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Evaluation of Lentil Varieties/Lines for Utilization of Rice Fallow in Tripura

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ABSTRACT

A field experiment was conducted during 2013-14 and 2014-15 to evaluate the performance of lentil varieties under reduced tillage condition in rice fallow. Seventeen lentil (*Lens culinaris*) varieties/lines were tested in rice fallow under reduced tillage condition with residual soil moisture. Results revealed that the varieties/lines, L-112-7 and ILL-237 took minimum number of days (52-54 days), however, ILL-10971 took maximum number of days (67-69 days) for 50% flowering. Variety L-112-7 was matured 85-89 days after sowing, while ILL-10971 required maximum number of days (99-103 DAS) for 50% pod maturity. RL-12-171 was recorded maximum root length and nodule number/plant followed by L-112-7, BM-5 and ILL-10951, while lowest root length and minimum number of nodule/plant was found in ILL-10971. Root length and nodule number/plant were showed a significant linear relationship with seed yield. The highest numbers of branches/plant were recorded with ILL-10951 (9.9) in 2013-14 and RL-12-171 (8.6) in 2014-15. The maximum number of pods/plant was recorded with L-4076 (118.7) in 2013-14 and ILL-10951 (87) in 2014-15. Number of seeds/pod was the highest in WBL-81 (2.0). The test weight (weight of 1000 seed) was recorded to be highest in ILL-8180 (69.0-70.0) followed by ILL-10897 (55.0-56.0). The highest seed yield was recorded in RL-12-171 followed by L-112-7 and ILL-10951, all of which were significantly higher than those of other cultivars. Most of the cultivars matured in about 100 days with very few maturing in about 110 days. Thus, the study revealed the opportunity of lentil cultivation in lowland rice fallow with appropriate technologies in Tripura. Therefore, lentil is a potential crop for crop diversification and enhancing productivity of rice based cropping systems in Tripura.

1. Introduction

An increasing emphasis on world food security in general and its regional impacts in particular have come to forefront of the scientific community under the growing recognition of global climate change. Agriculture productivity of rainfed regions is expected to suffer severe due to water crisis, delayed monsoon, uneven distribution of rain as a result of climate change.

Approximately 82% of the rice fallow lands are concentrated in the states of Eastern Uttar Pradesh, Bihar,

The impact of climate change on pulses appears to be more serious. It is most unlikely that any additional area will be available for pulses cultivation in future, due to more returns with cereals under irrigation and also due to shrinking land base for agriculture. However, of the 44.6 million ha of rice grown in India, about 11.7 million hectares remains fallow during the *rabi* (post-rainy season) after harvest of *kharif* (rainy season) rice.

The state is showing the self-sufficiency only in rice production, those constituents the more than 90% of total

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Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, West Bengal and North East India (Layek et al. 2014). These fallow lands with diverse soil types and climatic conditions are suitable for growing cool season pulses profitably during post rainy-season. The residual moisture left in the soil at the time of rice harvest will be sufficient to raise a short-season pulse crops. Further, by use of short duration and high yielding varieties of rice allowing rice to vacate fields in September-October, the traditional rice-fallow cropping can be converted into rice-pulses system. Inclusion of cool season pulses such as chickpea, lentil, fababean, lathyrus, peas etc. in rice fallow will increase the productivity as well as the sustainability of the rice based systems.

In North Eastern region of India, where a large part of the area remains fallow after the *kharif* season rice (Das et al. 2012), there exists a scope for expansion of area under pulse crops like lentil (*Lens culinaris*) in rice fallows (Das et al. 2013). Lentil is the important pulse crop mainly grown on residual soil moisture and prominent source of vegetable protein (Singh et al. 2011). Besides fixing atmospheric N and benefitting the succeeding crop with residual nitrogen in soil, lentil is also adapted to local climatic and soil fertility conditions (Srinivasarao et al. 2012). Lentil has a very good potential for increasing farm income as well as cropping intensity (Das et al. 2013). Thus, introduction of lentil in rice fallows with appropriate production technologies may usher in another green revolution in the backward, poverty ridden and deprived region of the country. The soil structure is also improved by growing second crop (pulse) after rice with suitable seeding and tilling methods. Conservation tillage provides better ecosystem to crop than that of conventional tillage (Blanco-Canqui et al. 2013; Lal 2013). Higher yield of pulse after wet season (*kharif* season) rice with reduced tillage was also reported by Gangwar et al. (2006). Minimum tillage with crop residue management is found to reduce soil water evaporation, soil sealing and crusting (Gangwar et al. 2006). Early maturing lentil varieties may escape the terminal moisture stress in rice fallow (Erskine et al. 2011) and could convert these mono-cropped areas into double cropped areas, and thus, increase legume production and sustain productivity of the rice-based systems. Tripura, one among the north eastern states of India is also successful in achieving self-sufficiency in various sectors by increasing its food production in manifolds. But it has not yet solved the problem of chronic food security at the household level and year to year fluctuations in food production (Yadav et al. 2013).

The state is showing the self-sufficiency only in rice production, those constituents the more than 90% of total food grain production. However the status of pulse production is very poor. The share of total pulse production including the oil seed production was less than 1%. The agricultural production of the state is not in the pace with population growth at 14.75 per cent per decade (Yadav et al. 2013). Now the state showed the significant shortage in pulses production is because non-availability of high yielding short duration varieties of pulses with recommended production technology. To find out the answers of these questions, a field experiment was conducted to evaluate performance of different varieties/lines of lentil in rice fallow under reduced tillage condition.

2. Materials and methods:

Experimental site

A field experiment was conducted at agronomy farm of the Research Complex of the Indian Council of Agricultural Research (ICAR) for NER, Tripura Centre, Lembucherra, Tripura (W), India ($23^0$54'24.02" N and $91^0$18'58.35"E, 162 m a. s. l.) during 2013-14 and 2014-15. The annual rainfall of Lembucherra is 2200 mm. The soil (*Typic Kandihumults*) of the experimental field is sandy loam and the baseline soil sample had 6.8 g kg^{-1} SOC, 285.0 mg kg^{-1} available nitrogen (N), 8.9 mg kg^{-1} available phosphorus (P) and 289.5 mg kg^{-1} available potassium (K). The pH of soil was 5.1 (soil and water ratio of 1:2.5).

Experimental design and crop management

The experiment consisted of seventeen varieties/lines of lentil collected from International Center for Agricultural Research in the Dry Areas (ICARDA), Syria and Bidhan Chandra Krishi Viswa Vidyalaya (BCKV), Kalyani, West Bengal. Lentil was sown at 20 cm spacing under reduced tillage condition. The 17 cultivars were tested in complete randomized block design (CRBD) and replicated thrice. The gross plot size was 4 m x 3 m. A recommended dose of 20 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha were applied in furrows before sowing of lentil seeds and covered the seed with soil to give a good seed-soil contact. The crop was raised with residual soil moisture and one lifesaving irrigation was provided at flowering stage for better growth.

Plant sampling

Yield attributes (branches/plant, pods/plant, seeds/pod and 1000 seed weight) and seed yield of lentil were measured at harvest. For studying nodulation and root length, five plants were selected randomly 60 days after sowing (DAS) from the rows meant for sampling from each plot. Nodules separated from the roots and number of nodules were counted from each plant and expressed as number of nodules/plant. Length of all the primary, secondary, and tertiary roots were measured and expressed as total root length. Yield of lentil was estimated from weight of sun dried seeds obtained from each net plot after threshing and cleaning at 12% moisture content.

Statistical analysis

The experimental data pertaining to each parameter of study were subjected to statistical analysis by using the technique of analysis of variance and their significance was tested by "F" test (Gomez and Gomez 1984). Standard error of means (SEm+) and least significant difference (LSD) at 5% probability (p=0.05) were worked out for each parameter studied to evaluate differences between treatment means.

3. Result and discussion

Crop ontogeny

The lentil cultivars were sown on second week of November during 2013-14 and 2014-15 and germinated 4-5 DAS. All the lentil varieties/lines took 52-69 days for 50% flowering (Table 1). Among the varieties/lines, L-112-7 and ILL-237 took minimum number of days (52-54 days), however, ILL-10971 took maximum number of days (67-69 days) for 50% flowering (Layek et al. 2014). Fifty percent pod maturation was observed from 85 to 103 DAS. Variety L-112-7 was matured 85-89 days after sowing (Table 1), while ILL-10971 required maximum number of days (99-103 DAS) for 50% pod maturity (Layek et al. 2014). All the tested varieties were matured in February during both the years, therefore, all the varieties were escaped from terminal drought.

Root length and nodulation

There was significant variation observed in root length and nodule number at flowering and pod initiation stages in all the varieties/lines (Layek et al. 2014). RL-12-171 was recorded maximum root length and nodule number/plant followed by L-112-7, BM-5 and ILL-10951, while lowest root length and minimum number of nodule/plant was found in ILL-10971 (Figure 1 & 2).

Root length and nodule number/plant were showed a significant linear relationship with seed yield (Figure 3 & 4). Therefore, more root length and nodule number/plant responsible for higher seed yield

Table 1. Flowering and maturity time of different lentil varieties/lines

Treatment	Days to 50% at flowering		Days to 50% at pod maturity	
	2013-14	2014-15	2013-14	2014-15
BM-7	58	60	88	93
BM-5	62	64	93	97
ILL-8180	61	63	90	94
L-4076	58	60	89	93
L-112-7	52	54	85	89
ILL-10971	67	69	99	103
ILL-237	52	54	87	91
ILL-10897	59	61	89	93
WBL-81	62	64	95	99
RL-12-171	62	64	96	100
BM-6	59	61	93	97
BM-2	55	57	88	92
L-1112-14	62	64	94	98
L-1112-6	59	61	91	95
ILL-10951	61	63	94	98
ILL-10803	60	62	91	95
ILL-10805	59	62	90	91
SEm±	2.4	3.2	1.8	3.5
CD	7.1	9.7	5.3	10.4

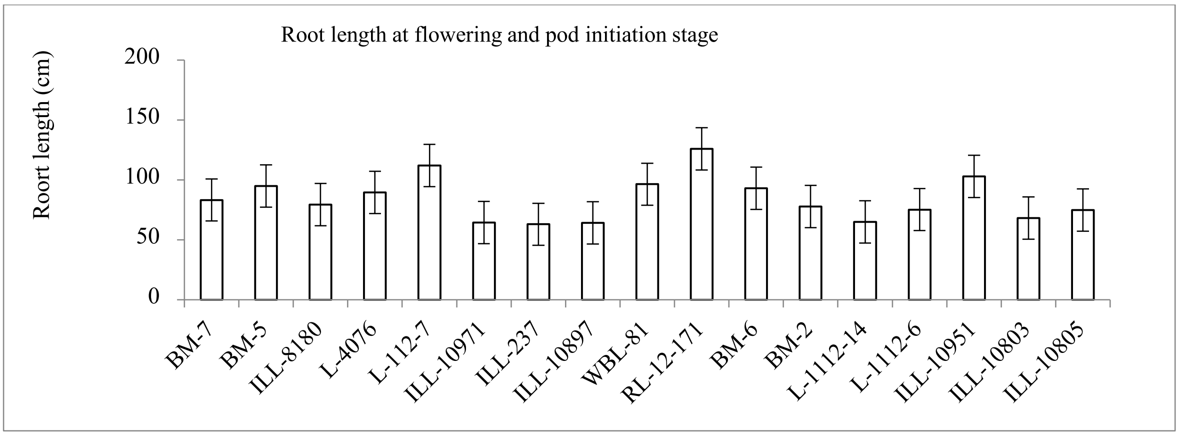

Figure1. Root lengths of different lentil varieties/lines

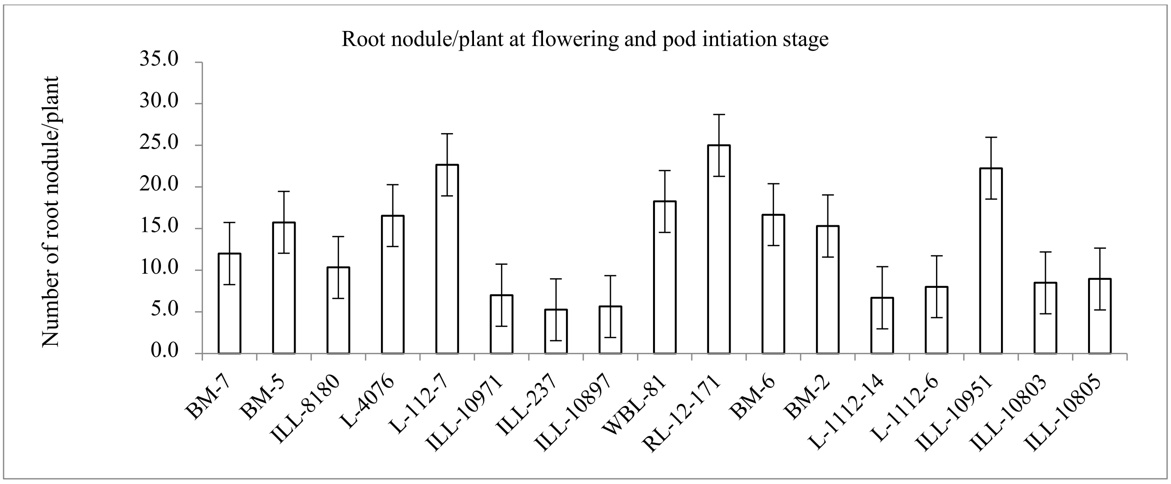

Figure 2. Root nodule producing potential of different lentil varieties/lines

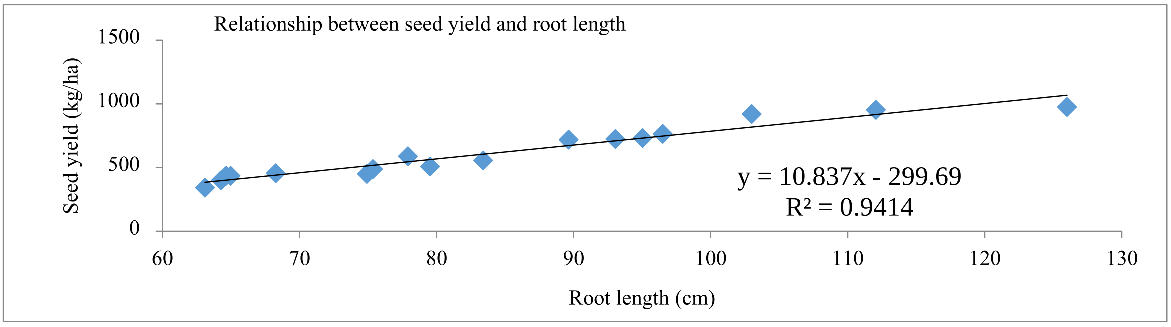

Figure 3. Relationship between seed yield and root length of lentil

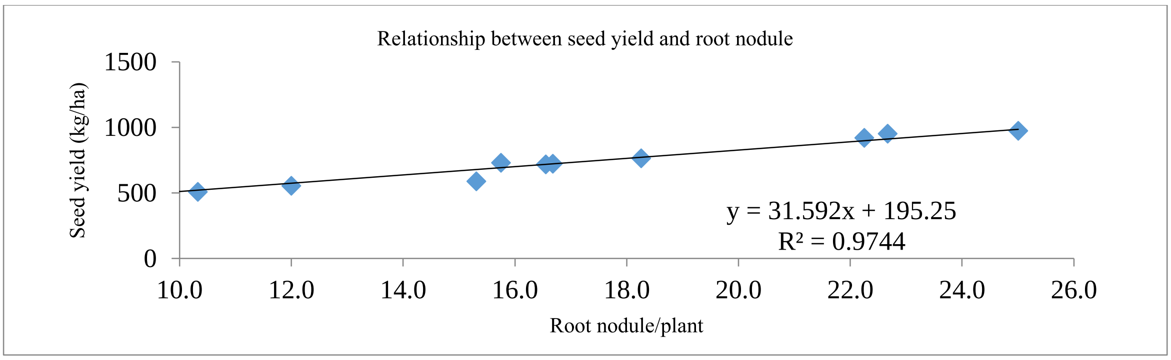

Figure 4. Relationship between seed yield and root nodule of lentil

Table 2. Yield attributes and yield of different lentil varieties/lines

Treatment	Branches/Plant		Pods/Plant		Seeds/pod		1000 Seed weight (g)		Seed yield (t/ha)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
BM-7	7.8	5.2	38.8	25.9	1.6	1.6	17.0	16.0	1.21	0.55
BM-5	7.3	5.5	34.6	48.5	1.8	2.0	19.0	18.0	1.46	0.73
ILL-8180	5.8	3.8	47.3	31.5	1.4	1.4	70.0	69.0	1.02	0.51
L-4076	9.6	6.4	118.7	71.0	1.9	1.9	19.0	18.0	1.43	0.72
L-112-7	6.7	8.5	48.2	80.0	1.4	1.4	18.0	17.0	1.90	0.95
ILL-10971	8.0	5.3	59.0	29.5	1.4	1.4	28.5	27.5	0.87	0.43
ILL-237	6.8	4.5	48.9	22.5	1.6	1.6	38.0	37.0	0.68	0.34
ILL-10897	7.5	5.0	53.5	30.7	1.2	1.2	56.0	55.0	0.80	0.40
WBL-81	5.3	6.5	40.4	55.5	2.0	2.0	22.5	21.5	1.53	0.76
RL-12-171	6.7	8.6	71.7	79.1	1.8	1.8	17.5	16.5	1.95	0.97
BM-6	7.5	5.5	73.5	49.0	1.8	1.8	17.0	16.0	1.44	0.72
BM-2	8.7	5.8	110.3	32.5	1.4	1.4	14.0	13.0	1.17	0.59
L-1112-14	6.5	4.3	55.6	37.1	1.9	1.9	19.5	18.5	0.87	0.43
L-1112-6	9.3	5.1	83.4	34.5	1.9	1.9	17.0	16.0	0.97	0.49
ILL-10951	9.9	7.5	63.4	87.0	1.6	1.6	18.5	17.5	1.84	0.92
ILL-10803	7.3	4.9	46.6	36.1	1.6	1.6	24.5	23.5	0.91	0.46
ILL-10805	7.7	5.1	56.7	32.9	1.7	1.7	26.5	25.5	0.91	0.45
SEm±	0.41	0.6	3.31	4.9	0.09	0.08	1.80	2.36	7.68	3.81
LSD (*p=0.05*)	1.22	1.7	9.93	14.6	0.26	0.25	5.38	7.07	2.30	11.52

Root length and nodulation

There was significant variation observed in root length and nodule number at flowering and pod initiation stages in all the varieties/lines (Layek et al. 2014). RL-12-171 was recorded maximum root length and nodule number/plant followed by L-112-7, BM-5 and ILL-10951, while lowest root length and minimum number of nodule/plant was found in ILL-10971 (Figure 1 & 2). Root length and nodule number/plant were showed a significant linear relationship with seed yield (Figure 3 & 4). Therefore, more root length and nodule number/plant responsible for higher seed yield.

Yield attributes

The highest numbers of branches/plant were recorded with ILL-10951 (9.9) followed by L-1112-6 (9.3) in 2013-14 and RL-12-171 (8.6) followed by L-112-7 (8.5) in 2014-15, while the lowest number of branches/plant was recorded with WBL-81 (5.3) followed by ILL-8180 (5.8) in 2013-14 and ILL-8180 (3.8) followed by L-1112-14 (4.3) in 2014-15. The maximum number of pods/plant was recorded with L-4076 (118.7) followed by BM-2 (110.3) in 2013-14 and ILL-10951 (87) followed by L-112-7 (80) in 2014-15 (49.04), while the lowest number of pods/plant was recorded with BM-5 (34.6) followed by BM-7 (38.8) in 2013-14 and ILL-237 (22.5) followed by BM-7 (25.9) in 2014-15. Number of seeds/pod was the highest in WBL-81 (2.0) followed by L-1112-6 (1.9) and lowest in ILL-10897 (1.2) followed by L-112-7 (Table 2). The test weight (weight of 1000 seed) was recorded to be highest in ILL-8180 (69.0-70.0) followed by ILL-10897 (55.0-56.0). The lowest test weight was recorded in BM-2 (13.5) Followed by BM-7 (16.5).

Seed yield

The highest seed yield was recorded in RL-12-171 (1.95 t/ha) followed by L-112-7 (1.90 t/ha) and ILL-10951 (1.84 t/ha) significantly higher over rest of the varieties in 2013-14. Similar trend was also found in 2014-15 but seed yield was low in 2014-15 as compared to 2013-14 due to less plant population (Table 2). This may be mainly due to better growth and their positive influence on the yield parameters than other varieties. The greater number of pods per plant, seeds per pod and seed index in lentil resulted in higher seed yield in these cultivars. Similar type of result was also recorded by Maurya and Rathi (2000) and Layek et al. (2014). It becomes important that while selecting for high grain yield, due weightage is given to these characters (Tickoo et al., 2005).

Conclusions

From the study it can be concluded that there is enough scope for cultivation of lentil in lowland rice fallow under reduced tillage system in Tripura. Varieties/lines like RL-12-171, L-112-7, ILL-10951, BM-6 and BM-5 are the most potential in terms of growth and productivity (yielding more than 1.0 t/ha) for Tripura. However, more varieties/lines from different institutes should be tested to identify short duration and high yielding verities suitable for the state.

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