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Impact of organic and inorganic seed priming methods on growth and yield attributes in lentil (*Lens culinaris* L.)

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Abstract
Background: Lentil is one of the oldest annual grain legume srich in proteins, essential amino acids like isoleucine, lysine, dietary fiber, folate, vitamin B_1, and minerals. Several biotic and abiotic factors were found as constraints that limit the seed production. Hence, seed priming methods were employed to access the effect on plant growth and yield of lentil.
Methods: Twelve treatments used in the study comprised of Control, KCl, KNO_3, Rhizobium, Pseudomonas, Pungam, Moringa and Curry leaf extracts at various concentrations. Seeds were soaked for 12 hrs.in the cited treatments prior to sowing and experiment was carried out with an objective to assess its impact on growth and yield attributes.
Result: Irrespective of treatment type and concentration, all the treatments were found to be significant with respect to growth and yield parameters that were recorded. The treatments T_5- Rhizobium @ 1% and T_6- Pseudomonas @ 1% recorded maximum growth and yield amongst the treatments and found to be promising.

Keywords: Constraints, KCl, KNO_3, lentil, leaf extracts, pseudomonas and rhizobium

Introduction
Pulses are the second most important source of human food and play an important role in sustainability of agricultural systems by fixing nitrogen and reducing soil erosion (Parsa and Bagheri, 2009). Protein rich pulses such as lentils and beans stand as a major source alternate to meat. As of a legume, lentil fixes the atmospheric nitrogen to fulfill its nitrogen requirements; deficiency of nitrogen shows impact on biomass, harvest index (%) and seed yield (Gan *et al.,* 2009). Being enriched with protein, calcium and phosphorus lentil is preferred as fodder for animals compared to wheat straw (Gupta *et al.,* 2013). Due to indeterminate growth type, it is possible to find the flowers, immature pods and mature pods on the plant at the same time. Major constraints that hinder the plant growth and seed production in lentil are fusarium wilt, anthracnose, floral abscission and water stress at pre-flowering stage. Hence, the study was carried with an objective to assess the impact of seed priming on growth and yield attributes.
Seed enhancement aims to improve seed germination and seedling growth, encompasses many techniques performed on seed after harvest and before sowing. A simple low-cost low risk technology called on farm seed priming has been shown to improve emergence, seedling vigour and yield in range of crops including grasses and legumes (Kalneni Jahnavi *et al.,* 2020) [11].
Potassium chloride (KCl) is the most widely used halo primer in grasses and legumes as it provides macro nutrient potassium and micro nutrient chloride respectively. KCl acts an osmoticum to enhance germination, helps in the uptake of nutrients and promotes germination under salinity conditions (S. B. Solang *et al*., 2014) [10]. Potassium nitrate (KNO_3) as a primer increases germination (%) and promotes establishment of a seedling by providing macro nutrients K^+ and N_2.
Bio-priming is directly involved in the enhancement of plant growth by the secretion of compounds and mineral solubilization. Nitrogen is an important constituent of amino acid, chlorophyll and other structural components of plants (Shah *et al.,* 2016). One of the fundamental requirements for the usefulness of PGPR is their capability to colonize hosts rhizosphere, rhizoplane, or the root interior (Glick *et al.,* 2007). Biopriming with pseudomonas triggers the innate resistance against the fusarium wilt through pathogenesis related protein

activation and phenyl propanoid pathway (Subramanyan *et al.*, 2018).

Organic seed priming provides hardiness to high temperature, low moisture especially in semi-arid tropics, enhances root growth, increases nitrogen uptake, increase phosphate uptakeand promotes faster germination leading to vigour which is pre-requisite in increasing the crop productivity (Annie Apporva Joycy J. *et al.*, 2018) [13].

Materials and methods

The present study was carried out at crop research farm of the Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and Science, Naini Agriculture Institute, Pryagraj (U.P).

Treatments

T_0 – Control, T_1- KCl@ 1%,T_2-KCl@ 3%,T_3- KNO_3@ 1%,T_4- KNO_3@ 3%,T_5- Rhizobium@ 1%,T_6- Pseudomonas @ 1%,T_7- Pungam leaf extract @ 3%,T_8- Pungam leaf extract @ 5%,T_9- Moringa leaf extract @ 3%,T_{10}- Moringa leaf extract @ 5%,T_{11}- Curry leaf extract @ 3% and T_{12}- Curry leaf extract @ 5%.

Methodology

For the preparation of solution of saturated salt, 10g KCl was taken in a beaker. The chemical was added in 1000 ml. of distilled water with constant stirring. The volume of solution will finally constitute to one litter, and then it became 1% stock solution of KCl chemical and so on. The flasks containing chemicals were covered with muslin cloth to avoid any contamination.

For the preparation of solution of the Bio-agent, to prepare 1% solution of Rhizobium, 10 g. Rhizobium culture were taken in a beaker or tray. Lentil seeds were presoaked for 12 hours in water. Then all seeds were treated with rhizobium culture @10g/kg seeds using natural gum in beaker or tray. After that seeds were treated with bioagents as per the treatments given below and shade dried overnight by spreading on ground at room temperature.

For the preparation of solution of the Botanicals, to prepare 5% solution of Curi leaf ex-tract, 50 g Curi leaf extract (powder) were taken in a beaker and the chemical were added in 1000 ml. of distilled water with constant stirring. The volume of solution will finally constitute to one litter, and then it became 5% stock solution of Curi leaf extract and so on. The flasks containing chemicals were covered with muslin cloth to avoid any contamination.

Result and Discussion

The table 01 indicates that for growth parameters *viz.*, days to 50% flowering, plant height (cm) and number of primary branches per plant was found maximum with the treatment T_6 Pseudomonas @1%which was 68.67 days, 31.51 cm and 5.33 primary branches respectively.

For yield attributes *viz.*, maximum field emergence (%) of 58.67, pods per plant of 56.93, seeds per pod of 2.00 was recorded with the T_6- Pseudomonas @1%.

Seed yield per plant, per plot and per hectare was recorded maximum with the treatment T_6- Pseudomonas @1% which was 3.43 g, 294.07 g and 7.351 g respectively.

Discussion

Based on present study, it can be concluded that the treatment T_6 Pseudomonas 1% is found promising for growth parameters due to their contribution in growth promotion and induced systematic resistance in plants through the different mode of action like suppression of plant diseases, improved nutrient acquisition, phytohormone production and superior nodulation resulting in higher nitrogen fixation leading to improved flowering. These findings are in similar with the earlier research works of Ahemad and Kibret, (2014) [3]; Chanway *et al.*, (1989); Gulati *et al.*, (2007); Mwale *et al.*, (2003); Mahmoudi *et al.*, (2012).

Significantly maximum seed yield per plant, seed yield per pot, seed yield per ha, Biological yield and Harvest index was recorded in Pseudomonas @ 1% is due to increment in grain yield, the most important character regarding economic value of the crop, might be due to improvement in various parameters that is flowering, branches per plant and shoot dry matter accumulation. Similar results of seed yield per plant was observed by Jaderlund*et al.*, (2008); Kloepper *et al.*, (1989); Golmohammadzadeh *et al.*, (2014); Biswas *et al.*, (2009); Lucy *et al.*, (2004) and Mahmoudi *et al.*, (2012).

Table 1: Effect of treatments on plant growth and yield of Lentil (*Lens culinaris* L.)

S. No.	Treatments	Field Emergence percentage	Days to 50% Flowering	Plant height (cm)	Number of Branches Per Plant	Number of Pods Per Plant	Number of Seeds Per Pod	Seed yield per plant (g)	Seed yield per plot (g)	Seed yield per ha (q)	Biological yield (g)	Harvest index (%)
1	T_0	71.67	75.67	27.91	3.47	46.23	1.33	1.77	126.77	3.169	3.73	47.35
2	T_1	77.67	72.33	29.27	3.40	44.23	1.33	2.43	202.53	5.063	4.40	55.45
3	T_2	70.67	70.33	27.73	3.00	38.10	1.67	2.00	167.20	4.179	3.90	51.60
4	T_3	81.00	70.33	31.12	4.20	35.70	1.67	2.07	167.27	4.180	4.00	51.29
5	T_4	77.00	75.33	29.28	4.33	37.97	1.67	1.77	136.17	3.404	3.43	50.70
6	T_5	83.00	74.00	32.86	5.50	56.00	1.67	3.33	271.13	6.777	5.27	63.32
7	T_6	85.67	68.67	31.51	5.33	56.93	2.00	3.43	294.07	7.351	5.40	63.55
8	T_7	83.67	72.00	28.57	4.13	41.00	1.33	2.33	195.10	4.877	4.07	56.79
9	T_8	83.67	70.67	29.50	4.33	42.57	1.67	2.20	184.17	4.604	4.20	52.09
10	T_9	75.33	71.00	28.30	3.57	43.47	1.33	1.83	137.80	3.444	3.70	49.10
11	T_{10}	81.00	77.00	28.10	3.83	43.60	1.33	1.90	153.83	3.845	3.87	48.50
12	T_{11}	78.67	74.00	25.75	4.67	40.60	1.33	1.50	117.73	2.943	3.23	46.25
13	T_{12}	76.00	70.33	26.02	3.67	39.03	1.33	1.57	119.07	2.976	3.37	46.19
Grand Mean		78.85	72.28	28.92	4.11	43.49	1.51	2.16	174.83	4.365	4.04	52.48
C.D.(5%)		3.66	2.38	2.54	0.55	1.56	0.97	0.37	30.98	0.65	0.48	7.34
SE(m)		1.25	0.82	0.87	0.19	0.54	0.33	0.13	10.61	0.22	0.16	2.52
SE(d)		1.77	1.15	1.23	0.27	0.76	0.47	0.18	15.01	0.32	0.23	3.56
C.V.		2.76	1.95	5.22	7.92	2.13	38.04	10.24	10.52	8.95	7.01	8.30

Conclusion

On the basis of results obtained from the present experiment the treatment T_6-Pseudomonas @1% was found to be promising among all the treatments considered for study. Similarly, at par treatment T_5- Rhizobium@ 1% was found to be significant for plant growth and yield parameters.

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