

Potentiality of Seedling Root of Lentil Seed Developed under Diverse Cultivation Practices

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ABSTRACT

Tillage is dominant factor affecting crop root distribution patterns in utilization of nutrients from soil for better crop and crop produce. The mulching effect in cultivation pattern produced the optimum class of seed to retain the quality standard in storage duration. In assessment of seed storability, the selection criteria related to most promising young root initials developed from primary or secondary root should be supportive for nutrient absorption from rhizospheric zone of soil that is strictly adhered to the enhancement of surface area and total root length. The seedling roots were helpful to plant stand as well as nutrient uptake in association of water. The assessment of quality seed production through characterization of root at storability pattern, the zero tillage with mulching at irrigated (T7) and rainfed (T10) showed maximum support in young root development allied to pattern of cultivation though a few exceptions were observed in average root diameter and higher diameter range of root. Added average root diameter may be helpful to plant stand especially in stress but nutrient uptake predominantly dependent lower diameter containing young roots. Therefore, the specific cultivation schedule must be integrated in seed production manual for continuance in quality of produced seed.

Key words: Tillage, root development, zero tillage, storability, cultivation, rhizospheric zone

INTRODUCTION

In crop cultivation, the various crops predominantly pulses were used in crop rotations with conventional cereal crops under New Alluvial Zone of West Bengal not only to reduce diseases, pests, weeds etc., it was significant to fulfil the nutritive status and food habit of the local population. Long term rotation of legumes with cereals advanced the physical and chemical properties of soil with well adaptation of natural habitation¹. In

practice, the cultivation techniques not have done properly due to inadequate proficiency and negligence on second crop. In advanced agricultural system, quality seed was one of the indispensable commodities in approach of crop or seed production for enhancement in productivity and quality of the produce. In seed production, seed quality is rigorously interrelated to basic seed source, cultivation methods, environmental status at seed growth etc.

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Accordingly, advanced genotypes may not exploit their supremacy in absence of appropriate earlier correlated features. In reformed cultivation schedule, suitable genotype can recover the position through escalation as high potential seed that is recognizable with the crop/seed production in the next season. Unexposed genotypic potentiality is allied to absence of harmonious situations in cultivation that can be performed in next by formation of poor seed. The seed quality determining indicator, seedling potentiality primarily depends on steady root parameters like total root length, surface area, root types, rhizospheric nature etc⁸. where storability and storage duration of seed have an influence. Good storability of seed may be endured through optimum seed growth allied to both inherent potential and best cultivation schedule. The study on precise root system can recognize superior seedling helpful for confirmation of decisive target i.e. development of good seed in specific cultivation schedule. In scientific literature, the information regarding retaining of seed quality at storage is inadequate especially in performance of seedling roots, even though their maximum influence at early stages to maintain uniformity and field emergence, the fundamental features of production. Root information on any crop may possibly support the producers to adapt the system of crop rotation with existing resource use efficiency as the inclusion of crops with different rooting patterns in a cropping system may settle the water and nutrient use efficiency.

Being highly associated with cultivation schedule, soil is an essential part of the complete global ecosystems, obligatory for maintaining most life processes due to its unique biological composition. Also, soil is a vital source to motivate the association of root system and cultivation pattern in which there are diverse organisms involve in nutrient cycling, regulating soil organic matter, and enhancing plant health crucial for growth of quality seed. To prioritise the seedling potential, the present research objective is

characterizing of rooting patterns for qualitative assessment of seed produced at various cultivation schedule with emphasising their potential attitude in storability under a crop, Lentil.

MATERIAL AND METHODS

The field trial was conducted in 'AB -Seed farm' under BCKV, Nadia, West Bengal considering the years 2013-14 and 2014-15 with a medium well drained sandy-loam soil containing land in an elevation of 9.75 m above MSL. The variable techniques of field trial on crop lentil (cv. Subrata) were executed as treatments to consider the seed production viz. CT (conventional tillage) + recommended NPK (20:40:20 kg/ha) + IR (Irrigated) as **T1**; CT + low NPK (15:40:20 kg/ha) + IR as **T2**; CT + high NPK (25:40:20 kg/ha) + IR as **T3**; CT + recommended NPK + RF (Rainfed) as **T4**; ZT (zero tillage) with 10 cm rice straw + recommended NPK + IR as **T5**; ZT with 20 cm rice straw + recommended NPK + IR as **T6**; ZT with rice straw mulching + recommended NPK + IR as **T7**; ZT with 10 cm rice straw + recommended NPK + RF as **T8**; ZT with 20 cm rice straw + recommended NPK + RF as **T9**; ZT with rice straw mulching + recommended NPK + RF as **T10**. The freshly harvested lentil seed of various treatments were stored in ambient condition to judge the storing capability of seed and these were assessed at 2 months of interval (viz. 4, 6, 8, 10, 12 months as M1, M2, M3, M4, M5 respectively) considering the seedling root growth crucial for field establishment. The variable duration of stored seed of various field treatments were assessed at the day of final count i.e. 8 DAS (days after sowing) to categorize the root characters through Glass-plate technique². The extended seedling roots under various treatments along with definite intervals were evaluated through Root Image Analyser, WIN RHIZO (PRO BASIC STD4800).

Computerised analysis of root characters was done using the software of Win RHIZO (Regent Instrument Inc.), which works under Windows through skeletonization method for

measuring the root parameters^{1, 13, and 6}. The program operated with 256 levels grey-scale images in TIFF file format, which were further converted into threshold (binary) and skeleton images. Threshold images were used for evaluation of root diameter, while root length was measured on so called skeleton images^{1,15}. Measurements involved total root length, average root diameter, surface area, as well as root length measurements as a function of different root diameter classes. The scanning procedures were done by using the flat-bed scanners (Epson Expression/STD 1600 scanner).

Completely Randomized Design (CRD) was utilized for statistical analysis of facts associated to these activities. The outcomes were achieved at 1% level of significant by using the computer software system, OPSTAT.

RESULTS

Better emergence in addition to proper establishment of seedling in field position depends on seedling vigour where rhizospheric pattern play a pivotal role. The primary categorization on rhizosphere at initial stage of seedling through root analyzer was precious for estimating the seedling quality indispensable for field establishment. The stored seed settled under modified cultivation system were analyzed to ensure the storability with following root parameters –

Mean treatment effects on total root length (Table 1) indicated a considerable variation among diverse treatments where T7 (ZT, Mulching, recommended NPK, IR) and T3 (CT, higher NPK, IR) confirmed best effect followed by T4 (CT, recommended NPK, RF). The prospective parameter, external surface area of total root system specified a positive outcome (Table 1) in existence of different treatments useful for establishment of seedlings at early period. High values of T7 (ZT with mulching, recommended NPK, IR), T10 (ZT with mulching, recommended NPK, RF) and T3 (CT, higher NPK, IR) reassured seed quality during exposure of root surface supportive to produce vigorous plant. For

categorization of root system, the average root diameter considering total root system was one of the key parameter particularly at early stages (Table 1) that may promote seedling strength. T1 (CT, recommended NPK, IR) and T2 (CT, lower NPK, IR) deliberated as highest effect in mean treatment effects under two years. Root diameter up to 1.5 mm (Table 1) was associated with the occurrence of new roots initials or lateral roots at early seedling stage which can be favorable to water uptake as well as a number of minerals essential to make a nutritive balance for the seedling. The root length of this defined diameter may be a sign of good seed with retaining quality as a reflection of modified cultivation pattern. A highest performance was observed in T7 (ZT with mulching, recommended NPK, IR) and T10 (ZT with mulching, recommended NPK, RF) followed by T3 (CT, higher NPK, IR) in a significant manner considering two year treatment mean. The next step of root diameter from 1.5 to 4.5 mm was similarly constructive in nutrient absorption in addition to establishing the seedlings at early stages where different treatments mean indicated the significant variation bearing topmost effect in T1 (CT, recommended NPK, IR), T4 (CT, recommended NPK, NIR) and T5 (ZT with 10 cm straw, recommended NPK, IR). The maximum root diameter (4.5 - >4.5 mm) containing root length was primarily accommodating to keep the plant stand in soil, while it may be supportive to absorb moisture from different soil layer by operating their penetrating capability. Here, the mean value of treatments signified a positive variation with greatest effect in T1 (CT, recommended NPK, IR), T4 (CT, recommended NPK, NIR) followed by T5 (ZT with 10 cm straw, recommended NPK, IR) among all treatments. In consideration of diverse treatment effects, the considerable treatments followed same pattern in total root length, surface area and lowest diameter containing root that was associated to newly formed root initials in surface level (lateral roots) or may be as primary or secondary roots mostly in short duration crop. Assessment of root system for

the rest i.e. average diameter and root length of upper diameters may be supportive to seedling strength in field.

The varied duration seed storage (Table 2) indicated a significant disparity with diverse rate of deterioration that was habitually highest in M4 (8 months storage). A significant decline was continued with the progression of storage independently in each year. But it was surprising that the value of surface area and root length of specific diameter (1.5 to 4.5 mm) was somewhat increased in M2 (4 months) and then decreased usually with progression of storage duration. The average diameter of the root progressively deteriorated with the storage sequence in a significant manner considering mean value of both years.

In interaction effects of treatment-year and year-storage duration also indicated same pattern as overall mean of treatments and months of storage respectively. Considering interacted values of total factors like variety, treatment and month of storage pointed out a non-significant variation where values of T7 was top irrespective of all with only exemption in average diameter. The interaction of treatment-year showed same non-significant response though T10 (ZT, Mulching, recommended NPK, RF) and T7 (ZT with mulching, recommended NPK, IR) showed highest in Y2 and Y1 respectively. In length of 0 to 1.5mm diameter containing root, the rate of deterioration was maximum in M6 (12 months storage) and M5 (10 months) under Y1 and Y2 respectively. The root length of specific diameter (1.5 to 4.5mm) was slightly increased at M3 (6 months storage) and suddenly dropped after that. In leading diameter containing root (>4.5mm), the root length deterioration was commence at M4 (8 months) and it was continued after that for both years. In interacted values, the different levels of interaction demonstrated contradictory approach exclusively in average diameter though higher diameter containing root length pursued in some cases. The uneven root diameter specifically lower type showed non-significant interaction in treatment-year combination.

The variation within year showed a widespread isolation with a significant prominence of Y2 (2nd year) (FIG. 1) for considerable root parameters in rhizosphere though trend was similar for each year considering both cultivation patterns and storability.

In present observation, the quality seed determination during root study at varied storage duration accompanied by diverse cultivation schedule was pertinent for its secure association at seed formation and seedling establishment in next season. The root morphology and branching patterns were important determinants of water and nutrient uptake by plants that may be promoted through cultivation adaptation^{4,12}. The specific root thickness conferred drought resistance, as roots are capable of increasing root length density and water uptake by producing more and larger root branches at early establishment in field⁷. The spatial distribution of roots and their density in soil are the major determinants of the ability of crops to acquire the nutrients and water necessary for growth at later stages^{10,4}. In view of definite root characters, seed quality can be judged which was developed at definite cultivation schedule. In cultivation system, tillage is a factor affecting crop root distribution patterns by inducing variations in the soil nutrient status and its impact on root sharing was evident in the layer affected by ploughing^{8, 9}. Zero tillage often resulted in the stratification of soil nutrients, especially the immobile elements such as phosphorus, thus inducing a higher root length density in the topmost layer may facilitates the good plant in addition to quality seed progress^{3, 16, 14, 10}. Roots in zero tillage system accumulated to a greater extent from 0 to 5 cm compared with the roots in conventional tillage system^{8, 9}. The promising rhizospheric nature may have an influential role in final product i.e. seed through a qualitative up gradation in terms of seed storability. Moreover, primary establishment of seedling for next crop is fully dependent on developed quality seed, potential to maintain seed storability. The seed containing good storability was ideal to keep

seedling strength through perfect rhizospheric pattern positive to early germination and

uniformity that was the creation of specific cultivation schedule.

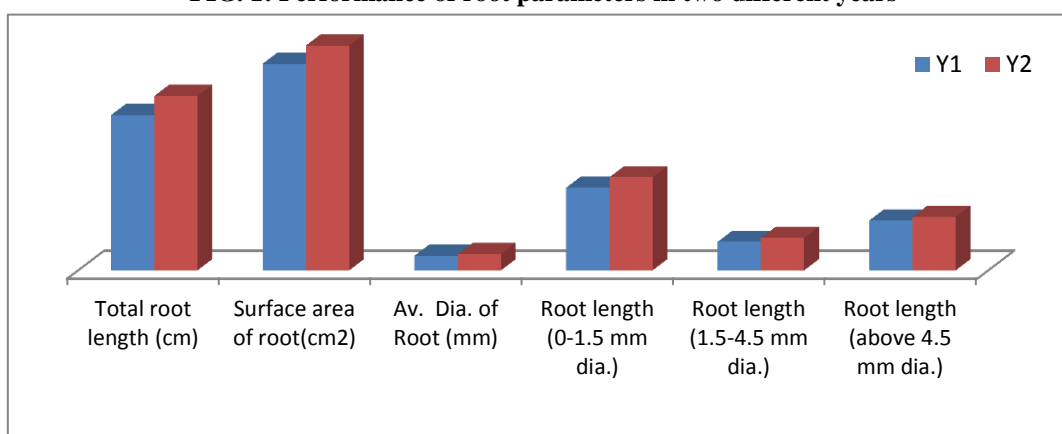
Table1: Study on root parameters of Lentil seed developed in varied cultivation techniques

ROOT PARAMETERS	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	SEM	LSD (1%)
Total root length (cm)	43.23	42.34	45.9	45.08	42.38	41.84	46.48	39.16	40.87	44.73	0.21	0.77
Surface area of root (cm ²)	55.46	53.14	60.65	53.53	54.31	54.51	61.77	55.04	55.77	61.56	0.26	0.96
Av. Dia. of Root (mm)	4.26	4.21	4.01	4.17	3.84	4.01	3.78	3.95	4.15	3.8	0.02	0.07
Root length (0-1.5 mm dia.)	22.81	22.49	24.47	22.56	21.94	21.15	24.8	22.48	22.93	24.72	0.11	0.4
Root length (1.5-4.5 mm dia.)	8.28	7.98	7.8	8.28	8.24	8.05	7.58	7.98	7.81	7.74	0.04	0.14
Root length (above 4.5 mm dia.)	13.2	13.56	13.5	13.41	12.87	13.48	14.01	13.73	13.73	13.79	0.06	0.24

Table2: Deterioration pattern of root parameters during varied storage duration

ROOT PARAMETERS	M1	M2	M3	M4	M5	M6	SEM	LSD (1%)
Total root length (cm)	62.3	57.195	49.17	37.255	28.68	24.6	0.16	0.59
Surface area of root (cm ²)	64.655	67.215	61.495	57.88	48.195	40	0.20	0.75
Av. Dia. of Root (mm)	4.915	4.37	4.085	3.62	3.65	3.47	0.01	0.05
Root length (0-1.5 mm dia.)	29.33	28.745	25.055	22.93	18.375	13.77	0.08	0.31
Root length (1.5-4.5 mm dia.)	8.94	9.475	9.56	6.81	7.23	5.83	0.03	0.11
Root length (above 4.5 mm dia.)	17.075	16.415	16.675	12.13	10.755	8.12	0.05	0.18

FIG. 1: Performance of root parameters in two different years



REFERENCES

1. Bauhus, J. and Messier, C. Evaluation of fine root length and diameter measurements obtained using RHIZO image analysis. *Agron. J.* **91**: 142–147(1999).
2. Chakraborti, P. Effect of Na-salts on seedlings of Sesame genotypes. *Crop Research*. **36(1,2& 3)**: 160-165(2010).
3. Crozier, C.R., Naderman, G.C., Tucker, M.R. and Sugg, R.E.. Nutrient and pH

- stratification with conventional and no-till management. *Commun. Soil Sci. Plant Anal.* **30**: 65–74 (1999).
4. Fageria, N.K. and Stone, L.F. Physical, Chemical, and Biological Changes in the Rhizosphere and Nutrient Availability. *J. Plant. Nutr.* **29**: 1327–1356 (2006).
 5. Fageria, N.K., Moreira A., Coelho, A.M. Yield and yield components of upland rice as influenced by nitrogen sources. *J Plant Nutr.* **34**: 361-370 (2011).
 6. Hatzig S. V., Schiessl S., Stahl A. and Snowdon R. J. Characterizing root response phenotypes by neural network analysis. *Journal of Experimental Botany.* **66(18)**: 5617–5624. DOI: 1093/jxb/erv235 (2015).
 7. Joshi, R., Shukla, A., Sairam, R. K. In vitro screening of rice genotypes for drought tolerance using Polyetheleglycol. *Acta Physiol. Plant.* **33**: 2209-2217 (2011).
 8. Ji, B., Zhao, Y., Mu, X. and Li, C. Effects of tillage on soil physical properties and root growth of maize in loam and clay in central China. *Plant Soil and Environment.* **59(7)**: 295-302 (2013).
 9. Leghari Naimatullah, Mughal, A.Q., Leghari, K. Q., Farhad, W., Mirjat, M. S. and Hammad, H. M. Effect of various tillage practices on soil properties and Maize growth. *Pak. J. Bot.*, **48(3)**: 1173-1182 (2016).
 10. Li, J. and Copeland, L. 2000. Role of malonate in chickpeas. *Phytochemistry* **54**: 585-589.
 11. Li Haixiao, Mollier, A., Ziadi, N. and Morel, C. The long-term effects of tillage practice and phosphorus fertilization on the distribution and morphology of corn root. *Plant and Soil.* 412(1-2). DOI: 10.1007/s11104-016-2925-y (2016).
 12. Mandal, A, Tarai P, Kaushik, S K, Mahata, A. C. and Chakraborti, P. Allelopathic action of *Rauwolfia tetraphylla* L. root extracts on gram seeds. *Journal of crop and weed.* **9(2)**: 72-75 (2013).
 13. Pierret, A., Gonkhamdee, S., Jourdan, C. and Maeght, J. L. I J_Rhizo, an open-source software to measure scanned images of root samples. *Plant Soil.* **373**: 531-539. DOI: 10.1007/s11104-013-1795-9 (2013).
 14. Qin Ruijun, Stamp P. and Richner W. Impact of tillage on maize rooting in a Cambisol and Luvisol in Switzerland. *Soil and Tillage Research.* **85(1)**: 50-59. DOI: 10.1016/j.still.2004.12.003 (2006).
 15. Regent Instruments. User Guide, Mac/WinRHIZO V4 1, Reference, Regent Instruments Inc (2000).
 16. Van Eerd, L. L., Congreves, K. A., Hayes, A., Verhallen, A. and Hooker, D. C., Long-term tillage and crop rotation effects on soil quality, organic carbon, and total nitrogen. *Can. J. Soil Sci.* **94**: 303-315 (2014).