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Effect of Cutting Height and Seed Cutting Date on Grain yield and Yield Components in Berseem Clover (*Trifolium alexandrinum* L.)

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ABSTRACT

In order to investigate the effect of cutting height and cutting date of seed on grain yield and yield components of berseem clover, a factorial experiment in randomized complete block design with three replications was carried out in Ahvaz in 2014-2015. The experimental factors included seed cutting date in three levels (February 3, February 18 and March 5) and three levels of cutting height (2, 6 and 10 cm). The results showed that cutting height caused the significant increase of grain yield, number of plants per m^2, number of inflorescences per plant, and 1000-grain weight. The highest grain yield (68.95 g/m^2) belonged to cutting height of 6 cm and the lowest grain yield (42.9 g/m^2) belonged to cutting height of 2 cm. Moreover, seed cutting date also significantly increased grain yield and yield components. The highest grain yield (75 g/m^2) belonged to cutting date of February 18, and the lowest grain yield by (39.6 g/m^2) belonged to cutting date of March 5. In general, cutting height of 6 cm and the cutting date of February 18 had the highest potential to achieve maximum yield in berseem clover.

Keywords: Plant inflorescence, Cutting height, Number of plants, 1000-grain weight

INTRODUCTION

Berseem clover (*Trifolium alexandrinum* L.) is a plant of leguminous family whose cultivation has been strongly welcomed by farmers in the recent decades due to its fast growth, several times of cutting, fresh forage production, and considerable quantity and quality. The first cutting of berseem clover is done at most 60-70 days after planting and the next ones are during 20-30 days intervals (Zamanian, 2003). Berseem clover is generally known as a forage plant and only its last cutting is likely to be allocated to seeds. The last cutting requires special environmental conditions including temperature, rate of humidity, evaporation, etc. (Reed *et al*., 2014). Cutting height from soil level plays an important role in plant re-growth as well as the rate of produced seed and grain filling rate. Therefore, cutting height has various effects on the yield which depend on the initial characteristics of the seedling of various cultivars. The traits which are mainly affected by cutting height include forage yield, grain yield, tillering and growth period (Rahimi Patroudi *et al*., 2012). Fraser *et al*. (2013) investigated the effect of seed cutting date on clover and reported that the mean grain yield in two or three cuttings per year was 28.1% higher and it was particularly 2.5% more than one or four cuttings per year. However, one or two cuttings per year increased the number of florets as 13.6%, the number of grains per spike about 10%, and grain length as

3.9% in comparison with four cuttings per year. The highest rate of moisture belonged to 4 cuttings per year. Giambalvo *et al*. (2011) investigated the effects of cutting intervals and height and showed that as the cutting frequency increased in breseem clover, its yield decreased. Due to the decrease of cutting height and frequent cutting, stored materials in plant decreases and consequently the plant ability to produce appropriate product in the next cuttings will decline. As the cutting frequency increases and the cutting height decreases, the leaves will fall more and more. Mezoni *et al*. (2013) showed that as the cutting height of berseem clover increased, total dry matter decreased.

This study aimed to determine the best cutting height and the most appropriate seed cutting date to achieve maximum yield in berseem clove in Ahvaz.

MATERIALS AND METHODS

This research was conducted in 2014-2015 in Agricultural Research Center in Ahvaz at latitude 31°20´N and longitude 48°40´E and 23 m above the sea level. The research was conducted as a factorial experiment in randomized complete block design with three replications. The experimental factors included seed cutting date in three levels (February 3, February 18 and March 5) and three levels of cutting height (2, 6 and 10 cm). Each plot had 8 rows 7 m long and 40 cm apart. Basic fertilizer (150 kg ammonium phosphate) was added to soil before the second disk. Seeds were planted manually in a rate of 15 kg/ha on October 15. Weed control was done manually. The first harvest was on February 3. Since clover flowers do not mature simultaneously, forage harvest was done at 10% flowering stage. After the first harvest when 75% of the capsules had got brown the final harvest was done. Grain yield was determine for rows number 4, 5 and 6 in an area of 4 m^2. The number of plants per m^2, number of inflorescences per plant, number of grains per inflorescence, and 1000-grain weight were measured and compared as grain yield components. The data were analyzed using SAS software and Duncan test at 5% probability level was used to compare the means.

RESULTS AND DISCUSSION

Number of plants per square meter

The ANOVA results showed that the number of plants per square meter was significantly affected by the seed cutting date at 1% probability level; however, the effects of cutting height and the interaction effect of seed cutting date and cutting height on the number of plants per square meter were not significantly different (Table 1). The highest number of plants per square meter (300 plants) was obtained on February 18 and the lowest number (270 plants) was achieved on March 5 (Table 2). The greater number of plants per square meter on cutting date of February 18, was due to the harvest in the best conditions in terms of temperature, light, and lack of environmental stress in comparison with the two other cutting dates.Clifford (1986) reported that the number of inflorescences per square meter during the harvest was 953 in seed cutting of mid-November November and 505 in seed cutting of mid - December. The results of this study were consistent with the findings of Wilson and Kendal (2009) who showed that the highest numbers of plants per square meter and grain yield were, respectively obtained for cutting dates of 60 and 90 days after planting.

Table 1. The ANOVA results for studied traits in Berseem clover

		Mean of squares				
Sources of variations	df	Number of plants per m^2	Number of inflorescences per plant	Number of plants per inflorescence	1000-grain weight	Grain yield
Replication	2	15088.88**	0.02^{ns}	12.04**	0.726**	493.45**
Cutting height	2	73.55^{ns}	1.58**	17.41**	0.781**	1664.11**
Seed cutting date	2	7662.68**	0.52**	136.67**	0.504**	2832.43**
Cutting height × seed cutting date	4	299^{ns}	0.0027^{ns}	3.05^{ns}	0.100^{ns}	86.13^{ns}
Error	16	463.2	0.01	1.62	0.052	35.44
Coefficient of variations	-	7.50	3.72	5.00	6.90	10.23

ns, *, **: are non-significant, and significant at 5% and 1% probability levels, respectively.

Number of inflorescences per plant

The ANOVA results showed that the number of inflorescences per plant was significantly affected by cutting height and seed cutting date at 1% probability level; however, the interaction effects of these two factors on the number of inflorescences per plant were not significantly different (Table 1). The highest number of inflorescences per plant (3.11) was obtained at the cutting height of 6 cm and the lowest number (2.1) was obtained at the cutting height of 2 cm. It seems likely that at the cutting height of 2 cm stored carbohydrates in plant will reduce. In such conditions, the initial growth time or period (plant regrowth time) was much delayed than the time when the harvest was done at a greater height. Inadequate carbohydrates disrupt root breathing and therefore, nutrients intake from the soil decreases which leads to the reduction of the number of inflorescences per plant which is confirmed by the findings of Rahimi Patroudi *et al.* (2012). On the other hand, it can be stated that in plants with greater cutting heights, due to more storage of nonstructural carbohydrates, the ability of plant to produce reproductive organs enhances and consequently the number of inflorescences in plants will increase (Turner and Fund, 2001). The highest number of inferences per plant (2.95) was obtained on February 18 and the lowest number (2.47) was obtained on March 5 (Table 2). The greater number of inflorescences per plant on cutting date of February 18, was due to appropriate and cool weather conditions and lack of environmental stress in comparison with the two other treatments. On the other hand, it seems that on February 18, in comparison with February 3, the plant had more time from the previous cutting date to accumulate stored materials. Also on March 5, the increase of temperature during the reproductive stage has caused the reduction of the number of inflorescences per plant in comparison to February 18. In this regard, Wilson and Kendal (2009) have stated that good temperature conditions as the most important environmental factor affects flowering time and the number of plants per unit area in forage plants such as clover.

Table 2. Mean comparison of the effects of cutting height and seed cutting date on the studied agronomic traits in berseem

treatments	Number of plants per m^2	Number of inflorescences per plant	Number of grains per inflorescence	1000-grain weight (g)	Grain yield (g/m^2)
Cutting height above ground					
2 cm	285.00 a	2.10 c	23.70 b	2.90 c	42.90 c
6 cm	280.00 a	3.11 a	26.20 a	3.60 a	68.95 a
10 cm	290.00 a	2.28 b	26.20 a	2.70 b	1.60 b
Seed cutting date					
February 3	280.00 b	2.70 b	25.00 b	3.35 a	59.00 b
February 18	300.00 a	2.95 a	28.70 a	3.50 a	75.00 a
March 5	270.00 c	2.47 c	21.00 c	3.00 b	39.60 c

Means in each column for each treatment with at least one common letter are not significantly different at 5% probability level

Number of grains per inflorescence

The ANOVA results showed that the number of grains per inflorescence was significantly affected by the cutting height and seed cutting date at 1% probability level; however, the interaction effects of these two factors on the number of grains per inflorescence were not significantly different (Table 1). The highest number of grains per inflorescence (26.2) was obtained at the cutting height of 6 and 10 cm and the lowest number (23.7) was obtained at the cutting height of 2 cm above the ground. It seems likely that the reduction of the number of grains per inflorescence in the treatment with cutting height of 2 cm is due to the reduction of stored materials and reduced capability of plant to produce grain in inflorescence. The greater number of grains per inflorescence in plants with cutting height of 6 and 10 cm is due to the accumulation of more nonstructural carbohydrates and the increased ability of plant to produce grains in inflorescence. In this regard, Giambalvo *et al.* (2011) stated that as the cutting frequency of berseem clover increased, the crop yield decreased. The results indicated that due to the reduction of cutting height and frequent cutting, stored materials in the plant were reduced and consequently the plant potential to produce grain and to have appropriate performance in the next cutting decreased. The obtained results were consistent with the findings of Mezoni *et al.* (2013), Ventroni *et al.* (2010). The highest number of grains per inflorescence (28.7) was obtained on February 18 and the lowest number (21) was obtained on March 5 (Table 2). It seems that higher number of grain per inflorescence on February 18 is due to good environmental conditions, so that warm weather in March has provided good conditions in terms of both temperature and sunny hours to produce reproductive organs. Researchers have stated that the number of seeds depends on the type, conditions, and region of cultivation as well as environmental factors and time of planting and harvesting dates (Mobasser *et al.*, 2012).

1000-Grain weight

The ANOVA results showed that 1000-grain weight was significantly affected by the cutting height and seed cutting date at 1% probability level; however, the interaction effects of these two factors on 1000-grain weight were not significantly different (Table 1). The highest 1000-grain weight (3.6 g) was obtained at the cutting height of 6 cm and the lowest weight (2.9) was obtained at the cutting height of 2 cm above the ground (Table 2). It seems likely that 1000-grain weight reduction in the treatment with cutting height of 2 cm is due to the fact that stored carbohydrates in the stem base is less than the other two cutting heights. Wherever that carbohydrate supply is not sufficient, the initial growth will be slow and the total production of plant will reduce. This leads to the reduction of 1000-grain weight at this cutting height. Giambalvo *et al.* (2011) examined the cutting intervals and cutting height and showed that as the cutting frequency in berseem clover increased he weight of crop grain decreased. Due to the reduction of cutting height and frequent harvest, stored materials in plants decreased and consequently, the plant ability to produce appropriate products in the next cuttings declined and 1000-grain weight decreased. The results were consistent with the findings of this research.

Comparison of the means showed that on seed cutting dates of February 3 and 18, no significant difference was observed in terms of 1000-grain weight and the highest 1000-grain weights (3.55 and 3.5 g) belonged to February 3 and February 18, respectively (Table 2). On seed cutting dates of February 3 and 18, due to cooler days the plants made maximum use of light increase of photosynthesis and accumulation of stored materials in seeds, 1000-grain weight increased. Warm temperature or lower temperature than the desired one lead to the reduction of photosynthesis as well as vegetative and reproductive growth and consequently the reduction of yield and yield components. The results were in consistent with the findings of Zamanian (2009). On the other hand, the results of the experiment conducted on clover by Wilson and Kendal (2009) showed that as the plant harvest was delayed or the harvest intensity was heavier, 1000-grain weight and the yield would decrease.

Grain yield

The ANOVA results showed that grain yield was significantly affected by the cutting height and seed cutting date at 1% probability level; however, the interaction effects of these two factors on grain yield were not significantly different (Table 1). The highest grain yield (68.95 g/m^2) was obtained at the cutting height of 6 cm above the ground and the lowest (42.9 g/m^2) was obtained at the cutting height of 2 cm (Table 2). It seems that at the cutting height of 2 cm, the stored carbohydrates in plant decreases. In such conditions, the initial growth period (plant regrowth time) was longer than the harvest at a higher height. Insufficient carbohydrates disrupt root breathing and nutrient absorption from the soil decreases and ultimately plant faces the reduction of grain yield and yield components. However, as the cutting height increases, due to the increase of stored materials in plant, the plant growth capacity enhances and more seedlings are produced. Therefore, the rate of stored materials has a great effect on the production of photosynthetic materials and development of reproductive organs which in turn leads to the increase of grain yield in plant (Turner and Fund, 2001). Furthermore, Rahimi Patroudi *et al.* (2011) reported that the highest grain yield and dry matter input in berseem clover was obtained at the cutting height of 7.5 and 10 cm and every three month of cutting.

The highest grain yield (75 g/m^2) belonged to seed cutting date of February 18 and the lowest (39.6 g/m^2) was obtained on March 3 (Table 2). On seed cutting date of February 18, due to appropriate temperature and good day length the vegetative and reproductive growth of clover as well as other traits were enhanced which led to the superiority of grain yield and yield components compared to other seed cutting dates. However, with delay in seed cutting date on March 5, the grain yield decreased with regard to the increase of temperature and thus significant reduction of the number of grains per inflorescence and 1000-grain weight which was consistent with the findings of Wilson an d Kendal (2009) in clover. In Addition, Shushi Dezfuli (2009 and 2010) reported that the highest grain yield in clover belonged to planting dates of October 11, October 31, and November 20 (1128, 1179, and 1050 kg seeds per hectare respectively). The best cutting treatment was March 29 which was predictable with regard to more growth period of clove in this treatment.

CONCLUSION

The results of this study showed that cutting height and seed cutting date in Ahvaz weather conditions lead to different potentials in grain yield and yield components of berseem clover. The yield components and grain yield at the height of 6 cm were more than the height of 2 and 10 cm. The highest grain yield (68.95 g/m^2) belonged to the treatment with cutting height of 6 cm and the lowest (42.9 g/m^2) belonged to the treatment with cutting height of 2 cm. Due to the providing dry matter and storing assimilates as well as the increase of transferring assimilates into the seeds and increasing reproductive and vegetative growth, the cutting height of 6 cm led to the increase of yield and yield components in berseem clover. Among the seed cutting dates, February 30 showed a considerable superiority to February 3 and March 5, due to be having in good environmental conditions and more light and temperature by clover. The highest grain yield (75 g/m^2) belonged to cutting date of February 18, and the lowest (39.6 g/m^2) belonged to cutting date of March 5. In general, the treatment with cutting height of 6 cm and cutting date of February 18 had the highest potential to achieve maximum grain yield in berseem clover in Ahvaz climate conditions.

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