Morpho-agronomical variation among diverse lentil genotypes under rainfed environments in Nepal

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Abstract

Lentil (*Lens culinaris* M.) is one of the major grain legumes in Nepal whose seed yield is low and unpredictable as it is grown under limited soil moisture conditions during the winter months. However, there may be a potential to increase lentil yields by utilizing germplasm that is adapted to rainfed conditions and residual soil moisture from the preceding crop. Nineteen diverse lentil genotypes and a locally adapted grasspea (*Lathyrus sativus*) were evaluated for phenology, growth, yield and yield components at a mid-hill site in Nepal during 2001/02. Lentil genotypes showed significant variation in morphology, root characteristics, seed yield, yield components and disease susceptibility, although there was little soil moisture stress in the post-flowering period during the above season.

Media summary

The identification and development of the best adapted genotypes in terms of vigour, earliness, biomass production, seed yield and diseases resistance will provide stable seed yield under rainfed environments of Nepal.

Key words

Lens culinaris, genotypic variation, soil moisture deficit, earliness, biomass, root length density

Introduction

Lentil (*Lens culinaris* Medikus) is the major legume crop that occupies 59% of the area and production of grain legumes in Nepal (ABPSD, 2003) (Figure 1). Lentil is generally grown as a relay crop in rice or post rice/maize or as a mixed crop with wheat, barley, mustard, linseed, grasspea and field pea. In all the cropping systems, lentil crop is depended predominantly on the residual soil moisture from the preceding crop. Soil water deficit during early (establishment) and post-flowering periods is one of the major constraints affecting productivity of the crop. The aims of this study were to identify the variation in the adaptation of contrasting lentil genotypes and characterize the morphological and phenological traits associated with high biomass and seed yield under rainfed conditions.

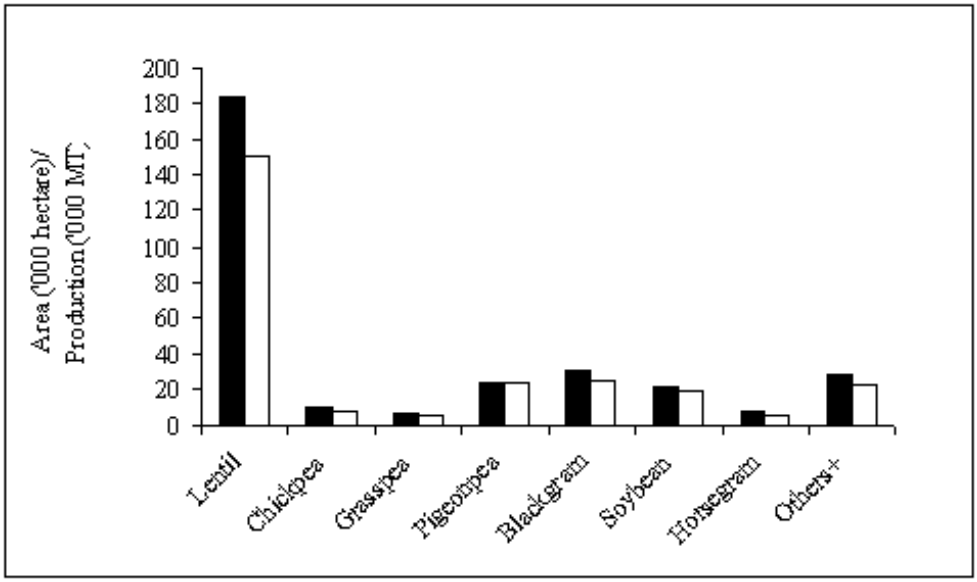

Figure 1. Area (■) and production (□) of grain legumes in Nepal (2002/03)

Methods

Nineteen lentil genotypes and a local grasspea (Table 1) were evaluated at two sites in Nepal representing a mid-hill position (Khumaltar) and terai lowlands (Nepalgunj) during 2001/02 (Figure 2). *Stemphylium* blight severely affected the lentil crop in Nepalgunj hence only data from Khumaltar are presented here. Khumaltar, which is about 8 km south from centre of Kathmandu, experiences a warm temperate climate (the average summer temperature ranges from 18 ^{o}C to 27 ^{o}C and winter temperature ranges from of 2 ^{o}C to 19 ^{o} C), with an annual rainfall of around 1200 mm (Figure 3). The soil is silt loam to silt clay loam with slightly acidic pH. Nepal has a monsoonal climate with a dry season starting from October to May and a wet season (monsoon) from June to September, the winter months receive only about 10% of the total rainfall.

Table 1. Lentil genotypes, their origin and pedigree and the grasspea used in the experiment.

Accession Number	Seed weight (g/100 seed)*	Origin	Pedigree
ILL 7957 (FLIP96-25L)	3.5	ICARDA	ILL 5883 (Syria) x ILL 6246 (Syria)
ILL 7978 (FLIP96-46L)	4.3	ICARDA	91S 82379 (selection)
ILL 7983 (FLIP96-51L)	2.3	ICARDA	91S 88607 (selection)
ILL 8006A	3.9	ICARDA	Not known
ILL 8621 (FLIP2002-20L)	3.6	ICARDA	ILL 5883 (Syria) x ILL 7149 (Syria)

ILL 8633 (FLIP2001-12L)	3.0	ICARDA	ILL 5883 (Syria) x ILL 7005 (Syria)
ILL 3512 (LG 7, Simal)	1.6	India	Landrace
ILL 2573 (PL 639, Khajura 2)	1.7	India	Landrace
ILL 2580 (L 1278)	1.6	India	Landrace
ILL 7346 (LG 198, Khajura 1)	2.0	India	Landrace
ILL 7200B (FLIP92-35L)	1.7	ICARDA	Not known
ILL 4402	1.7	Pakistan	Landrace
ILL 7723	2.7	Pakistan	89503, landrace
ILL 8010 (Sindur)	1.6	Nepal	Landrace
ILL 6829 (FLIP89-71L)	1.9	ICARDA	ILL 4407 (Pakistan) x ILL 4605 (Argentina)
ILL 7537R (FLIP93-36L)	2.2	ICARDA	90S 30799
ILL 7979 (FLIP96-47L)	2.4	ICARDA	91S 87270 (cross made in 1983)
ILL 7982 (FLIP96-50L)	2.1	ICARDA	91S 88526 (cross made in 1983)
ILL 7986 (FLIP96-54L)	2.9	ICARDA	ILL 5748 (Syria) x ILL 2578 (India)
Sarlahi local (grasspea)	4.2	Nepal	Landrace

* Seed weight at room temperature

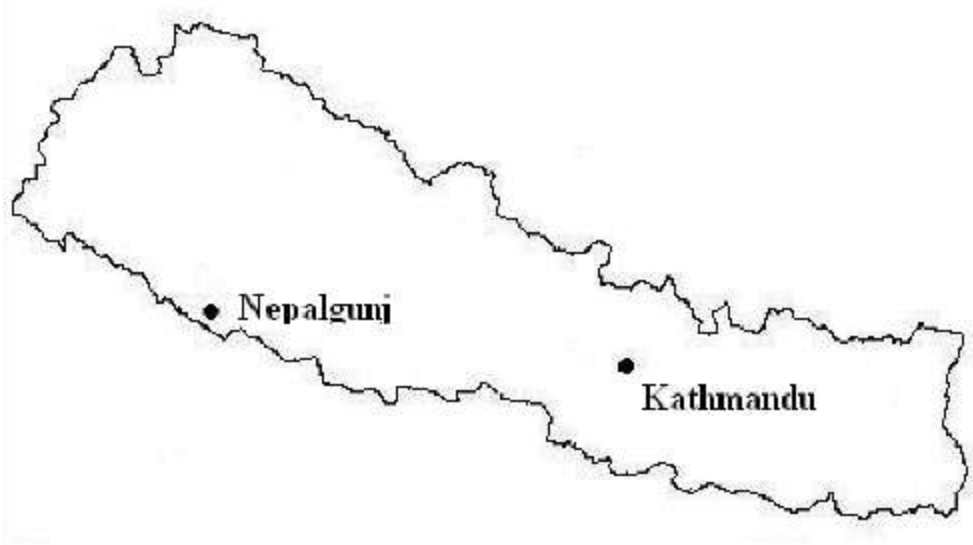

Figure 2. Location of the field experiment site in Nepal (Courtesy: B Pradha, Institute of Forestry, Nepal)

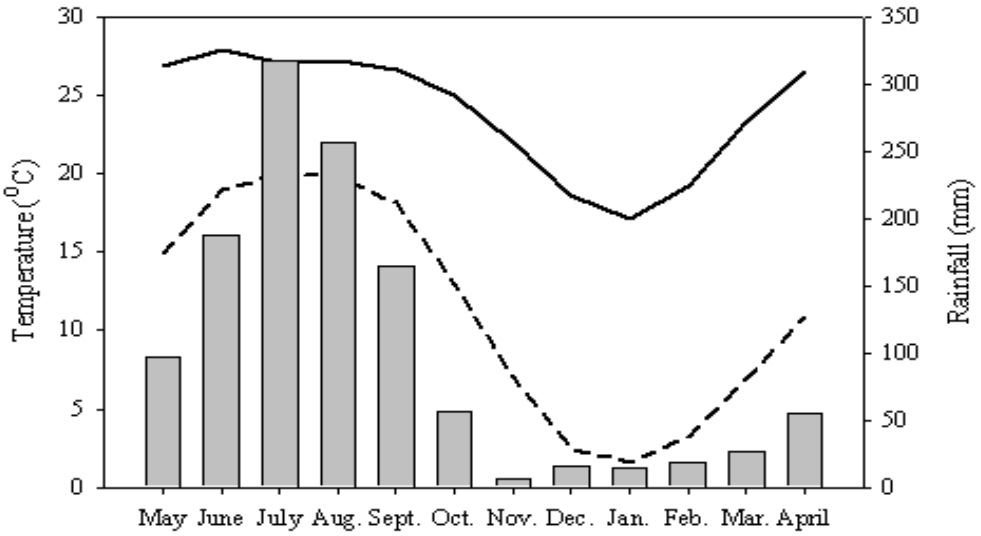

Figure 3. Mean maximum (—), minimum (– –) temperatures and rainfall (ف) in Khumaltar (1970-2001)

Days from sowing to 50% flowering, 50% podding and physiological maturity were recorded on a whole plot basis. Ten uniform plants were selected randomly at physiological maturity to measure the number of pods and seeds. Seed yield was measured from a net harvest area of 7.5 m^2 at maturity.

Root samples were collected for 8 selected genotypes in 10 cm increments to the maximum possible depth (where no roots were found) by using a tube auger (50 mm diameter). One sample consisted of two cores (one core centred over the cut stem of a plant and other core between rows) was collected at different growth phases. Root length density was estimated using the modified line intersect method (Tennant, 1975).

Results

Phenology

The South Asian genotypes flowered in about 89 days and matured at approximately 160 days. The West Asian genotypes took 132 days to 50% flowering and 178 days to mature at the mid-hill location (Khumaltar).

Seed yield and yield components

Mean seed yield ranged from 0.13 to 1.80 t/ha, with small-seeded South Asian genotypes yielding more than 1 t/ha (Table 2). Genotypes from South Asia and ICARDA selections (cross bred lines) produced 108-128% greater number of filled pods per plant than West Asia genotypes. Large-seeded West Asian genotypes produced fewer filled pods with a greater number of empty pods and hence extremely low yields.

Cluster analysis

Genotypes from Nepal, Pakistan, India, and ICARDA selections and crossbreds were grouped in a cohesive cluster based on stem pigmentation (red), leaf anthocyanin (present), leaf pubescence (dense to very dense), reaction to cold (resistant), testa colour (speckled) and cotyledon colour (red) characteristics. Large-seeded West Asia genotypes were characterised by large leaflets, light colour foliage, yellow stem with ash to yellow testa colour.

Root characters

Genotypes attained their maximum root length at different growth phases. Grasspea, Simal and Sindur produced the maximum root length at podding whereas ILL 7978, ILL 7983, Khajura 2 at flowering. Grasspea produced the greatest total root length (13.2 km/m^2) followed by Simal (8.5 km/m^2) and ILL 7978 (6.9 km/m^2). ILL 7978 and ILL 7983 showed fast root growth at the early vegetative stage while the slowest growth was observed in grasspea. The maximum mean rooting depth was recorded in grasspea (53 cm) followed by Simal (45 cm) and ILL 7979 (38 cm).

Table 2. Seed yield and yield components of 19 lentil genotypes and grasspea grown at Khumaltar, Nepal in 2001-2002.

Genotypes	Pods/ plant	Empty pods/ plant	Seed yield (t/ ha)	100 seed weight (g)	Total dry matter (t/ha)	Harvest index
ILL 7957	37	10.4	0.242	2.0	2.85	0.08
ILL 7978	58	8.8	0.435	2.2	1.79	0.24
ILL 7983	53	8.2	0.507	1.4	3.06	0.16
ILL 8006A	27	32.1	0.129	1.7	1.66	0.08
ILL 8621	38	23.3	0.340	2.0	2.67	0.12

ILL 8633	33	13.4	0.337	1.8	2.63	0.13
Simal	90	5.4	1.440	1.5	4.17	0.35
Khajura 2	88	4.9	1.220	1.4	3.59	0.34
ILL 2580	91	5.8	1.351	1.5	3.91	0.34
Khajura 1	96	4.4	1.094	1.3	3.45	0.32
ILL 7200B	112	6.2	1.152	1.4	3.61	0.31
ILL 4402	105	8.0	1.346	1.4	4.06	0.33
ILL 7723	93	9.0	1.125	1.8	3.76	0.30
Sindur	73	3.9	1.392	1.5	4.08	0.35
ILL 6829	96	5.6	1.715	1.7	4.24	0.40
ILL 7537R	84	5.0	1.795	1.7	4.52	0.40
ILL 7979	85	6.8	1.374	1.7	4.27	0.32
ILL 7982	107	5.3	1.477	1.8	3.64	0.41
ILL 7986	54	4.9	1.398	2.2	4.04	0.35
Grasspea	22	3.3	0.817	3.5	2.80	0.30
LSD (P=0.05)	34.1	7.4	0.322	0.22	0.301	0.064
SE mean	12.04	2.6	0.113	0.078	0.853	0.022

Conclusion

Lentil genotypes from South Asia and their progenies produced about 80% higher seed yield than the large-seeded West Asia genotypes. Seed yield was highly correlated with early vigour (fast growth and ground cover), early flowering, long flowering and podding duration; early maturity, greater number of seeds and pods; high total biomass and harvest index. Grasspea produced the greatest total root length density with the maximum rooting depth (80 cm) among the genotypes tested. Shallow rooting was

observed in ILL 7978, ILL 7983 and Sindur. The small-seeded South Asia genotypes were characterised by small hairy dark green leaflets, purple stem pigmentation and speckled seeds while the large-seeded West Asian genotypes were of light green foliage, less pubescence with yellow/buff colour testa. Leaf morphology and seed characteristics of crossbreds were intermediate between the South and West Asia genotypes. The early to medium duration lentils with green, hairy leaflets were found to utilize the residual soil moisture most efficiently by early establishment, vigour and biomass production and hence produced better seed yield under rainfed conditions.

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