ISSN 0258-7122
Bangladesh J. Agril. Res. 35(3) : 515-523, September 2010

NITROGEN UPTAKE AND PROTEIN YIELD IN LENTIL AS INFLUENCED BY SEED COLLECTION FROM DIFFERENT PARTS OF PLANTS

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Abstract

Field experiments were carried out during *rabi* (winter) seasons of 2004-2005 and 2005-2006 at the Bangladesh Agricultural Research Institute Farm, Gazipur to determine the effects of seeds collected from different plant parts on nitrogen content and nitrogen uptake, protein content, and protein yield of lentil. Lentil seeds were collected from different parts of lentil plants viz. i) seeds collected from upper parts (P_1), ii) seeds collected from middle parts (P_2), and iii) seeds collected from lower parts of lentil plants (P_3). Significant variation among the three test varieties of lentil was observed for nitrogen content and nitrogen uptake, and protein content where the highest concentration of nitrogen was observed in BARI Masur-4 which ultimately gave higher protein yield, while the lowest was in BARI Masur-2. Seeds collected from different plant parts had significant effect for nitrogen and protein content where P_3 site recorded the highest results. BARI Masur-2 seeds collected from lower parts of lentil recorded higher N content and protein content but BARI Masur-4 seeds collected from lower parts or BARI Masur-3 seeds collected from middle parts gave higher N uptake and protein yield.

Keywords: Lentil, nitrogen uptake, protein yield.

Introduction

Seed maturation refers to morphological, physiological, and functional changes that occur from the time of fertilization to maturation of ovules that are ready for harvest (Delouche, 1973). While, Abdul-Baki and Baker (1973) defined seed development as the period between fertilization and maximum fresh weight accumulation; and seed maturation begins at the end of seed development and continues upto harvest. According to Harrington (1972), physiological maturity of seeds means attaining maximum dry weight at which nutrients are not flowing into seed from mother plant. At physiological maturity, vascular connection to the seed is broken by formation of an abscission layer which looks black to the naked eye. The seed potential may be impaired, while the seeds are still developing on the mother plant.

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Seed development and maturation study is important to ensure good yield associated with seed viability, vigour and field performance (Dharmalingam and Basu, 1990). If the seeds are retained on the mother plant for longer duration after physiological maturity might lead to development of hard seeds or off-colour seeds in pulse crops (Dharmalingam and Ramakrishnan, 1978).

Moisture content of harvested crop affects seed quality and hence it determines with which moisture content the crop should be threshed. Harvesting at high moisture content increases the chances of mycofloral infection on chickpea seed, while harvesting at low moisture content increases mechanical damage to seed (Yadav *et al.,* 2005). Mahesha *et al.* (2001) reported that early harvested seeds of sunflower were immature and poorly developed and as such are poor storers compared to seed harvested at physiological maturity. Kumar *et al.* (2002) reported that seed yield and quality of paprika largely depends on the stage of maturity. As such, harvesting of seeds at right stage of maturity is most important since harvesting either at early or late stage results in lower yields with poor quality seeds. Afzal *et al.* (2003) found that BARI Masur-4 showed 4.13% nitrogen, while BARI Masur-3 had 4.08% and BARI Masur-2 had 4.53% nitrogen. Therefore, it is necessary to identify right time for harvesting pulse crops in order to ensure seed quality. The experiment was conducted to determine the effects of seeds collected from different plant parts on nitrogen content and nitrogen uptake, protein content and protein yield of lentil.

Materials and Method

Experiments were carried out at the Research Field of the Pulse Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Bangladesh during the *rabi* (winter) seasons of 2004-2005 and 2005-06. During *rabi* season of 2003-04, lentil seeds of three popular varieties viz. BARI Masur-2, BARI Masur-3, and BARI Masur-4 were collected from three sites of lentil plant viz. i) seeds collected from upper parts of lentil plant (P_1 parts), ii) seeds collected from middle parts of lentil plant (P_2 parts), and iii) seeds collected from lower parts of lentil plant (P_3 parts). The collected seeds were preserved in earthen pot. Before setting up the field experiment, laboratory experiment was carried out for recording seed quality data (moisture percentage, germination percentage and vigour). The experimental field was high land with drainage and irrigation facilities. The area belongs to the Agro-ecological Zone-28 (AEZ 28) under Madhupur Tract. The experimental site is situated at 24.00° North Latitude and 90.26° East Longitude. The area received a long-term average rainfall (2142 mm) and average maximum monthly temperature was observed in April (32.6°C) and the minimum in December (11.2°C) (BARI, 2004).

Field experiments were conducted using the collected seeds in a factorial randomized complete block design. Row to row distance was 30 cm and plant to

plant distance was 10 cm. Unit plot size was 3 m × 4 m. Seeds were sown in 18 November 2004 and 11 November 2005, and harvested on 01 March 2005 and 25 February 2006, respectively. After harvesting, seeds of whole plot were dried to attain 10% moisture content and kept in polyethylene bag for determination of nitrogen concentration in seed. All the data were statistically analyzed using IRRISTAT package programme.

Collection and preparation of seed samples for chemical analysis: Seed samples were collected from bulk harvest. The seed samples were then oven dried at 65°C for 24 hours and then ground. To obtain homogenous powder, the samples were passed through a 60-mesh sieve. The samples were stored in air tight polyethylene bags for nitrogen (N) determination (Page *et al.*, 1982).

Estimation of N: The N content in seed was determined by micro-Kjeldahl method. The seed samples (0.1 g seed) were digested with conc. H_2S0_4, hydrogen peroxide and K_2SO_4-catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se = 10: 1: 0.1) at 200°C for one and a half-hour. Nitrogen was estimated by distilling the digest with 10N N_aOH followed by titration of the distillate trapped in H_3B0_3 indicator solution with 0.0lN H_2SO_4 (Page *et al.*, 1982).

Calculation of protein content and protein yield: Protein content of lentil seed was determined by multiplying the N content of lentil seed with 6.25.

Nitrogen uptake and protein yield of lentil seed was computed from the following formulae-Nitrogen uptake (kg/ha) = {Nitrogen content (%) × seed yield (kg/ha)}/100.

Protein yield (kg/ha) = {Protein content (%) × seed yield (kg/ha}/100

Statistical analysis: The data for different characters were subjected to statistical analysis following a IRRISTAT package programme. The correlation co-efficient were done for different variables as needed.

Results and Discussion

Nitrogen content: Lentil varieties differed significantly in nitrogen content (Table 1). The highest N content was observed in BARI Masur-4, which differed from BARI Masur-2 but identical to BARI Masur-3 in both the years. Although, Shahjahan (2003) observed that lentil contained higher nitrogen content than chickpea (4.72% in lentil and 3.75% in chickpea), varietal differences in nitrogen content of lentil were not conspicuous e.g. BARI Masur-4 showed 4.13% nitrogen, while BARI Masur-3 had 4.08% and BAR! Masur-2 had 4.53% nitrogen (Afzal *et al.*, 2003). Tomar *et al.* (2000) reported that among four varieties of lentil, nitrogen content ranged from 3.05% to 3.21%. Shahjahan

(2003) found that lentil seeds contained 3.53-4.03% nitrogen in six types of containers over periods. Seeds collected from different plant parts were significant on N concentration (Table 2). During both the years, seeds collected from lower parts of lentil recorded significantly higher N content. It accumulated about 2% more N than seeds collected from upper parts of lentil plants. Interaction effect of varieties and seeds collected from different plant parts revealed that $V_1 \times P_3$ gave the highest N content, and $V_1 \times P_2$ gave the lowest N content (Table 3).

Nitrogen uptake: Varieties differed significantly for nitrogen uptake (Table 1). The highest N uptake was achieved by BARI Masur-4 in both the years that differed from other two varieties in 2004-05 but identical to other two varieties in 2005-06. Higher nitrogen uptake was associated with higher seed yield. The lowest N uptake was observed in BARI Masur-2. The results are in agreement with Bhuiyan (2004), who reported that varieties differed for N uptake in mungbean. Afzal *et al.* (2003) also reported similar results for nitrogen uptake in lentil. Nitrogen uptake was not significant in seeds collected from different plant parts (Table 2). Seeds collected from middle plant parts (P_2) apparently gave the highest N uptake which was similar to P_1 and P_3. Seeds collected from middle plant parts accumulated 13.8% more N in 2004-05 and 15.4% more N in 2005-06 than the seeds collected from upper plant parts.

Interaction effects of $V_3 \times P_3$ in 2004-05 and $V_2 \times P_2$ in 2005-06 showed significantly higher nitrogen uptake (Table 3). The highest nitrogen uptake recorded for $V_3 \times P_3$ in 2004-05, which was similar to $V_2 \times P_2$ and by $V_2 \times P_2$ in 2005-06 which was similar to $V_1 \times P_3$, $V_3 \times P_1$, $V_3 \times P_2$ and $V_3 \times P_3$.

Table 1. Effects of different lentil varieties on nitrogen content and nitrogen uptake.

Variety	N content (%)		Nitrogen uptake (kg/ha)	
	2004-05	2005-06	2004-05	2005-06
BARI Masur-2 (V_1)	4.25b	4.26b	30.3b	30.9
BARI Masur-3 (V_2)	4.3Oab	4.28a	31.6b	34.1
BARI Masur-4 (V_3)	4.34a	4.33a	37.2a	36.7
SE(±)	0.015	0.016	1.34	-
Level of significance	**	*	*	NS

In a column, the figure(s) having same letter(s) are not significantly different as per DMRT.

*significant at 5% level, **Significant at 1% level, NS: Not significant.

Table 2. Effects of lentil seeds collected from different plant parts on nitrogen content and nitrogen uptake.

Seeds collected from different plant parts	N content (%)		Nitrogen uptake (kg/ha)	
	2004-05	2005-06	2004-05	2005-06
Upperpart(P_1)	4.25b	4.25b	30.5	31.1
Middle part (P_2)	4.29ab	4.27b	34.7	35.9
Lower part (P_3)	4.34a	4.35a	34.0	34.6
SE(±)	0.015	0.016	-	-
Level of significance	**	**	NS	NS

In a column, the figure(s) having same letter(s) are not significantly different as per DMRT.

**significant at 1% level, NS: Not significant.

Table 3. Interaction effects of varieties and seeds collected from different plant parts on nitrogen content and nitrogen uptake.

Interaction (V × P)	N content (%)		Nitrogen uptake (kg/ha)	
	2004-05	2005-06	2004-05	2005-06
$V_1 \times P_1$	4.15c	4.18cd	35.bc	29.9bc
$V_1 \times P_2$	4.15c	4.17cd	25.5d	27.5c
$V_1 \times P_3$	4.44a	4.42a	30.2cd	35.4abc
$V_2 \times P_1$	4.25b	4.26bcd	25.3d	27.4c
$V_2 \times P_2$	4.39a	4.30abc	44.0ab	43.5a
$V_2 \times P_3$	4.25bc	4.27bcd	25.6cd	31.3bc
$V_3 \times P_1$	4.34ab	4.30abc	31.0cd	36.1abc
$V_3 \times P_2$	4.34ab	4.34ab	34.5bcd	36.7abc
$V_3 \times P_3$	4.34ab	4.35ab	46.1a	37.2ab
SE (±)	0.025	0.028	2.32	3.13
Level of significance	**	**	**	*
CV (%)	1.0	1.1	12.2	16.0

In a column, the figure(s) having same letter(s) are not significantly different as per DMRT.

*significant at *5%* level, **significant at 1% level.

Protein content: Varieties varied significantly regarding protein content in seeds (Table 4). The highest protein content in seeds was observed in BARI Masur-4, which was statistically identical to BARI Masur-3. Afzal *et al.* (2003) reported that BARI Masur-4 showed 25.80% protein, while BARI Masur-3 contained

25.50%, and BARI Masur-2 contained 28.31% protein. Seeds collected from lower plant parts had greater protein content than the seeds collected from middle and upper plant parts of lentil (Table 5). The highest protein content was recorded with seeds collected from lower parts (P_3) in both the years, which were statistically identical to BARI Masur-3 only in 2004-05. Interaction of variety and seeds collected from different plant parts was significant for protein content (Table 6). The highest protein content were found in $V_1 \times P_3$, which was statistically different from all other treatments except $V_2 \times P_2$, $V_3 \times P_1$, $V_3 \times P_2$, $V_3 \times P_3$ in 2004-05, and $V_3 \times P_2$, $V_3 \times P_3$ in 2005- 06.

Protein yield: The highest protein yield in seed was observed in BARI Masur-4, which was different from BARI Masur-2 in 2004-05, but statistically identical to other two varieties in 2005-06. The protein yield was the lowest in BARI Masur-2. Tomar *et al.* (2000) reported that among four lentil genotypes, Pant L 639 recorded significantly higher protein yield. Protein yield in seeds collected from middle part was higher than the seeds collected from upper or lower parts of lentil plants though statistically not significant (Table 5). Seeds collected from middle plant part produced higher yield of protein over seeds collected from lower or upper plant parts. Interaction effect of variety and seeds collected from different plant parts was significant on protein yield of lentil (Table 6). This might be due to dissimilar response of three varieties with seeds collected from different parts on protein yield. The highest protein yield was found in $V_3 \times P_3$ in 2004-05 and in $V_2 \times P_2$ in 2005-06.

Table 4. Effects of different lentil varieties on protein content and protein yield.

Variety	Protein content (%)		Protein yield (kg/ha)	
	2004-05	2005-06	2004-05	2005-06
BARI Masur-2 (V_1)	26.5b	26.6b	189b	192
BARI Masur-3 (V_2)	26.9ab	26.8ab	198ab	210
BARI Masur-4 (V_3)	27.la	27.la	232a	229
SE (±)	0.09	0.10	8.39	-
Level of significance	**	*	**	NS

In a column, the figure(s) having same letter(s) are not significantly different as per DMRT.

*Significant at 5% level.

**Significant at 1% level, NS: Not significant.

Table 5. Effects of lentil seeds collected from different plant parts on protein content and protein yield.

Seeds collected from different plant parts	Protein content (%)		Protein yield (kg/ha)	
	2004-05	2005-06	2004-05	2005-06
Upper part (P_1)	26.5b	26.6	190	195
Middle part (P_2)	26.8ab	26.7b	217	224
Lowerpart (P_3)	27.la	27.2a	212	212
SE(±)	0.09	0.10	-	-
Level of significance	**	**	ns	ns

In a column, the figure(s) having same letter(s) are not significantly different as per DMRT.

**Significant at 1% level, NS: Not significant.

Table 6. Interaction effects of lentil varieties and seeds collected from different plant parts on protein content and protein yield.

Interaction (V x P)	Protein content (%)		Protein yield (kg/ha)	
	2004-05	2005-06	2004-05	2005-06
$V_1 \times P_1$	25.9c	26.lc	219bc	187c
$V_1 \times P_2$	25.9c	26.lc	159cd	172c
$V_1 \times P_3$	27.7a	27.6a	189cd	217b
$V_2 \times P_1$	26.6bc	26.7bc	158d	172c
$V_2 \times P_2$	27.4a	26.9b	275ab	272a
$V_2 \times P_3$	26.6bc	26.7bc	l60cd	188c
$V_3 \times P_1$	27.lab	26.9b	194cd	226b
$V_3 \times P_2$	27.lab	27.lab	2l6bcd	229b
$V_3 \times P_3$	27.lab	27.2ab	288a	232b
SE(±)	0.16	0.17	14.53	18.91
Level of significance	**		**	*
CV(%)	1.0	1.1	12.2	15.6

In a column, the figure(s) having same letter(s) are not significantly different as per DMRT.

*significant at 5% level, **significant at 1% level.

Correlation: Correlation matrix among the plant characters of lentil is shown in Table 7. A positive and significant correlation was observed between seed yield and N uptake and protein yield, and N uptake and protein yield (2004-05 and

2005-06). Uptake by plant showed highly significant positive correlation with seed yield (Dwivedi *et al.,* 1990). Grain yield of chickpea was positively correlated with protein yield (Quader, 1990). Bhuiyan (2004) also found a positive and significant correlation between seed yield and N uptake and protein yield in mungbean. In another study, Hossain *et al.* (2004) found that nitrogen uptake in mungbean showed positive relationship with increasing seedling mass (R^2= 0.39).

Table 7. Correlation matrix among seed yield with N uptake and protein yield, and N uptake with protein yield of lentil.

Characters	Correlation coefficient (r value)			
	N uptake		Protein yield	
	2004-05	2005-06	2004-05	2005-06
Seed yield	0.996**	0.988**	0.996**	0.997**
N uptake	-	-	0.999**	0.993**

** Significant at 1% level.

The overall results revealed that significant variation was observed in three varieties of lentil for nitrogen content, nitrogen uptake, protein content, and protein yield except N uptake and protein yield in 2005-06. Seeds collected from different sites of the plant had significant effect on nitrogen content and protein content. Seeds collected from lower parts (P_3) recorded the highest nitrogen content, nitrogen uptake, protein content, and protein yield. Seeds collected from lower parts of BARI Masur-4 and seeds collected from middle parts of BARI Masur-3 recorded higher N uptake and protein yield.

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