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ORIGINAL ARTICLE **OPEN ACCESS**

Investigation of row orientation and planting date on yield and yield Components of lentil (*Lens culinaris* Med.)

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ABSTRACT
For estimation of lentil row orientation and planting date, a field study was conducted in Research Field of Islamic Azad University, Shahr-e-Rey Branch, Tehran, Iran in 2011. The experiment was planted as a randomized complete block design with split-plot arrangement and four replications in which treatments consisted of two seeding methods: seeding with East–west and North–South row orientations. Planting date of main plots is 23th Oct. and6th of Nov. and 22th of Nov. for subplots. The results of Analysis of variance for row orientation showed significant effects on grain yield, biomass, leaf wet weight, harvest index and fruit wet weight. Grain yield in east- west row orientation was 1519.76kgh^{-1} while this factor in another orientation method was 1266.46kgh^{-1} and It represented more than 21% yield loss on this condition. Effect of planting date on many of traits had significant effects which include grain yield, biomass, harvest index, and the number of seed per pod. The first planting date (23th Oct.) with 1599.56kgh^{-1} had the highest grain yield.
Keywords: *lentil, row orientation, planting date, yield and yield competition.*

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INTRODUCTION

Grain legumes are the most important protein and mineral food crops in the world, especially in developing countries. Lentil (*Lensculinaris* Medik.) is the most important food legume crop of rainfed cropping systems in Near East, traditionally grown in rotation with barley and wheat in low and medium rainfall areas, respectively.
Lentil has been used widely in human nutrition and has a major role in fighting protein deficiency because of its high protein level(20.40-30.90%) and its straw is a valued animal feed [1].
Given the importance of maximum utilization of environmental parameters during growth period, it is crucially important to choose an appropriate sowing date for any crop anywhere. Sowing date, ecological factors and cultural practices etc. Influence the yield and yield characteristics. It is very important to determine most suitable variety and sowing date and use of cultural practices in any region to increase quality and yield. Potential yield of crop can be achieved through optimum use of inputs and agronomic practices. Among the various agronomic practices, optimum sowing date and the best variety are of primary importance for potential yield [2]. Time of sowing determines time of flowering and it has great influence on dry matter accumulation, seed set and seed yield. Lentil planting at appropriate time allows its better-establishment before the commencement of growth-limiting temperatures [3]. Ramroodi et al. [4] showed that some lentil genotypes to different planting dates in Zabol and concluded that grain yield, grain number per plant, pod number per plant, biological yield and harvest index were affected by planting dates.Galavi et al. [5] reported that the best lentil sowing date was early-November in hot regions of Iran and early-March in Karaj, Iran and similar regions because of favorable weather. He studied the effect of sowing date and plant density on yield and yield components of lentil in Mashad, Iran, and observed that delayed sowing of spring lentil decreased its reproductive phase duration, seed yield, pod number per plant and seed number per pod because of the sudden increase in temperature during late-growing season. In a study on the effect of sowing date on lentil in Neishaboor, Iran, Reference [6] concluded that seed yield/ha, pod and seed number/plant and 1000-seed weight were higher at

earlier sowing than those at later sowing dates. Also Turk et al. [7] reported that out of three sowing dates of December 30, January 14 and February 3, the highest yield (1786 kg ha^{-1}) was obtained at the earliest sowing date. Additionally, delayed sowing decreased seed yield per plant, 1000-seed weight and pod number per plant. Also, Reference [8] mainly related the yield loss of lentil at delayed sowing to the decrease in pod number/plant, seed number/plant and 100-seed weight.

MATERIALS AND METHODS

This study was conducted in Research Field of Islamic Azad University Shahr-e-Rey Branch, Tehran, Iran (35°42'N,51°25'E, 1060 m) in 2011 and 2012. 20 samples from 0-30 cm depth were collected and analyzed by y soil testing laboratory for basic soil physical and chemical properties (table 1) to determine soil characteristics. The experiment was planted as a randomized complete block design with split-plot arrangement and four replications which treatments consisted of two seeding methods: seeding with east–west and north–south row orientations. Planting date of main plots is 23thOct,6th and 22th of Nov for subplots. Each plot planted at 5 lines with length of 8meter and width of 50 cm and there was a distance equal to 1 meter between plots and 2 meters between replications. P and N fertilizer were applied according to the recommendation of soil testing laboratory in form of ammonium phosphate urea respectively. Weeding method was used for Control of weeds during the culture. For measurement of yield components, 5 normal plants randomly from the two middle rows of each plot were selected. In order to evaluate grain yield, biomass (g) and harvest index (%), 3 middle rows of each plot (3m)were harvested. Data analysis was done using SAS software and means were compared using Duncan's multiple range test at 0.05probability level. Before statistical analysis, all data were passed normality test and were transformed when needed.

RESULTS

Method of seeding

The effect of row orientation on grain yield and yield components is summarized in Table 2. According to the results, row orientation showed significant effects on grain yield, biomass, leaf wet weight (in $P \leq 0.05$), and harvest index and fruit wet weight (in $P \leq 0.01$). East-west row orientation cased more than amounts compared with northsouth orientation in all traits, Based on results of means comparison for grain yield and yield competitions (Table 3).Grain yield in east- west row orientation was 1516.76kgh^{-1} but this factor in other orientation method was 1266.46kgh^{-1}which represent more than 17.41% yield loss on this condition. There are some reductions in other traits in north-south orientation illustrating 39% reduction in harvest index, 29% in stem dry weight and 26% in biomass (Table 3).

Date of planting

Results of variance analysis showed that the effect of planting date on most of the traits was significant in a way that grain yield, biomass, harvest index were meaningful in probability level of 1% and respectively the number of seed per pod in probability level of 5% (Table 2). According to results of means comparison (Table 3) in some of traits (grain yield, harvest index and number of seed per pod), the first planting date (23th Oct) had the highest amounts compared with other planting dates as grain yield in this treatment was 1599.56kgh^{-1}. But delay in planting caused 33% yield loss (at 6th Nov). On the other hand, about traits that have high relationship with biomass (stem, leaf and fruit wet weight) the highest amounts were in second panting date (22thNov).

DISCUSSION

In general, Selection of east-west row orientation resulted better grain yield (Table 3). Main cause of this result might be high amounts of biomass and harvest index in this planting condition, regarding row orientation treatment not being significant effect on traits of seed number per pod, number of pod per plant and 100 grain weight. Generally when water and nutrients are not limiting, production of plant dry matter is determined by the amount of solar radiation in field canopy. Namely the production of dry matter by plants depends on the amount of photo synthetically active radiation (PAR) absorbed by the leaves and its efficiency of conversion into chemical energy. Otherwise, the amount of absorbed radiation depends on the efficiency of interception of solar radiation by leaves. One of the most important factors estimating this potential of plants is row orientation. Therefore, these plants (with east-west row orientation) possibly.

Received higher solar ratios, and contributed to more photosynthetic partitioned to shoots and developing seed. The highest grain yield as mentioned was in first planting date (23th Oct), and there was yield loss order in other planting dates (6thNov and 21thNov respectively); however, biomass shows difference procedure so that second planting date (6thNov) showed the highest amount. It is probably the reason why there was higher temperature in second planting date and therefore seeds had faster emergence and higher vegetative growth, but reproductive grow of plants and sensitive stages (for example pollination stage) confronts the heat stress. Decreasing in the number of seed per pod is an example of these damages (Table 3). Therefore with decrease in reproductive growth duration, most of energy of plants remains in vegetative parts and grain yield is big loser. Early sowing time possibly caused very strong root system and plants developed strong in the spring [9]. Azizi et al. [10] reported that planting date was effective on seed yield and delayed planting caused the weakness of performance so that the highest on the first planting and the third seeding date had lowest performance. Kayan [1] showed that the most suitable period for winter lentil sowing date is between 1st and 15th of October in the Eskisehir conditions.

In conclusion, we suggested that early sowing is clearly important to produce a successful lentil Crop. Namely delaying in planting date due to the loss of plant potential for the growth, and so this leads to yield decrease. On the other hands, selection of east-west row orientation by better use of solar radiation and avoidance of shade was better grain yield can produce higher grain yield.

Table 1 soil properties of the experimental plots

Soil texture	K(solvable) (ppm)	P(solvable) (ppm)	N total (ds/m)	PH	EC(ppm)	Organic carbon percentage (% O.C)
Loam-clay	440	22.43	0.1	7.59	3.43	1.09

Table 2: Analysis of variance for grain yield and yield competitions

S.O.V	df	Grain yield	biomass	Harvest index	100 grain weight	number of pod per plant	number of seed per pod	Stem wet weight	leaf wet weight	Fruit wet weight
replication	3	658.86 ns	24.03ns	2.43ns	0.06n.s	236.56*	23.41*	2.61ns	0.94ns	0.15ns
Method of seeding (A)	1	11548.93*	1229.56*	181.76**	0.07ns	36.4ns	2.04ns	14.58ns	11.93*	15.46**
Error (A)	3	870.8	37.83	4.36	0.47	13.34	0.81	2.73	0.75	0.03
Date of Planting (B)	2	18205.63**	4198.43**	94.46**	0.18ns	8.76ns	3.88*	45.31**	114.12**	61.49**
A*B	2	3276.13*	87.76ns	32.73**	0.23ns	8.8ns	0.009ns	0.03ns	0.34ns	6.16**
Error	12	804.4	43.93	1.16	0.09	13.67	0.65	1.22	0.64	0.08
C.V (%)	-	13	12	14.5	11.6	18.4	14.9	17.9	15	7.75

ns, *and **means non-significant, significant at 5 and 1% levels of probability, respectively

Table 3: means comparison for grain yield and yield competitions

	Grain yield (kgh^{-1})	biomass (kgh^{-1})	Harvest index(%)	100 grain weight	number of pod per plant	number of seed per pod	Stem wet Weight ($grplant^{-1}$)	leaf wet weight ($grplant^{-1}$)	Fruit wet Weight ($grplant^{-1}$)
Method of seeding									
North – south orientation	1266.46b	2622.1b	30.27b	4.61a	112a	1.82a	6.86a	9.17b	5.02b
east –west orientation	1519.76a	2988.1 a	34.80a	4.81a	113a	1.84a	9.56a	11.61a	7.80a
Date of Planting									
23th Oct	1599.56a	3298.9a	35.52a	4.97a	113a	1.86a	6.11b	7.20b	5.82b
6thNov	1566.06a	3150.7a	33.70a	4.70a	111a	1.69b	12.96a	17.91a	11.48a
21thNov	1080b	2579.2b	31.88b	4.45a	1.1a	1.31c	5.56b	6.05b	1.93c

For a given means within each column of each section followed by the same letter are not significantly different ($p<0.05$)

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