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Influence of Sowing Dates on Yield and yield components of lentil under semi-arid region of Tunisia.

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Abstract - A field experiment was conducted at Kef research station (INRAT) located in a semi-arid zone in north-western of Tunisia to study the effect of two sowing dates (27 November 2014 and 7 February 2015) on phenology, growth and yield components of nineteen lentil lines. Our results showed that the different lines responded differently to different sowing dates. As sowing was replayed from November to February, numbers of days until flowering (NDF) and numbers of days until maturity (NDM) were decreased by 41% (78.3 vs. 133.4 days) and by 29.2% (171.8 vs. 121.7 days) respectively. On the other hand, the delay in sowing of lentil lines from November to February reduced the plant height (PH), the biological yield per plant (BYPP), the number of productive branches per plant (NPBPP) , the pods number per plant (PNPP) and grain yield/ha (GY/ha) by 28%, 21%, 46%,45% and 66% respectively. It is important to note that some lentil lines (line4 and line8) produce more grain yield under later sowing date comparatively to early sowing date. These lentil lines need more attention and can be incorporated in lentil breeding programme for the development of short stage varieties.

Keywords: Lentil (*Lens culinaris* L.), sowing date, yield, semi-arid, Tunisia.

1. Introduction

Lentil (*Lens culinaris* L.) is the fourth most important pulse crop in the world. It is an annual food legume highly valued in the food and nutritional security of millions of people for its grain. It contents relatively higher amount of protein, carbohydrate and calories compared to other legumes and it is the most desired pulse because of its high average protein content and also rich in Fe, Zn, Ca, fibres, pretein, hiacin and micronutrients. Singh (2001) reported that lentil contains about 11% water, 25% protein and 60% carbohydrates. This crop is adapted to low rainfall and is predominantly grown in the winter in regions where the annual average rainfall is 300 to 400 mm (Sarker et al., 2003).In Tunisia, lentil is grown, as small-scale farms as a food and cash crop, in arid areas (Southeast) and semi arid. For this reason, it is exposed to less biotic stresses than other legumes. Total production of lentil in Tunisia in the year 2013-2014 was 750 tons from an area of 1745acres with an average yield of 4.3 qx ha-1 (Faostat, 2015). This low yield of the crop is mainly due to the agronomic practices. Ouji et al, (2016) mentioned that lentil is commonly grown under rainfall condition during winter on soils that conserve moisture from the preceding monsoon. So, this crop is characterized by its ability to enter into a symbiotic relationship with the *bactrium Rhizobium leguminosarum* in the fixation of atmospheric nitrogen. It helps in reducing the amount of added nitrogenous fertilizer to the plants. Like other pulses, it has remained as an abandoned crop due to low input-use and other production constraints. Among cultivation practices, sowing time is an important parameter which affects the growth, development and yield of lentil to a great extent (Sen, 2016).

Choosing an optimum sowing time can also be a compromise between maximizing yield potential and minimizing disease levels. Earlier sowing can expose the crop to more rain events which can increase the risk of disease. It will also increase crop biomass, increasing the risk of lodging and soil moisture deficit during grain fill. Later sowing can result in shorter plants (harvesting difficulties), but may reduce vegetative water use and reduce the exposure to disease infection events (Matthews and McCaffery, 2011).

Early sowing of lentil may not result in higher yields, despite earlier flowering, due to the increased risk of disease and the impact of low temperatures on flowering but later sown can compensate through shortening their vegetative phase and flowering at temperatures more conducive to subsequent pod

development. Determination of optimum sowing time is important as declining temperatures may affect the final yield. Mechanisms for the yield decline are not well explained. There is limited information published on the optimum sowing date for lentil in Tunisia. So, the objectives of this study were to determine the optimal sowing date in the Tunisia semiarid region and to select the earliest lentil lines.

2. Materials and methods

A field experiment to study the effect of sowing dates on the yield and yield components of different lentil lines was conducted at Kef research station (INRAT) located in a semi-arid zone in north-western Tunisia. The experiment was laid out in a randomized split-plot design with three replications (4 rows of 4m long each replication). Nineteen lines (Table1) were sown at two sowing dates (27 November 2014 and 7 February 2015). Number of days until flowering (NDF), number of days until maturity (NDM) , plant height (PH), number of productive branches per plant (NPBPP), pods number per plant (PNPP), grain yield/ha (GY/ha) and biological yield per plant (BYPP) were recorded. Finally, statistical analyses were performed by using ANOVA procedure in statistica software.

Table 1: Lentil tested lines name and origin.

Line number	Line name	Origin
1	LIEN-E T(36)	Tunisia
2	LIEN-E T(25)	ICARDA
3	LIEN-E T(6)	ICARDA
4	LIEN-E T(5)	ICARDA
5	LIEN-E T(17)	ICARDA
6	LIEN-E T(15)	ICARDA
7	LIEN-E2 T(31)	ICARDA
8	LIEN-E T(5)	ICARDA
9	LIEN-E T(3)	ICARDA
10	LIEN-E T(14)	ICARDA
11	LIEN-E T(2)	ICARDA
12	LIEN-E T(34)	ICARDA
13	LIEN-E T(31)	ICARDA
14	LIEN-E T(17)	ICARDA
15	LIEN-E T(20)	ICARDA
16	LIEN-E T(8)	ICARDA
17	LIEN-E T(16)	ICARDA
18	LIEN-E T(10)	ICARDA
19	LIEN-E T(4)	ICARDA

3. Results and Discussion

The effect of lentil lines, sowing dates and interaction between them were significant for all measured parameters (Table 2).

Number of days until flowering (NDF)

Table 2. Analysis of variance of sowing dates, lentil lines and interaction between them on Number of days until flowering (NDF), Number of days until maturity (NDM) , Plant height (PH), Number of productive branches per plant (NPBPP), Pods number per plant (PNPP), Grain yield/ha (GY/ha) and Biological yield per plant (BYPP) grown under November and February sowing dates.

	Genotype (A)		**Treatment (B)**		**Interaction A*B**	
	M.S.	**F value**	**M.S.**	**F value**	**M.S.**	**F value**
NDF	53.69	8.7**	86625.5	14072.4**	27.8	4.5**
NDM	44.85	18.32**	71851.26	29358.58**	31.3	12.78**
PH	17.6	4.9**	2008.4	566.3**	73.9	20.8**
NPBPP	412.9	5.91**	4261.4	61.0**	214.0	3.06**
PNPP	1177.4	3.509**	18877.97	56.26**	736.62	2.195**
GY/ha	1697.5	9.35**	10326.3	568.9**	32609.5	17.9**
BYPP	27.1	4.46**	58.6	9.67**	6.9	1.138**

** Significant at the 0.01 probability levels. M.S. = Mean square

Statistical analysis of the data showed that there were a highly significant differences (P < 0.01) (Table 2) in Number of days until flowering (NJF) due to different sowing dates. The effect of lines and interaction between lines and sowing dates were also highly significant. Number of days until flowering (NJF) were decreased as sowing was replayed from November to February (Table 3).

Table 3. Effect of sowing times on Number of days until flowering (NDF), Number of days until maturity (NDM) , Plant height (PH), Number of productive branches per plant (NPBPP), Pods number per plant (PNPP), Grain yield/ha (GY/ha) and Biological yield per plant (BYPP).

	November sowing dates	February sowing dates	Percent reduction
NDF	133.4A	78.2B	41
NDM	171.8A	121.7B	29
PH	30.3A	21.9B	28
NPBPP	26.6A	14.4B	46
PNPP	57.8A	32 B	45
GY/ha	913.2A	311.3B	66
BYPP	7.1A	5.6B	21

Values within the same column followed by the different letters are significantly different

Mean values of sowing dates revealed that minimum number of days until flowering (NJF) 78.3 days was recorded when sowing was done on February. While the lengthiest number of days until flowering (133.4 days) was recorded when sowing was done on November. Results showed that when lentil lines were sown in November, line3 and line9flowered at short time (75days) whereas line10 took maximum days to flower (81.3 days). On the other hand, when lentil lines were sown in February, line18flowered at short time (117.3 days) while line15took maximum days to flower (138 days).

Number of days until maturity (NDM)

Statistical analysis of the data showed that there were a highly significant differences (P < 0.01) (Table 2) in number of days until maturity due to different sowing dates. The effect of cultivar and interaction between lines and sowing dates were also highly significant.

Mean values of sowing dates revealed that the number of days until maturity were decreased as sowing was deployed from November to February (Table 3). Indeed, the numbers of days until maturity were 121.7 and 171.8 days respectively for November to February sowing dates. So, the number of days until maturity was decreased by 50 days.

When lentil lines were sown in November results showed that line7 and line13 attend maturity at short time (117days) while line2 took maximum days to maturity (132 days).When lentil were sown in February, line12attend maturity at short time (117days) while line 4 andline8 took maximum days to maturity (177.3 days).

Grain yield/ha (GY/ha)

Table2 revealed that different lentil lines, sowing dates and interaction between them had a significant effect on grain yield (P < 0.01). Results of table3 showed that highest grain yield (913.2 kg/ha) was produced when sowing was done on November while, sowing in February recorded the minimum grain yield (311.3 kg/ha).

When lentil lines were sown in November results showed that line15 showed the lowest grain yield (109.1 kg/ha) while line8 showed the biggest seed yield (876.6 kg/ha).When lentil lines were sown in February, results showed that line18 showed the lowest grain yield (336.4 kg/ha) while line 1 showed the biggest seed yield (1876.2 kg/ha).

Examination of the data indicated that line4 andline8 responded better when sown on February than November as compared to other lines. They produced 876.6 and 570 kg/ha respectively. Line18 gave equal yield at the two sowing dates. So, line4,line8 and line18 were suitable to be sown later.

Biological yield per plant (BYPP)

Statistical analysis of the data showed that there were a highly significant differences ($P < 0.01$) (Table 2) in biological yield per plant (BYPP) due to different sowing dates. The effect of line and interaction between lines and sowing dates were also highly significant.

The mean values of the data revealed that biological yield decreased as sowing date delayed from November to February (Table 3). Examination of the mean for planting dates indicated that the highest biological yield per plant of 7.1g/plant was produced when sowing was done on November. While, the lowest biological yield (5.6g/plant) was recorded when sowing date was done on February.

When lentil lines were sown in November results showed that line2 showed the lowest grain yield (3.2g/plant) while line11 showed the biggest seed yield (13.4g/plant).When lentil were sown in February, results showed that line7 showed the lowest grain yield (2.7g/plant) while line8 showed the biggest seed yield (9.8g/plant).

Number of productive branches per plant (NPBPP)

Combined data (Table 2) indicated that number of productive branches per plant was affected significantly ($P < 0.01$) due to main effects of lines and sowing dates. Mean Number of productive branches per plant (26.6 branches) was recorded when lentil lines were sown on November as against minimum (14.4 branches) was noted in February sowing. The interaction between sowing date and varieties influenced significantly the number of productive branches per plant. When planted on November, lentil line11produced significantly higher average number of productive branches per plant (41.7productive branches). The minimum number of productive branches per plant (12branches) was recorded from lentil line2. For the plots that were sown on February, maximum number of productive branches per plant (40.3branches) was obtained from lentil line4while the minimum (3.7branches) was recorded in line17.

Plant height (PH)

The effect of sowing dates, lentil lines and interaction between them was significant on plant height (Table2).Delay in sowing from November to February reduced the plant height by 28% (30.3 vs. 21.9 cm) (Table3). Besides, when sowing time was November, plant height of the tested lines range between 20.5 cm (line7 and line11) and 35.5 cm (line5 and line14). For the plots that were sown on February, maximum plant height (31.5cm) was obtained from line7 while the minimum (19 cm) was recorded in line15, line 16 andline18.

Examination of the data indicated that line7 responded better when sown on February than November as compared to other lines (31.5 vs. 20.5 cm).

Pods number per plant (PNPP)

The effect of sowing dates, lentil lines and interaction between them were significant on pods number per plant (PNPP) (Table2).Sowing time had significant influence on number of pods per plant of lentil lines tested in the study. Lentil sown on November produced the highest number of pods per plant (57.8 pods) compared to February sowings (32 pods).So, variation in sowing time from November to February was found to decrease the number of pods per plant (Table3). When sowing date was in November, the highest number of pods per plant was observed in line14 while the lowest number of pods per plant was found in line2.When sowing date was in February, the highest number of pods per plant was observed in line8 while the lowest number of pods per plant was found in line3.

The sowing date is one of the more important factors that determine yield of lentil. Previous studies of Muhammad et al, (2010) showed that the appropriate sowing time of various field crops results in higher economic yield without involving extra cost as it helps varieties to express their full growth potential. The optimal sowing time for lentil is a negotiation. Sowing too early increases the risk of cold damage and weed affect, while sowing too late decreases the grain weight during increasingly hot and dry conditions. It is important to study the varietal responses to sowing dates since varieties differ in their growth and development as previous cited by Singh and Ram (1986). Thus, an attempt was made to determine the most suitable sowing time for the promising lentil lines. Our results showed that different lines responded differently on different sowing dates. When lentil lines were sown in earlier date, it produced more podding comparatively to later sown date which produced lesser number of pods. These results were in consonance with the earlier findings of Aziz (1992). Moreover, delay in sowing causes

a reduction in yield of lentil. Similar results are also reported by Aziz, (1992) and Sekhon et al., (1986). Higher seed yields produced under sowing on November were attributed to increased number of pods. These results supported the earlier findings of Ahlawat et al. (1982), Singh et al. (1990), Roy et al, (2009) and Ali et al. (1993). The reduction of grain yield due to delay in sowing can also be attributed to shorter growth period at the disposal of the late sown crop as the time taken by the crop to mature decreased with delay in sowing. Same results were reported by Tawaha and Turk (2001) for narbon vetch.

In the current study, it is important to note that there is some lentil lines (line4 and line8) which produce more grain yield under later sowing date comparatively to early sowing date. These lentil lines need more attention for developing short stage varieties and could be recommended for late sowing.

In this study, sowing time exerted significant influence on plant height of lentil crop. This is agree with previous study made by Tawaha et al, (2002) who mentioned that the delay of sowing time affected grain yield, plant height , primary branches per plant and the number of pods per plant. The cause of plant height reduction might be happened due to rapid increase in temperature as well as reduction of soil moisture.

Our results showed that the delay of sowing dates decrease the number of days until flowering as well the number of days until maturity. The duration of lentil crop was reduced with delay in sowing from November to February. Nayeem and Delve, (1993) reported that the difference in number of days to maturity may be due to difference in their genetic makeup and also due to their differential response to different sowing season. Akther et al, 2013 mentioned that sowing dates greatly influenced vegetative and reproductive growth stages as well as crop maturity of lentils genotypes.

4. Conclusion

Almost all lines of lentil that were sown on November registered higher seed yields. Delaying planting to February caused reduction in seed yield. Some lentil lines which produce more grain yield under later sowing date comparatively to early sowing date. These lentil lines need more attention and can be incorporated in lentil breeding programme for the development of short stage varieties. Additional characters should be taken into account in the future for more reliable analyses.

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