early-mature than *Brassica napus* L. (Alizadeh, 2005). The treatments of trial were: two canola and mustard cultivars (Bard 1 and Hyola 401) and five seed rates (2, 3.5, 5, 6.5 and 8 Kg/ha). These five levels of seed rates were equal to the 50, 87, 125, 162 and 200 of plant density per square meter. Soil tillage, including plowing and disking was carried out in the early autumn and subsequently, rows of experiment were made by deep dry work. Consumption of fertilizers were 75 kg ammonium phosphate, 50 kg potassium sulfate and 50 kg urea per hectare that were determined by soil testing and except of urea that was given to the soil at the planting time, other fertilizers were used at the same time with soil tillage. These amounts corresponded with the minimum amount of usable fertilizer on irrigated farms and were located under the seed by deep furrow drill (Khajepour, 1993). According to the results of previous years if the planting is done earlier, grain yield years of experiment were analyzed by two years combined analysis of variance and the effect of treatments on grain yield and the other important characteristics were evaluated and the effect of environmental factors were examined in each year too. In addition, the obtained results showed that in both years of the experiment, the response of cultivars for all studied characteristics and the response of intended densities were difference in some of the parameters.

3.2. The number of pods per plant

Usually in Dryland farming areas, climatic conditions vary in different years, and so it has different effects on different characteristics of plants. In this experiment the effect of year on the number of pods per plant was also significant (Table 2). Also, the average number of pods per plant in the different plant densities classified in the various groups (Table 3). The number of pods per plant decreased with an increase in the plant density so that maximum (242 pods) and minimum of number of pods per plant was obtained from 2 and 8 kg/ha seed rates year separately and two years combined analysis was also carried out.

Table 1.Data weather of Dryland Agricultural Research Station Shirvan during rapeseed growth

3. Results and Discussion

3.1. Weather conditions

In cold dry rain-fed conditions such as this experiment location, drought and frost stress cause some difficulties in the growth and development of dryland crops each year. Rainfall was low during the flowering season and rapeseeds grain filling in 2005 (Table 1). The weather temperature also was -11 ° C in March in this year that it was equal to the coldest temperature recorded in the winter and January of 2004. Since the plants were not germinated or were small, the frost did not damage to rapeseed severely. In the second year of experiment, 1.4 mm rainfall only occurred in May and the temperature of weather was also low (Table 1). Distribution of precipitations was not appropriate in both years of experiment. A large variety of climatic conditions were observed during the years of experiment. The results of both an increase in the density from 40 to 80 plants causes a reduction in the number of pods per plant. This is due to the lack of availability of nutrients that leads to an increase in falling flowers down. However, when the number of plants per unit area increased, the lack of pods per plant compensated and made the number of pods per unit area rise. The number of pods per plant directly affects the yield of rapeseed (Inayt et al., 2009).

The effect of cultivar on the number of pods per plant was significant (Table 2). The highest and lowest number of pods per plant was observed to the Bard 1 with the average of 237 pods and Hyola 401 with 128 pods respectively (Table 3). In this experiment, the role of the number of pods per plant in the final product yield determination was higher than the other yield components. Bard 1 cultivar that produced more grain yield than the Hyola 401 hybrid cultivar was only superior for this component of yield and in the two other components of yield (thousand kernel weight and number of seeds per pod), Hyola 401 had respectively. It seems that the rapeseed reduces the number of side branches by increasing plant density and thus the number of pods per plant reduced. But this reduction can be compensated by increasing in the other yield components such as thousand kernel weight and finally the grain yield remains constant. Rapeseed grain yield is a function of the number of pods per plant, number of seeds per pod and thousand kernel weight (Taylor and Smith, 1992) Thurling (1991) and Alizadeh et al. (2003) noted that the optimal number of pods per plant was 111.5. Also, the interaction between cultivars and seed rates (Table 6) showed that the number of pods per plant decreased in both cultivars with an increase in the plant density. Szczygielski and Owczarek (1987) expressed that an increase in plant density leads to a reduction in the number of pods per plant and can cause different variations in structure, size, level of cold resistance, grain yield. In a study, the number of pods per plant increased in all environments by reducing plant density (Angadi et al, 2003). Habekotte (1993) also observed that the plant increases grain filling rate to reduce the effects of the stresses and to create balance in photosynthesis, respiration and storage of nutrients. It is also possible that plants face to drought stress at the end of season or warm wind during grain filling in the cold rain-fed condition. These factors cause the seeds become shrivelled and small and its effect is stronger in the higher plant densities. Zang and Sedum (1995) also obtained the same result.

The effect of cultivar on the thousand kernel weight was significant at the 1% level (Table 2). Thousand kernel weight was 2.595 and 2.902 g for the Bard1 and Hyola 401 cultivar respectively (Table 3). It observed that although the Hyola 401 cultivar had lower pods per plant but, it had higher thousand kernel weight than Bard1 cultivar. Since each plant has a certain threshold for yield in any environment, increase or decrease of one component will inevitably cause a decrease or increase in the other yield components. It is expressed that the thousand kernel weight is the last component of yield and its changing is greatly advantage. Habekotte (1993) expressed that the grain yield per plant is strongly dependent on the number of pods per plant, which confirms the results of this experiment. Kandil et al. (1995) also reported that the number of pods per plant has an effective role on the grain yield so that 40 percent of diversity in the grain yield is justified by this agronomic character. It has been reported that high correlation exists between the number of pods per plant and seed yield (Thurling, 1974).

3.3. Thousand kernel weight

The number of stands in the Bard1 cultivar was more than Hyola 401 (Table 3) but, the thousand kernel weight was lower in the Bard1 cultivar. According to the rise of stands, the thousand kernel weight showed a decreasing trend. In fact, the increase of plants per unit area causes competition between plants, decrease in the availability of nutrients, and decline in plant ability to use the environmental condition for photosynthesis performance. As such, these factors made the bio homeostasis in plants disturb and some kinds of stresses on the plants. Hence, per plant and number of seeds per pod, and these traits are associated with the size of the plant. None significant difference was observed between the numbers of seeds per pod in the different seeding rates (Table 5).

3.5. Grain Yield

The effect of cultivar on grain yield was significant (Table 2). Bard1 mustard cultivar produced higher grain yield than Hayola 401 cultivar (Table 3). It seems that the early-mature Bard1 cultivar with more compatibility to dryland conditions is able to produce higher grain yield. Bard1 is an Indian mustard cultivar that is an early-mature compared to rapeseed (Alizadeh, 2005). Although Hyola 401 is a cultivar with high yield and low water requirement (Danesh Shahraki, 2008) but, it seems that it can not compete with mustard cultivars in dryland conditions. Part of the leaf blade changes to petiole to reduce evaporation in the mustards that are from *Brassica juncea* L. species. Also, mustards are early-mature species as compared to influenced by the other yield components (Sarmadnia and Koocheki, 1993). Rao and Mndham (1991) concluded that the better environmental conditions such as the optimum temperature and humidity at the end of the growing season and the longer prolongation of the grain filling period cause the larger grains and so that an increase in the thousand kernel weight. In this experiment an increase in the thousand kernel weight was observed in both cultivars by reducing the number of pods per plant (Table 3).

3.4. Number of seeds per pod

The hyola 401 cultivar has more seeds per pod than the Bard1 (Table 3). With respect to higher yield of the Bard1 than Hyola 401, more seeds per pods in Hyola 401 had not significant effect on the final yield. Thurling (1974) expressed that the correlation between the number of seeds per pod and seed yield was not significant in the rapeseed. If the number of pods per plant be kept constant, seeds per pod characteristic show a considerable effect on yield. Also, it is often an inverse relationship exists between the number of pods

Rapeseed lies in a range of the plant density which the plant population can produce similar grain yield. It is expressed that when the distribution of plant density is uniform changing of density will have less impact on rapeseed yield (Angadi et al, 2003). In general, the relative decrease in the grain yield was less than the decrease of the number of plants per area that this matter is related to the effects of plant competition and flexibility of rapeseed yield. The highest seed yield was obtained with consumption of 6.5 kg seed per hectare (Table 3). Christensen and Drabble (1984) also concluded that the seeding rate of 7 to 14 kg ha^{-1} had not significant effect on grain yield. In the dryland cultivation of rapeseed in other the regions of the country such as Golestan and Kermanshah provinces, 6.5 kg ha^{-1} of plant density is produced the highest yield (Ranjbar, 2006; Bagheri, 2004). The lowest grain yield was obtained from the use of 3.5 kg seed. Usually an increase in plant density reduces the number of pods per plant, number of seeds per pod and thousand kernel weight due to the lack of *Brassica napus* L. and escape from late season dry.

Rapeseed yield did not change significantly in a wide range of plant density (Table 3). In the cold rain-fed conditions, cold stress in the early growing season when the plants are small and weak (i.e. March and April) and drought and heat stress during and at the end of the growing season reduced the number of plants and the green surface area, while this problem does not exist in water condition and the plant is grown at the suitable time of planting and irrigated and plant goes to the rosette stage and resist to cold stress before beginning of the cold season. In many research of irrigated area condition, the effect of plant density on grain yield has been significant (Danesh Shahraki et al., 2008; Fathi et al., 2002; Fathi et al., 2002), but in the dryland condition, low temperatures, drought stress and soil crust create a poor and unsuitable bed for seed (Angadi et al, 2003) and thus the number of plants per area decrease and the rapeseed plant have compensatory effects on its yield component.

3.6. Days to flowering

The effect of year on the number of days to flowering was significant (Table 2). The weather conditions in dryland regions have dramatic changes in different years. These changes cause significant effect of year. The effect of density (seeding rate) on days to flowering was significant. The effect of cultivar on days to flowering was significant too. The Bard1 cultivar compare to the Hyola401 enter former to the flowering stage, and after 5 days the Hyola 401 hybrid cultivar enter into this developmental stage (Table 3). The maximum number of days to flowering (55.31 days) was observed from the application of 2 kg of seeds per hectare and the minimum number of days to flowering (50.69 days) was observed from the rate of 8 kg seed per ha. Increase in plant density caused that beginning of the flowering stage happens earlier that this matter was due to the competition among plants for available resources.

space and plants competition for water and nutrient absorption. But, the optimum level of plant density cause compensation in yield component decline by increasing the number of plants (Fathi et al., 2002; Bilgili et al., 2003; Lythgoe et al., 2001). Also Yazdifar et al (2006) observed that the grain yield decreased by increasing row spacing so that among the row spacing treatments (12, 18 and 24 cm), the highest grain yield were produced at 12 cm treatment.

There was non significant interaction between cultivar and seeding rate on grain yield and both cultivars produced the highest yield when the plant density was 6.5 kg ha^{-1} (Table 3). With an increase in plant density more than the optimum, competition occurs among plants for access to nutrients and use of environmental conditions such as sunlight for photosynthesis. This competition leads to lower yield in high density of plants in comparison with the desired density. In this study the grain yield decreased at 8 kg ha^{-1} and plant density had decreased trend.

they have tendency to escape from the lack of nutrient resources too. In fact, a physiological mechanism in crop plants cause that the plants prefer their survival and generation compare to growth and higher yield production (Khajepour, 1993). In both cultivars studied in this research, beginning of early flowering stage and maturity were observed with an increase in the seeding rate per hectare (Table 6).

3.8. Green percent

The mean comparison of stands percent (Table 3) showed that the Bard1cultivar had higher stands than Hyola 401 hybrid cultivar. These results showed that the mustard cultivar (Bard1) had excellence germination and early stand and establishment. Mustard cultivars usually are superior compare to rapeseed in these characteristics; they have adoption to dry land condition completely and are relatively early-maturity (Alizadeh, 2003). The maximum stands (76%) were observed with the use of 6.5 kg of seeds per hectare. With increasing plant density, the stands of both cultivars increased (Table 6) so

3.7. Days to maturity

Bard1 was more early-mature cultivar and it was prepared to harvest during 100 days from planting time, while the Hyola 401 cultivar was relatively late-mature and it was prepared to harvest 108 days after planting time (Table 3). Rapid early growth, early flowering stage after rosette, short and thick stems, resistance to lose at harvesting time, the number of pods per square meter (5000 to 8000), vertical elongated pod increasing and the number of pods per main stem has been reported the desired characteristics of rapeseed for higher yield production (Thurling, 1991). At the cold rainfed conditions in most of the years, rapeseed face with drought stress at flowering and seed filling stage, thus if the early reproductive stage was started earlier the grain yield will be higher.

Days to maturity decreased with an increase in plant density (Table 5). With an increase in plant density, competition increases for water and nutrients among plants so the plants have a tendency to complete their life cycle quickly and

74.52 cm and hayola 401 hybrid had 55.25 cm height. Alizadeh et al. (2003) were determined the best height for oilseed *Brassica* plants in cold dryland areas of the country is 92.2 cm that Bard 1 cultivar is closer to this optimum level.

The Hyola 401 hybrid cultivar was better than Bard1 cultivar in the number of seeds per pod and thousand kernel weight characters (Table 3).

Due to the occurrence of sudden cold in the late spring in 2005 that usually occurs with very low probability (once every 10 years) in the region and the problem of drought stress during the end of growing season occurs once every two years with the end of rainfalls period in May, usage of drought resistant cultivars such as mustards is preferred compare to cold tolerant cultivars. This study showed that the *Dosefer* mustard cultivars with 6.5 kg of seed per hectare are appropriate for planting in the cold dryland regions. with an increase in the plant density from 2 to 8 kg per hectare stand percent received from 27 percent to 51 percent and significant differences were statistically observed between stands of different seeding rates.

Mean comparison of interaction effect between seed and cultivar (Table 6) showed a significant difference in the interactive levels between treatments so that the highest stands (51.25%) was observed in the treatments Bard1 and Hyola401 hybrid cultivar with 6.5 kg seed per ha. The lowest stand (15%) was observed in the treatment Hyola 401 hybrid cultivar and 2 kg ha seeding rate. The stand is an important agronomic character in the crop plants because with the proper stands can be achieved to a suitable plant density. It is expressed that the optimum plant density in spring rapeseed produces a higher grain yield (Bilgili et al., 2003).

3.9. Plant Height

Table 4 showed that the plant height has significant difference between the two cultivars were tested, so that the mean height of Bard1 was

Table 1.Data weather of Dryland Agricultural Research Station Shirvan during rapeseed growth

Year	Month	Rainfall	Absolute minimum temperature	Average minimum of absolute temperature	Absolute maximum temperature	Average maximum of absolute temperature	Average temperature	The number of days below zero	Relative humidity (%)	Evaporation (mm)
2004	February	29.1	-11.4	-4.7	10.2	3.3	-0.6	27	84.2	0
2004	March	52	-7.8	1.3	21.6	13.8	7.5	8	68.2	15.5
2005	April	20	-11	2	28.6	16.4	9.2	8	60.2	51.3
2005	May	29	5.2	9.3	28	24.3	16.8	0	55.3	98.1
2005	June	6.2	7.2	11.9	36.4	28.5	20.2	0	52.2	153.1
2005	July	0	13	15.8	39	33.6	24.7	0	50	217.7
2005	February	21	-11	-2	18.6	9.9	3.8	19	71.2	26.6
2005	March	23.6	-5	0.5	26.8	14.2	7.3	12	59.8	41.5
2006	April	63.4	-0.2	4.5	27	19	11.7	1	55.8	73.1
2006	May	1.4	5	10.5	34.2	26.9	18.7	0	50.6	126.4
2006	June	10.8	9	12.7	37.4	30.2	21.4	0	35.1	177.4
2006	July	6	13	17.6	39.2	33.7	25.6	0	39.5	182.7

Table 2. Combined analysis of cultivar and density (the seeding rates) characteristics of the study (mean squares)

Sources	Degree of freedom	Grain Yield	Thousand Kernel weight	Number of Seeds per Pod	Number of Pods per Plant	Plant Height	Days to Maturity	Days to Flowering	Stand Percent
Year	1	2956.70 ns	11.416**	99.01 ns	709420.30**	0.46ns	838.51**	2431.01**	38281.25**
Error	6	8003.89 ns	0.258 *	25.20 ns	26757.89 ns	55.44ns	6.61*	7.71**	766.08**

Cultivar	1	123690.50**	1.897**	259.20**	236150.80**	7425.89**	1117.50**	446.51**	2332.80**
Cultivar ×Year	1	103128.49**	0.025 ns	320.00**	55730.40**	1.24ns	7.81*	70.31**	10305.80**
Plant density (Seeding rate)	4	12088.02 ns	0.168 ns	16.58 ns	21511.92ns	47.60ns	14.20**	4.58**	1630.97**
Year× Seeding rate	4	5017.78 ns	0.046 ns	17.93 ns	22413.35ns	15.97ns	8.39**	2.61 ns	110.03 ns
Cultivar × Seeding rate	4	7163.87 ns	0.068 ns	8.18 ns	18632.58ns	41.24ns	0.32 ns	0.29 ns	526.33 **
Year× Cultivar × Seeding rate	4	2499.99 ns	0.267 ns	33.94 ns	29599.43ns	72.83 ns	0.69 ns	1.97 ns	91.52 ns
Error	54	9396.24	0.123	36.29	15214.45	47.19	2.57	2.73	115.24
Coefficient of variance (C.V)	-	29.25	12.760	26.68	25.80	9.06	1.54	3.05	25.79

ns, * and **, show a non-significant, significant at 5 and 1%, respectively

Table 3. Mean comparisons of traits for cultivars, seeding rates and interaction effects of two years experiment

Varity	Seeding rate (Kg/ha)	Average of studied characteristics							
		Stand Percent	Days to Flowering	Days to Maturity	Plant Height	Number of Pods per Plant	Number of Seeds per Pod	Thousand Kernel weight (g)	Grain Yield (Kg/ha)
Bard 1		47.03 a	51.85 b	100.03 b	74.52 a	237.34 a	17.84 a	2.595 b	814.32 a
Hayola 401		36.23 b	56.58 a	107.50 a	55.25 b	128.68 b	21.44 b	2.902 a	735.68 b
	2	27.19 c	55.31 a	104.88 a	66.43 a	242.00 a	20.56 a	2.569 a	762.85 a
	3.5	36.63 b	54.75 ab	104.19 ab	65.05 a	181.47 ab	18.97 a	2.759 a	753.55 a
	5	42.44 b	54.69 b	104.00 ab	62.15 a	178.88 ab	20.91 a	2.797 a	758.56 a
	6.5	51.25 a	53.63 ab	103.38 bc	64.53 a	171.88 ab	18.69 a	2.812 a	821.14 a
	8	50.63 a	50.69 b	102.38 c	66.26 a	141.19 b	10.07 a	2.805 a	778.88 a
Bard 1	2	39.38 ab	52.88 b	101.13 d	76.71 a	351.81 a	18.94 a	2.319 b	805.43 a
Bard 1	3.5	46.50 ab	52.38 b	100.38 d	77.22 a	234.88 ab	16.63 a	2.606 ab	818.01 a
Bard 1	5	48.00 ab	52.25 b	100.25 d	70.51 a	221.63 b	20.00 a	2.725 a	799.92 a
Bard 1	6.5	51.25 a	51.50 b	99.88 de	73.06 a	195.44 b	16.00 a	2.688 ab	826.79 a
Bard 1	8	50.00 a	51.25 b	98.50 e	75.10 a	182.94 b	17.63 a	2.635 ab	821.43 a

Hayola 401	2	15.00 d	57.75 a	108.63 a	56.16 b	132.19 b	22.19 a	2.819 a	720.26 ab
Hayola 401	3.5	26.75 c	57.13 a	108.00 ab	52.88 b	128.06 b	21.31 a	2.912 a	689.08 b
Hayola 401	5	36.88 bc	56.13 a	107.75 abc	53.80 b	122.13 b	21.81 a	2.869 a	717.21 ab
Hayola 401	6.5	51.25 a	55.75 a	106.88 bc	55.99 b	161.63 b	21.38 a	2.937 a	815.49 a
Hayola 401	8	51.25 a	55.13 a	106.25 c	57.42 b	99.38 b	20.50 a	2.975 a	736.33 ab

Means within a column followed by the same letter are not significantly different at p = o.o5 (Based on Duncan Multiple Test)

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