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Effect of seed priming technologies on planting value of lentil (*Lens culinaris* M) cultivars under sub-optimal condition

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Abstract
Early and maximum field emergence, seedling vigour and stand establishment of lentil (*Lens culinaris* M.) are considered as the most important yield contributing factors in rainfed areas. Therefore, for enhancing the planting value of Lentil under sub-optimal condition, a field experiment was conducted during *Rabi* season 2019-20 and 2020-21 in Split Plot Design with two varieties in main plot and fourteen different seed priming treatments in sub plot at Oil Seed Farm, CSA University, Kalyanpur Kanpur, India to evaluate the effects of different seed priming technologies including hydro-priming, halo-priming and bio-priming on field emergence, seedling vigour and stand establishment of Lentil. Analysis of variance of pooled data of both year showed that seed coating (on hydroprimed seed) with Bio NPK and drought alleviating bacteria on seeds of variety K-75significantly improved field emergence, seed vigour index, seedling length and dry weight in both the varieties (KLB-303 and K-75) compared to other treatments. Also, variety K-75 showed significantly better performance in terms of planting value than variety KLB-303 It was, therefore concluded that seed coating (on hydroprimed seed) with Bio NPk and drought alleviating bacteria is a simple and environmental friendly technique for improving the planting value of lentil under sub-optimal condition.

Keywords: Priming, planting, cultivars, sub-optimal, *Lens culinaris* M

Introduction
Lentil is an important food legume, cultivated during *Rabi* season in rainfed areas in the Gangetic Plains of Northern India where rainfall is not only low but also variable. In these areas important abiotic stresses like heat stress, water stress and salinity may individually or in combination adversely affect the planting value of lentil which suffers considerable yield losses because of various biotic and/or abiotic stresses (Sellami *et al.*, 2019) [12]. The lentil is a species that is generally grown in dry conditions and often faces water deficit during key growth stages (Foti *et al.*, 2000) [6]. Water deficiency at any stage can affect plant growth as a result of reducing crop production, especially during seed filling of the reproductive phase. Lack of adequate soil moisture in the field is one of the major obstacles to the establishment of lentil, because inadequate soil moisture can reduce germination, slow down seedling growth and yield in rainfed crops. (Sharma and Prasad, 1984). One of the most important effects of drought is the failure to establish plant stand which consequently results in reduction of growth and yield.
Rapid field emergence and seedling vigour substantially contribute to high lentil yield under drought conditions (Khan et al., 2016a) [16]. Seed priming can be considered as a solution against problems related to germination, seedling vigour and crop stand establishment especially, under unfavourable environmental conditions (Khan et al, 2017a) [17]. Priming exhibits uniform and faster germination rate, seedling vigour and crop establishment under sub-optimal conditions. Seed priming is considered to be an easy, highly effective, low cost and low risk technique. Seed priming is pre sowing strategy for influencing seedling development by modulating pre germination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance. During priming seeds are partially hydrated so that pre-germinative metabolic activities proceed while radicle protrusion is prohibited and then seeds are dried back to the original moisture level. It entails imbibition of seeds in different solutions for a specified duration under controlled conditions, then drying back them to their original moisture content (Khan *et al.*, 2016b; Khan *et al.*, 2017b) [18, 19].

Primed seeds are more useful because of numerous advantages such as uniformity, early and faster appearance (A.M. Musa *et al.*, 1999) [3], germination in broad range of temperature and, crop establishment, efficient use of water, enhancing root to grow deeper, allowing germination in dormant seeds by increasing metabolic events to initiate growth of organs for reproduction (H. Soleimanzadeh, 2013) [7]. Nowadays different priming treatments have been developed to provide better seed quality such as hydro-priming, halo-priming, nutri-priming, osmo-priming, matrix priming, osmo-hardening, on farm priming, hormone priming and bio-priming Khan *et al*., 2017b [18]. Since the effect of seed priming on field performance of lentil is poorly documented, this research was aimed to investigate the effects of hydro-priming, halo-priming and bio-priming on seed invigoration and planting value of the crop in the field.

Materials and Methods

The present investigation entitled effect of seed priming techniques on planting value of lentil cultivars was conducted during the *Rabi* season of 2019-20 and 2020-21. The experiment was laid out with two factors and three replications in Split Plot Design with first factor in the main plot and second factor in the sub-plot. The first factor consist of two varieties KLB-303 (V_1) and K-75 (V_2) and second factor consists of fourteen seed priming treatments including T_1-control (untreated), T_2-control (recommended seed treatments as per package of practices), T_3-hydropriming (soaking in water for 8h at 25 °C and air drying at 25 °C),T_4–halopriming 1 (soaking in KNO_3@ 0.3% solution and drying), T_5- halopriming 2 (soaking in KH_2PO_4@ 0.5% solution and drying), T_6-nutripriming (soaking in Zn_2SO_4@ 0.3%+MnSO4@ 0.5% solution and drying), T_7-seed coating (on dry seeds) with *T. harzianum* @ 15g/kg seed, T_8-seed coating (on hydro-primed seeds) with *T. harzianum* @ 15g/kg seed, T_9-seed coating (on hydroprimed seeds) with BioNPK, T_{10}-seed coating (on hydroprimed seeds) with Biogrow, T_{11}-seed coating (on hydroprimed seeds) with Biophos, T_{12}-seed coating (on hydroprimed seeds) with Drought Alleviating Bacteria + BioNPK, T_{13}-seed coating (on hydroprimed seeds) with Drought Alleviating Bacteria + Biogrow, T_{14}- seed coating (on hydroprimed seeds) with Drought Alleviating Bacteria + Biophos. The crop was sown at Oil Seed Farm, CSA University, Kanpur in a plot of size 4m x 2m with a spacing of 30cm x 10cm without irrigation. At the time of final land preparation, recommended dose fertilizers was applied to the soil. The observations were recorded on the effect of seed priming techniques on planting value *viz*., field emergence (equation I), plant stand establishment, seedling length, seedling dry weight, seedling vigour index-I &II (equation II & III) of two lentil cultivars.

Field Emergence

Field emergence was recorded on 10th day after sowing with the help of following equation:

$$\text{Field emergence (\%)} = \frac{\text{Number of seeds emerged out of soil}}{\text{Total number of seeds sown}} \times 100 \text{ .... (I)}$$

Seedling Vigour

Ten plants were randomly uprooted from each plot and the length of seedling was measured. Same seedlings were placed in oven for drying at 80/60^{0}C till two consecutive constant weight obtained. Seedling Vigor Index-I and Seedling Vigor Index-II were calculated with the help of following equations.

$$\text{Seedling Vigor Index-I} = \text{Seedling Length (cm)} \times \text{Field Emergence (\%)} \text{ .... (II)}$$

$$\text{Seedling Vigor Index-II} = \text{Seedling Dry Weight (g)} \times \text{Field Emergence (\%)} \text{ .... (III)}$$

Plant Stand Establishment after 3 Weeks Plant Stand Establishment was calculated by dividing No. of plants standing in the plot after 3 weeks of sowing with total No. of seeds sown then multiplying with 100 (equation IV).

$$\text{Stand Establishment (\%)} = \frac{\text{No. of plants after 3 weeks of sowing}}{\text{Total number of seeds sown}} \times 100 \text{ .... (IV)}$$

Results and Discussion

In the present investigation, both the cultivars of lentil when primed with micronutrient, bio fertilizers and drought alleviating bacteria (seed priming) showed significant increase in planting value on pooled basis data of both the year except stand establishment while the interaction effect was not found to be significant for influencing the planting value of lentil.

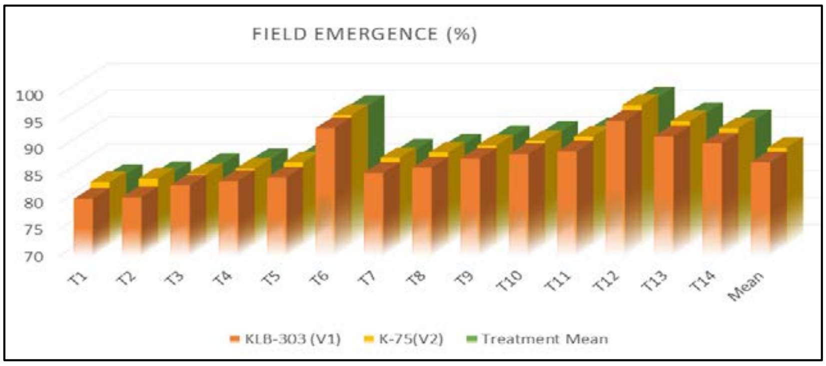

Fig 1: Effects of seed priming on field emergence in lentil cultivars

The pooled data of both the year (Table 1 and Figure 2) revealed that Variety K-75 was significantly superior than variety KLB-303 except plant stand establishment and showed maximum field emergence (88.23%) seedling length (9.99cm) Seedling dry weight (0.104gm) Seedling Vigour Index-I (889.65) seedling vigour index-II (9.17) final plant stand (84.48%) as compared to variety KLB-303. Our finding corroborates the findings of various scientists.

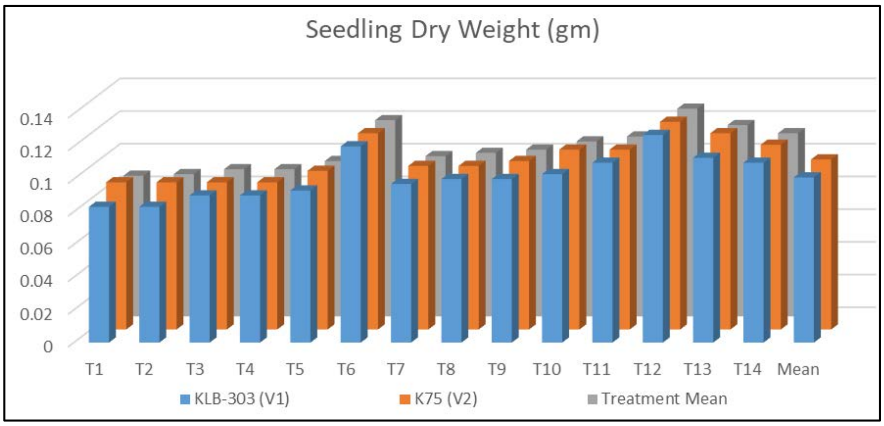

Fig 2: Effects of seed priming on seedling dry weight in lentil cultivars

Kazem Ghassemi-Golezani *et al.*, (2014) [8] reported that the highest yield components (except 1000 grain weight) and grain yield per unit area were obtained by plants from large seeds while Munir *et al.*, (2004) [10] reported that large seed cultivars had higher germination percentage and germination speed under moisture stress than small seed cultivars. Akjun and Al-Tindal (2010) [4] reported in triticale that germination percentage was higher in high test weight genotypes than in low test weight genotypes.

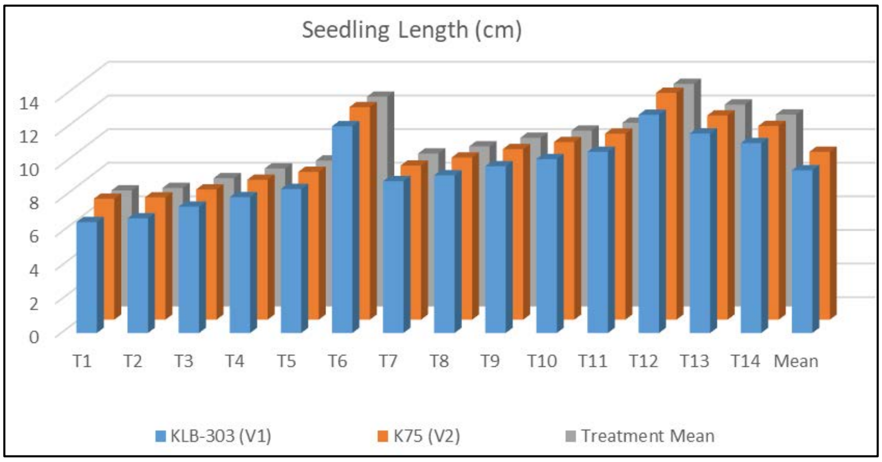

Fig 3: Effects of seed priming on seeding length in lentil cultivars

Among seed priming treatments, the analysis of data of both the years on pooled basis showed that Seed coating (on hydroprimed seed) with drought alleviating bacteria + Bio NPK (T_{12}) was significantly superior in terms of field emergence (95.67%) seedling length (13.24cm) Seedling dry (weight (0.127gm), Seedling Vigour Index-I

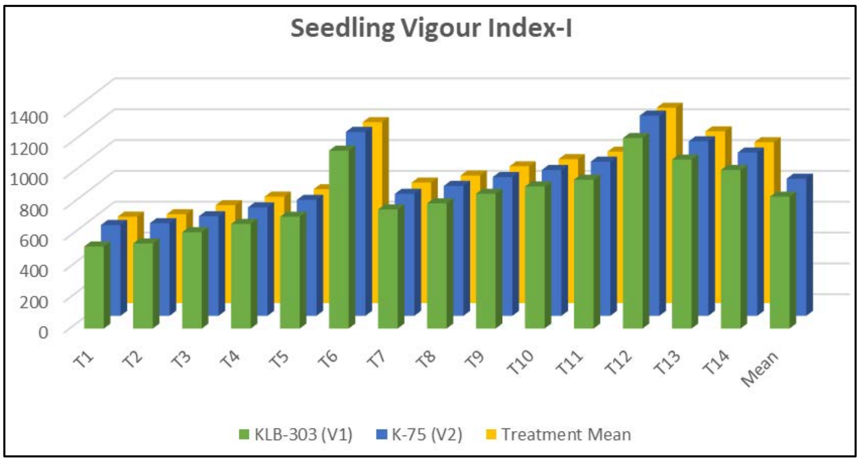

Fig 4: Effects of seed priming on seedling vigour index-I in lentil cultivars

(1267.13) seedling vigour index-II (11.96) and final plant stand (93.17% %) followed by (T_6) Halopriming (soaking seed in ZnSO4 @0.3% + MnSo4 @0.5% solution and drying) where 94.08% field emergence, 12.48cm seedling length, 0.120gm Seedling dry weight, 1173.66 Seedling Vigour Index-I, 11.32 seedling vigour index-II and 90.58% final plant stand while all the yield attributing traits were found to be minimum in unprimed seed on pooled basis of two years of experiment. In the present investigation, BioNPK along with drought alleviating bacteria was used and BioNPK consists of NFB, PSB and KSB. Our finding is in accordance with the findings of several scientis. Cakmakci *et al.*, (2007) [5] suggested that under drought stress, PGPBSs can induce ACC deaminase activity directly or indirectly which enhances plant growth. Zhikang Wang (2019) [15] reported that inoculation with NFB and PSB results in the elevation of soil available nutrients with improvement in plant growth. A Rawia Eid *et al.*, (2009) [2] increased growth parameters of *Matthiola incana* with the application of NFB and PSB along with mineral nutrients. Navsare *et al.*, (2018) [14] concluded that germination percentage and other growth parameters increases with application RDF + Rhizobium + PSB + KSB + ZSB.

The interaction of varieties with seed priming treatments was not found to be significant for enhancing the planting value of lentil on pooled basis of both the year's data However, in our findings bold seed variety K-75 and pre sowing seed coating (on hydroprimed seed) with Drought alleviating bacteria + BioNPK (V_2T_{12}) showed maximum.

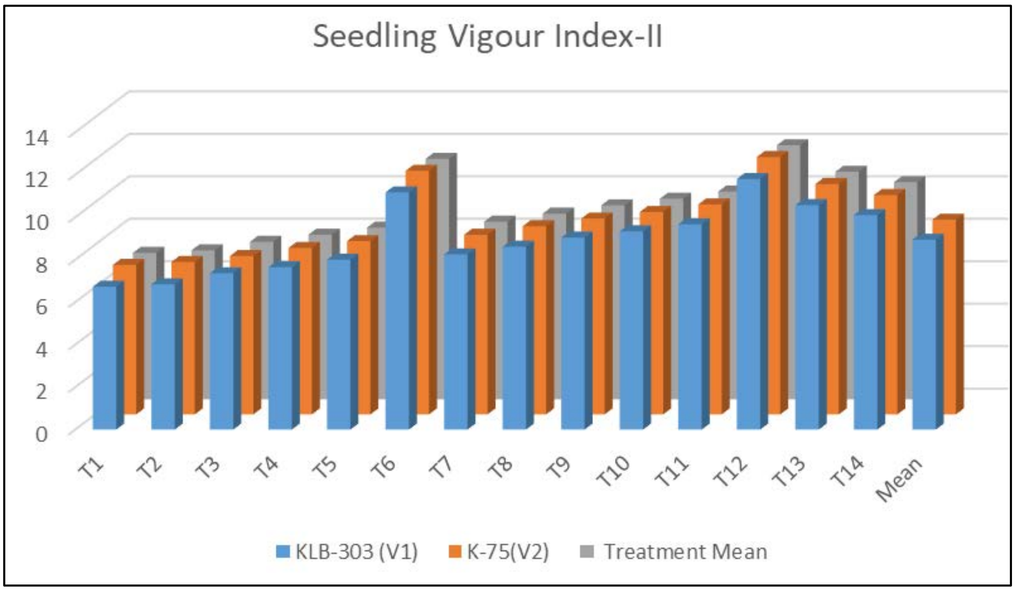

Fig 5: Effects of seed priming on seedling vigour index-II in lentil cultivars

field emergence (96.17%), seedling length (13.50), seedling dry weight (0.127g). Seedling Vigour Index-I (1298.50), Seedling Vigour Index-I (12.12), and Final Plant stand (93.67) as compared to unprimed small seeded variety KLB-303 (V_1T_1). The fact behind the result may be due to bold seed of Variety K-75 because they produce larger and more vigorous seedlings as suggestedted by Moles and Westboy (2004). Also invigoration of seed by hydropriming of such seeds improves seed germination and seedling emergence of lentil (Saglam *et al*,. 2010) and better establishment and growth and growth, earlier flowering, increase tolerance to adverse environmental condition (Harris *et al.*, 2007) and also Biofertilizers containing Nitrogen fixing bacteria and Phosphate solubilizing bacteria along with recommended dose of growthfertilizers improved plant as reported by A. Rawia Eid *et al.*,2009 [2] in *Matthiolaincana.*

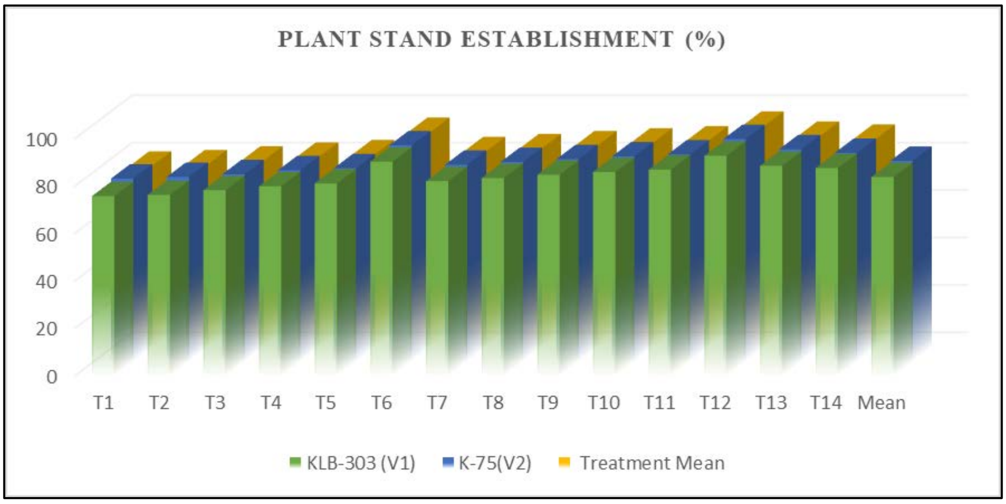

Fig 5: Effects of seed priming on plant stand establishment in lentil cultivars

Maximum plant height (54.96cm) on pooled basis was attained by variety KLB-303 when seed coating (on hydroprimed seed) with drough alleviating bacteria + BioNPK was done and this may be due to the varietal character and the effect of seed inoculation with PGPBs and drought alleviating bacteria which improved plant growth under water deficit condition as reported earlier by various scientists. According to Ngumbi and Kloepper (2016) [11], PGPBs may be applied as a strategy to reduce the damaging impacts of environmental stresses on plant growth and productivity by improving nutrient uptake, and consequently, increasing environmental stress tolerance. Also large seed cultivars had higher germination percentage and germination speed under moisture stress than small seed cultivars as reported by Munir *et al*., 2004 [10].

Table 1: Effect of seed priming techniques on planting value of lentil cultivars

	Field Emergence (%)			Seedling Length (cm)			Seedling Dry Weight (g)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	80.67	81.83	81.25	6.60	7.20	6.90	0.083	0.090	0.086
T_2	81.00	82.50	81.75	6.82	7.28	7.05	0.083	0.090	0.087
T_3	83.17	83.33	83.25	7.52	7.75	7.63	0.090	0.090	0.090
T_4	84.00	84.33	84.17	8.08	8.33	8.21	0.090	0.090	0.090
T_5	84.67	85.50	85.08	8.57	8.80	8.68	0.093	0.097	0.095
T_6	93.83	94.33	94.08	12.30	12.65	12.48	0.120	0.120	0.120
T_7	85.50	86.33	85.92	9.03	9.17	9.10	0.097	0.100	0.098
T_8	86.50	87.33	86.92	9.38	9.65	9.52	0.100	0.100	0.100
T_9	88.17	88.67	88.42	9.92	10.15	10.03	0.100	0.103	0.102
T_{10}	89.00	89.50	89.25	10.35	10.57	10.46	0.103	0.110	0.107
T_{11}	89.50	90.33	89.92	10.78	11.07	10.93	0.110	0.110	0.110
T_{12}	95.17	96.17	95.67	12.98	13.50	13.24	0.127	0.127	0.127
T_{13}	92.33	93.17	92.75	11.87	12.15	12.01	0.113	0.120	0.117
T_{14}	91.00	91.83	91.42	11.30	11.53	11.42	0.110	0.113	0.112
	87.46	88.23		9.68	9.99		0.101	0.104	
Factors	SE (m)	CD		SE (m)	CD		SE (m)	CD	
Variety	0.11	0.73		0.03	0.18		0.03	0.18	
Treatment	0.33	0.94		0.06	0.18		0.06	0.18	
Var. x Treatment	0.42	NS		0.10	NS		0.10	NS	
Treatment x Var.	0.46	NS		0.09	NS		0.09	NS	

Table 2: Effect of seed priming techniques on planting value of lentil cultivars

	Seedling Vigor Index-I			Seedling Vigor Index-II			Plant stand Establishment (%)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	532.45	589.18	560.82	6.73	7.04	6.89	75.67	77.00	76.33
T_2	552.12	601.03	576.58	6.84	7.18	7.01	76.17	77.67	76.92
T_3	625.12	646.10	635.61	7.36	7.46	7.41	78.17	78.83	78.50
T_4	679.05	702.92	690.98	7.65	7.84	7.75	79.83	80.50	80.17
T_5	725.35	752.45	738.90	8.00	8.16	8.08	81.00	81.33	81.17
T_6	1154.22	1193.10	1173.66	11.17	11.47	11.32	90.17	91.00	90.58
T_7	772.62	791.52	782.07	8.25	8.46	8.36	82.00	82.83	82.42
T_8	812.07	842.93	827.50	8.61	8.86	8.74	83.33	84.00	83.67
T_9	874.35	900.30	887.33	9.04	9.22	9.13	84.67	85.17	84.92
T_{10}	921.48	945.83	933.66	9.34	9.53	9.44	85.83	86.33	86.08
T_{11}	965.52	999.90	982.71	9.67	9.89	9.78	86.83	87.17	87.00
T_{12}	1235.75	1298.50	1267.13	11.80	12.12	11.96	92.67	93.67	93.17
T_{13}	1095.88	1132.05	1113.97	10.57	10.85	10.71	88.50	89.33	88.92
T_{14}	1028.52	1059.27	1043.89	10.10	10.33	10.22	87.50	87.83	87.67
	855.32	889.65		8.94	9.17		83.74	84.48	
Factors	SE (m)	CD		SE (m)	CD		SE (m)	CD	
Variety	3.35	21.95		0.03	0.20		0.21	NS	
Treatment	6.61	18.81		0.06	0.18		0.44	1.24	
Var. x Treatment	12.54	NS		0.12	NS		0.78	NS	
Treatment x Var.	9.61	NS		0.09	NS		0.63	NS	

V_1- KLB-303, V_2- K-75, T_1-Control (Untreated), T_2 - Control (recommended seed treatments as per package of practices), T_3-Hydropriming (Soaking in water for 8h at 250C and air drying at 250C for 48h), T_4 – Halopriming (Soaking in KNO_3 @ 0.3% solution and drying), T_5- Halopriming (Soaking in KH_2PO_4 @ 0.5% solution and drying), T_6-Halopriming (Soaking in Zn_2SO_4 @ 0.3%+MnSO4 @ 0.5% solution and drying), T_7-Seed coating (on dry seeds) with T. harzianum @ 15g/kg seed, T_8-Seed coating (on hydro-primed seeds) with T. harzianum @ 15g/kg seed, T_9-Seed coating (on hydroprimed seeds) with BioNPK, T_{10}-Seed coating (on hydroprimed seeds) with Biogrow, T_{11}-Seed coating (on hydroprimed seeds) with Biophos, T_{12}-Seed coating (on hydroprimed seeds) with Drought Alleviating Bacteria+ BioNPK, T_{13}-Seed coating (on hydroprimed seeds) with Drought Alleviating Bacteria+ Biogrow, T_{14} - Seed coating (on hydroprimed seeds) with Drought Alleviating Bacteria+ Biophos

Conclusion

In many rainfed areas, germination and subsequent seedling growth can be inhibited by adverse conditions in the field which decreases the planting value. Priming is helpful in reducing the risk of low germination, seedling vigor and poor stand establishment under a wide range of environmental conditions. Our findings revealed that seed coating (on hydroprimed seed by soaking in distilled water for 8 hours and then drying for 48 hours) with drough alleviating bacteria and BioNPK is a simple and useful technique for enhancing planting value of lentil. These effects can improve field emergence, seedling vigour and crop stand establishment of this important legume.

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