Lentil Crop Production in the Context of Climate Change: An Appraisal

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ABSTRACT

Climate change and agriculture are inter-related processes both of which takes place on global scale. Climate over Indo-Gangetic plains has generally changed significantly over last thirty years. The rate of warming has varied temporally and spatially. Change in precipitation has been even more variable. Temperature increases above 2.5ºC will generally have negative overall effects on world agriculture. Reproductive performance of Lentil is particularly affected because Lentil has poor tolerance for high temperatures, especially at flowering and pod set stage. The synchrony of current and future trends reinforces the need for investigating the adaptation of Lentil Crop to climate change. Continued research into adaptive capabilities of current Lentil crop production technologies and the development of future technologies will contribute to maximizing crop production in the future. Adaptive technologies include changing sowing dates, seasonality of crop production, efficient plant nutrient management etc. The present paper include the observations on the floral phenology, reproductive performance, and realised yield of Lentil crop in relation to weather changes at Agra.

Key Words: *Climate change; Lentil; Reproductive performance: Temperature; Yield;*

Agriculture is highly vulnerable to climate change. Higher temperature eventually reduces yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long run production declines. Although there will be gain in some crops in some regions of the world, the overall impacts of climate change on agriculture are expected to be negative, threatening global food security. In developing countries climate change will cause yield declines for the most important crops and results in price increases (*Dubey et al., 2011*).

Cultivated Lentil (*Lens culinaris* Medik.), an annual crop has been grown as an important food source for over 8,000 years. They come in two varieties macrosperma (with large seeds and little pigmentation) and microsperma (with small seeds pigmentation). Lentil has a tolerance of extreme environment conditions such as drought and hot temperatures and can be grown in semi-arid regions without irrigation; Moreover, the crop can be grown in rotation with cereal crops to reduce soil erosion, improve disease and weed control and reduce demand for Nitrogen fertilizers. Beyond their longstanding food agronomic attributes, lentil is also emerging as biomass energy crop and for other non industrial, non food uses. The comparative economics of winter season crops were worked out taking net returns into consideration. It was observed that the cultivation of Lentil is more profitable than other crops under rain-fed conditions (*Handbook of Agriculture, 2006, ICAR, New Delhi; Yadav et al., 2007*).

Lentil is a major international pulse crop (3.7 million hectares harvested in 2009). Lentils are grown in the cooler temperate zones of the world or in the winter season in countries such as India and Australia which have a warm winter and hot summer. In India Lentil occupies 1.51 million hectare area with a production of 0.95 million tonnes (*FAOSTAT, 2009*). It is mainly cultivated in Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar and West Bengal. These states together account for 80-90% of total area and production of Lentil, respectively (*Rao et al.,2011*).

METHODOLOGY

The present study was conducted in Dayalbagh area of Agra district (Uttar Pradesh) during Rabi seasons for two successive years (2009-2010 and 2010-2011). The cultivar DPL-62 was selected for sowing. The variety was procured from IARI, New Delhi. The seeds were treated with synthetic as well as Biofertilizers (*Gaur 2010*). The cultivar was evaluated for vegetative and reproductive performance at different days after sowing (DAS). The sowing of crop was done on almost at the same dates in both the years i.e. 14th and 17th November respectively. Before the sowing of crop, the bacterization of seeds with with *Rhizobium* and *Panibacillus* (PSB) bioertilizers was undertaken. The various vegetative and reproductive parameters were observed from date of sowing to harvesting of crop. The vegetative parameters included plant population density, plant height, primary branches/plant leaflets/ plant and nodules/plant and reproductive parameters included flowering phenology, floral density, pods/plant, seeds/plant and pod drop.

The weather data for the above period is procured from Indian Metrological Department for the analysis of present study of Lentil crop production. (*Sulochana Gadgil and Seshagiri Rao,2000*).

RESULTS AND DISCUSSION

Lentil can be grown on wide range of soil types and soil pH although there is evidence that, in comparison with other Legume crops (e.g. chickpea, fababean and pea) it is more sensitive to water loging and soil pH<6.5 (Tang and Thompson 1966). The soil of Dayalbagh crop fields is sandy with slightly alkaline which is suitable for Lentil cultivation (*Rao et al., 2009*).

The study of vegetative and reproductive parameters shows that plant population density, flowers/ plant and pods/plant were more in year 2010-2011 as compared to 2009-2010. However, the observations of pod traits shows that pod length and pod circumference and seeds/pod were less in 2010-2011 as compared to previous year. There is 552 kg/ha yield difference in both the years. This yield reduction may be due to a combination or one of the factors i.e. flower drop or pod drop. Abundant pod drop was observed in Lentil crop field in 2010-2011 due to increase in maximum and minimum temperatures than previous year. Consequently the yield decreased by 552kg/ha in 2010-2011 when compared to the previous year. (Kalra *et al.*,2008; (Table 1 and 2).

Table 1. Estimation of various vegetative parameters of Lentil crop in different DAS

S. N.	Traits	Average values at different DAS	
		2009-2010	2010-2011
1.	Plant Population Density	51 (106 DAS)	61 (106 DAS)
2.	Plant Height	32.5cm(106 DAS)	30.0cm(106 DAS)
3.	Primary Branches/ Plant	7 (122 DAS)	7(116 DAS)
4.	Primary Roots/ Plant	8 (122 DAS)	9 (116 DAS)
5.	No. of Leaflets/ Plant	132 (122DAS)	130 (122 DAS)

Table 2. Estimation of various reproductive parameters of Lentil crop in different DAS

S. N.	Traits	Average values at different DAS	
		2009-2010	2010-2011
1.	Floral Density	1845 (110 DAS)	2952 (110 DAS)
2.	Flowers/Plant	65(110 DAS)	72(110 DAS)
3.	Pods/Plant	50 (150 DAS)	52 (122 DAS)
4.	Pod Length	1.83cm (150 DAS)	0.99 (122 DAS)
5.	Pod circumference	1.19(150 DAS)	1.17(150 DAS)
6.	Seeds/pod	2 seeds	1seed
7.	100 seed weight	3.30 gm	3.40gm
8.	Seed Yield	1683kg/ha	1131kg/ha

Average Temperature Changes Pattern: The data given in Table 3 reveal that average maximum temperature for the year 2007-2011(August) is 32.8ºC whereas average minimum temperature during the same period was 21.2ºC. However an increase of maximum temperature by 1 ºC and minimum temperature by 2 ºC was recorded for the year 2010. These increase both in maximum and minimum temperature may be responsible for flower and pod drop in Lentil that ultimately resulted in an average yield loss of about 552kg/ha.It was further computed that with every 0.1ºC increase in maximum and minimum temperature the reduction in yield was 55.2kg/ha and 16.2kg/ha respectively. (*Sinha and Swaminathan 1991)* (Table 4).

Table 3. Change pattern of maximum and minimum temperature in Agra region over the years (2009-2011)

S.N.	Year	Average Maximum Temp(°C)	Average Minimum Temp(°C)	Average maximum temp for base year (2007-2008)	Average maximum temp for base year (2007-2008)	Average deviation of maximum temp from the base year	Average deviation of minimum temp from the base year
1.	2007	32.4	18.5	-	-	-	-
2.	2008	32.0	19.9	-	-	-	-
3.	2009	32.9	22.3	32.2	19.2	+0.7	+3.1
4.	2010	33.7	22.7	-	-	+1.5	+3.5
5.	2011	33.0	22.9	-	-	+0.8	+3.7
Overall Average		32.8	21.2	-	-	+1.0	+3.4

Table 4. Consequences of changed weather parameters on the yield of Lentil crop

S.N.	Year	Increase in temperature (°C)		Actual yield (kg/ha) of	Declined yield (kg/ha) of
		Max .temp	Min. temp	Lentil crop	Lentil crop in two years
1.	2009	+0.7	+3.1	1683 (2009-2010)	-552
2.	2010	+1.5	+3.5	1131(2010-2011)	
3.	2011	+0.8	+3.7		
Average		+1.0	+3.4	-	552

Change in yield reduction with every 0.1ºC increase in max. and min. temperature — Max. Temp -55.2kg/ha; Min. Temp -16.2kg/ha

CONCLUSION

Findings of the study provide empirical evidences of consequences of changing climatic conditions on Lentil productivity at Agra. The synchrony of current and future trends reinforces the need for investigating the adaptation of Lentil crop to climate change. Continued research into adaptive capabilities of current Lentil crop production technologies and the development of future technologies will contribute to maximizing crop production in the future. Adaptive technologies include the following: (a) changing sowing date, choice of crop varieties, and development of new varieties, (b) efficient plant nutrient, water and weed management and plant protection, (c) efficient reproductive performance leading to enhanced seed yield, (d) and diversifying the farm enterprise leading to enhanced income and livelihood opportunities for marginal rural farming families.

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