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Study on influence of seed rate and seed priming on growth and yield parameters of fieldpea under rice-based utera cropping system

Parvati Karkey, GK Shrivastava, DK Chandrakar and Rahul Raj

Abstract
The investigation entitled "Influence of seed rate and seed priming on growth and yield parameters of fieldpea under rice-based utera cropping system" was carried out at the Research cum Instructional Farm, I.G.K.V, Raipur (C.G.). The primary objective was to examine how the varying seed rate and seed priming affected the growth and yield attributes of fieldpea chosen as *utera* crop. The experimental field's soil was vertisol, which had varying levels of N, P, and K content (low, medium and high, respectively) and was neutral in reaction. The variety taken for the experiment was Indira Matar-1. The experiment comprised of three replications and nine treatments in Randomized Block Design (RBD) *viz.* T_1: Dry surface seeding 80 kg ha^{-1}, T_2: Dry surface seeding 100 kg ha^{-1}, T_3: Dry surface seeding 120 kg ha^{-1}, T_4: Soaked seed surface seeding 80 kg ha^{-1}, T_5: Soaked seed surface seeding 100 kg ha^{-1}, T_6: Soaked seed surface seeding 120 kg ha^{-1}, T_7: Seed priming (1% 1% KNO_3) 80 kg ha^{-1}, T_8: Seed priming (1% KNO_3) 100 kg ha^{-1} and T_9: Seed priming (1% KNO_3) 120 kg ha^{-1}. The results revealed that treatment T_9: seed priming (1% KNO_3) 120 kg ha^{-1} resulted in highest plant population (m^{-2}) and plant height (cm) whereas, T_7: Seed priming (1% KNO_3) 80 kg ha^{-1} gave highest number of leaves per plant, leaf area plant per plant, number of nodules per plant, nodule dry weight per plant, pod length, number of pods per plant and seeds per pod. However, T_1: Dry surface seeding 80 kg ha^{-1} showed lowest values for these growth and yield parameters among all treatments.

Keywords: Seed rate, priming, utera, fieldpea

1. Introduction

One of the significant pulse crops in the leguminaceae family is field pea (*Pisum sativum var. arvense* L.) which is referred to as "matar" in Hindi. Fieldpea is an annual (*rabi* season), self-pollinating, legume pulse crop that is favored and well-liked among peoplein vegetarian diets. It is also commonly consumed throughout the world. Fieldpea is rich in protein content (15.8–32.1%) and also contains carbohydrate (18.6–54.1%), soluble sugars (5%), oil (0.6–5.5%), antioxidants, anti-inflammatory compounds, vitamins A, B, E, K, and C, omega-3 and omega-6 fatty acids (Sharma *et al.* 2022) [24]. These nutritional characteristics make fieldpeas good for humans and are highly beneficial for the efficient and cost-effective feeding of livestock due to their nutritional qualities. India is the largest producer, consumer and importer of pulses in the world. An estimated 26 Mt of pulses are consumed annually. In India fieldpea is grown on 1.826 million hectares with production of 1.82Mt respectively. In Chhattisgarh, Pulse crops, such as field peas, are grown as utera crops under rainfed conditions where the crop emerges before the rice harvest on the residual moisture available. Utera or paira cropping (relay cropping) is an ancient double cropping method followed under the rainfed conditions in which succeeding utera crop is directly sown in the precedingrice crop after the flowering stage (Sharma *et al.,* 2004) [25].

The primary challenges associated with fieldpea production in rice-based relay or utera copping systems under rainfed conditions are poor plant stand, inconsistent plant population, hindered growth, as well as low productivity since there is poor germination due to a lack of optimal moisture in the soil and improper interaction of seeds with moist soil. It is possible to meet the projected requirement for nutrients for rising population by increasing the area under fieldpea or optimizing yield per unit area by using suitable production technologies. With the adoption of optimum seed rate and appropriate management practices, it can be accomplished to satisfy the potential demand of nutrient for growing population. The simplest management strategy for varying plant populations and influencing yields is seeding rate. (Johnston *et al.,* 2002) [11].

It is possible to improve and enhance the productivity of fieldpea in the rainfed area by seed priming. Seed priming is a technique that has been widely utilized to reduce the time between sowing and the emergence of seedlings and to synchronize emergence. The principle of seed priming was firstly proposed by Heydecker (1973) [10]. The most common methods for seed priming that are used to improve and synchronize seed germination are hydro-priming (soaking seeds in water), halopriming (soaking seeds in salt solution like KNO_3), osmo-priming (soaking seeds in low osmotic potential solutions like PEG), matrix-priming (placing the seeds between insoluble solid matrix like saturated jute mat) and hardening, that involves alternately soaking and drying the seeds. (Mc Donald, 2000 and Basra *et al.*, 2002) [18, 3]. Hydro-priming and halo-priming are the two most basic and inexpensive priming techniques that may be used on the field itself, and they are quite beneficial for farmer. The popularity of fieldpea in recent years, as an utera crop has grown. an effort has been made to standardize techniques for management for boosting fieldpea yield under rice-based utera cropping systems.

2. Materials and Methods

The experiment "Influence of surface seeding, seed rate and seed priming on growth and yield parameters of fieldpea under rice-based utera cropping system" was conducted at Research cum Instructional Farm of IGKV, during rabi season of 2020-21. The region has a sub-humid to semi-arid climate. The experimental field's soil was vertisol, which had varying levels of N, P, and K content (low, medium and high, respectively) and was neutral in reaction. The crop variety under test was Indira Matar^{-1}. The experiment comprised of three replications and nine treatments in Randomized Block Design (RBD) *viz.* T_1: Dry surface seeding 80 kg ha^{-1}, T_2: Dry surface seeding 100 kg ha^{-1}, T_3: Dry surface seeding 120 kg ha^{-1}, T_4: Soaked seed surface seeding 80 kg ha^{-1}, T_5: Soaked seed surface seeding 100 kg ha^{-1}, T_6: Soaked seed surface seeding 120 kg ha^{-1}, T_7: Seed priming (1% KNO_3) 80 kg ha^{-1}, T_8: Seed priming (1% KNO_3) 100 kg ha^{-1} and T_9: Seed priming (1% KNO_3) 120 kg ha^{-1}. The recommended basal doses of nitrogen, phosphorus, and potassium ($N:P_2O_5:K_2O$) i.e., 20:50:20 kg ha^{-1}, was applied through urea, single super phosphate (SSP), and muriate of potash (MOP). As per the treatments, the seeds were soaked in water (hydropriming) and halo-primed with 1% KNO_3 overnight, respectively. Next morning, the soaked seeds were heaped in shade to air-dry. At the time of sowing, seeds treatment with 5 g rhizobium culture per kg seed was done that was common to all treatment. Thereafter, they were used for sowing. The seeds were broadcasted at different seed rates according to the treatment, 15 days prior to harvesting of the rice crop. Each net plot's produce was threshed separately by beating with sticks, then the seeds were cleaned carefully using a winnowing basket (Supa) and then weighed.

2.1 Computation

2.1.1 Leaf area index (LAI)

Leaf area index (LAI) can be defined as leaf area per unit of ground area. All fully opened leaves were scanned from the tip to the base of the leaf in a leaf area meter. It was computed by dividing the obtained leaf area by the ground area occupied by a plant at 30, 60 and 90 DAS. LAI is a unitless quantity.

$$\mathrm{LAI} = \frac{\text{Total leaf area m}^{-2}}{\text{Total ground area m}^{-2}}$$

3. Results and discussion

3.1 Plant population (No. m^{-2})

The plant population was observed at 20 DAS and at harvest, it varied from 59.3 to 82.1 plants m^{-2} and 48.3 to 75 plants m^{-2}, respectively (Table1). The maximum plant population was recorded under T_9: Seed Priming (1% KNO_3) 120 kg ha^{-1} inboth stages at 20 DAS and at harvest (82.1 and 75, respectively), but it was statistically at par with T_3: Dry surface seeding 120 kg ha^{-1} (78.7 and 66), T_5: Soaked seed surface seeding 100 kg ha^{-1} (73.1 and 64), T_6: Soaked seed surface seeding 120 kg ha^{-1} (80 and 68.7) and T_8: Seed priming (1% KNO_3) 100 kg ha^{-1} (74.3 and 63), respectively. The least number of plants m^{-2} at both the stages was recorded in case of T_1: Dry surface seeding 80 kg ha^{-1}. Seed priming along with increased seed rate resulted in enhancing plant population than dry surface seeding. This might be attributed due to positive effect of 1% KNO_3 on seed germination as it breaks seed dormancy and stimulated the hypocotyls growth, induces cell elongation resulting in more plant population.

3.2 Plant height (cm)

The data reveals that plant height continued to increase, and this increase was rapid throughout the early crop growth phase, i.e., 30, 60, and 90 DAS, and afterwards, plant height increased at a slower rate (Table 1). Primed seeds with higher seed rate produced significantly taller plants at 60, 90 DAS and at harvest than non-primed seeds. Significantly highest plant height (51.6, 67.9 and 69.8 cm) were recorded under the T_9: Seed priming (1% KNO_3) 120 kg ha^{-1} at 60, 90 DAS and at harvest, respectively, but it was statistically at par with T_3: Dry surface seeding 120 kg ha^{-1},T_5: Soaked seed surface seeding 100 kg ha^{-1}, T_6: Soaked seed surface seeding 120 kg ha^{-1}, T_7: Seed priming (1% KNO_3) 80 kg ha^{-1} and T_8: Seed priming (1% KNO_3) 100 kg ha^{-1}. While the lowest plant height was recorded under T_1: Dry surface seeding 80 kg ha^{-1}. The increase in plant height was due to the competition effect caused by increased seed rate causing plants to become taller for competing for more light interception and might be due to KNO_3 priming, as potassium plays an important role in cell division and cell elongation, which is responsible for internodal elongation. Similar type of findings were reported by Singh *et al*. (2014) [26] in cowpea, Golezani *et al*. (2011) [8] in mung bean, Kaur *et al*. (2015) [12] in okra and Asif *et al*. (2021) [2] in soybean.

3.3 Number of leaves plant^{-1}

The results on number of leaves plant^{-1} recorded at 30 and 60 DAS showed that surface seeding, seed rate and seed priming significantly increased the number of leaves plant^{-1} at 60 DAS. Solar radiation, temperature, mineral nutrients and water status are important factor that decide the number of leaves and size of leaf. The results thus revealed that number of leaves plant^{-1} ranged from 74.1 to 89.8, recorded at 60 DAS under different treatments. Significantly maximum numbers of leaves plant^{-1} at 60 DAS was recorded under T_7: Seed priming (1% KNO_3) 80 kg ha^{-1} (89.8), but it was found to be at par with T_1: Dry surface seeding 80 kg ha^{-1}, T_4: Soaked seed surface seeding 80 kg ha^{-1}, T_5: Soaked seed surface seeding 100 kg ha^{-1}, T_8: Soaked seed surface seeding 100 kg ha^{-1}, and T_9: Seed priming (1% KNO_3) 120 kg ha^{-1}.

While minimum number of leaves plant^{-1} (74.1) was recorded under T_3: Dry surface seeding 120 kg ha^{-1}. The result also showed that due to seed rate and seed priming, there was significant variation in number of leaves plant^{-1} at 60 DAS. The results are in accordance with Hassanpouraghdam *et al.* (2009) [9], that primed seeds were superior to that of un-primed seeds in terms of number of leaves.

3.4 Leaf area plant^{-1} (cm^2)

The leaf area plant^{-1} of fieldpea observed at 30, 60 and 90 DAS ranged from 100.19 to 141.2 cm^2 at 60 DAS and 126.7 to 162.8 cm^2 at 90 DAS under different treatments (Table 2). The perusal of data indicates that T_7: Seed priming (1% KNO_3) 80 kg ha^{-1}recorded significantly maximum leaf area plant^{-1} (141.20 and 162.81 cm^2) at 60 and 90 DAS, respectively, but it was at par to T_1: Dry surface seeding 80 kg ha^{-1}, T_4: Soaked seed surface seeding 80 kg ha^{-1},T_5: Soaked seed surface seeding 100 kg ha^{-1}, T_8: Seed priming (1% KNO_3) 100 kg ha^{-1} and T_9: Seed priming (1% KNO_3) 100 kg ha^{-1}. While the minimum leaf area plant^{-1} was observed under T_3: Dry surface seeding 120 kg ha^{-1}(100.19 and 126.78 cm^2) at 60 and 90 DAS, respectively due to the less plant emergence, lesser number of leaves and poor plant growth. The findings agreed with Mabhaudhi and Modi (2011) [17], that seed priming treatments significantly increased the leaf area as compared to control.

3.5 Leaf area index (LAI)

One of the most important parameters affecting growth is the leaf area index. Leaf area decides the amount of solar radiation intercepted. With the increase in leaf area index, light interception also increases. The observation was recorded at 30, 60 and 90 DAS (Fig.1). The findings showed that the crop attained the highest leaf area index at 90 DAS. T_9: Seed priming (1% KNO_3) 120 kg ha^{-1} recorded maximum leaf area (0.97 and 1.05) at 60 and 90 DAS and it was at par with T_5- Soaked seed surface seeding 100 kg ha^{-1} T_6- Soaked seed surface seeding 120 kg ha^{-1}**,** T_7: Seed priming (1% KNO_3) 80 kg ha^{-1} and T_8: Seed priming (1% KNO_3) 100 kg ha^{-1}. While the minimum leaf area index (0.55) at 60 DAS and 0.67 at 90 DAS was observed under T_1: Dry surface seeding 80 kg ha^{-1}. This increase in LAI with respect to seed priming might be due to increased leaf area, number of leaves and enhancement of physiological activities which provided food reserve to the developing seed and improved the performance of the crop plants. The findings were in agreement with Mohammadi (2009) [20] and Rehman *et al.* (2011) [22] who reported that seeds primed with 1% KNO_3 and increased seed rate gave maximum leaf area index respectively.

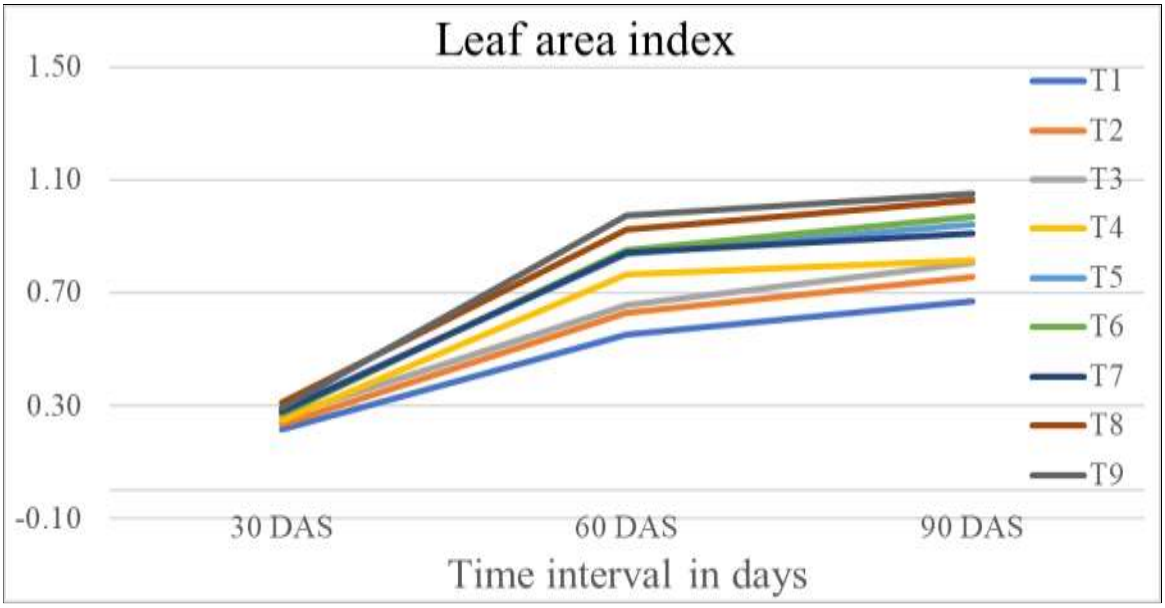

Fig 1: LAI of fieldpea as influenced by seed rate and seed priming treatment

3.6 Number of nodules plant^{-1}

The number of nodules plant^{-1} of fieldpea increased upto 60 DAS. Thereafter it reduces and reduction in nodule number was mainly due to its decay in later stages of crop. The numbers of nodules ranged from 6.5 to 7.3 at 30 DAS and 11.8 to 13.0 at 60 DAS under different treatments(Table 2).However at 60 DAS among all treatments, T_7: Seed priming(1% KNO_3) 80 kg ha^{-1} recorded significantly maximum number of nodules plant^{-1} (13.0) that remained at par with T_1: Dry surface seeding 80 kg ha^{-1}, T_4: Soaked seed surface seeding 80 kg ha^{-1}, T_5: Soaked seed surface seeding 100 kg ha^{-1} and T_8: Seed priming (1% KNO_3) 100 kg ha^{-1} and minimum number of nodules plant^{-1} was observed with T_3: Dry surface seeding 120 kg ha^{-1} (11.8) at 60 DAS. This increase in root nodule count with seed priming is because seed priming increased the root development and hence provided the better conditions for the nitrogen fixing bacteria. The results so obtained were in accordance to the impact of seed priming by potassium nitrate (KNO_3) on nodulation ability of common bean plants reported by Sarmadi *et al*. (2014) [23]. Mishra *et al*. (2017) [19] and Kumeera *et al*. (2018) [14] also reported similar findings. Lone *et al.* (2009) and Chaurasiya (2013) [5] reported declining nodule count with increasing seed rate.

3.7 Dry weight of nodules plant^{-1}

The dry weight of nodules plant^{-1} of fieldpea increased upto 60 DAS. Thereafter it reduced and reduction in nodule number was mainly due to its decay in later stages of crop. It ranged from 25.5 to 31.6 mg at 30 DAS and 41.8 to 58.6 mg at 60 DAS under different treatments (Table 2). The perusal of data indicates that significantly maximum root nodule dry weight plant^{-1} was recorded with treatment T_7: Seed priming (1% KNO_3) 80 kg ha^{-1} (58.6 mg) that remained at par with T_9: Seed priming (1% KNO_3) 120 kg ha^{-1},T_8: Seed priming (1% KNO_3) 100 kg ha^{-1}, T_5: Soaked seed surface seeding 100 kg ha^{-1}, T_4: Soaked seed surface seeding 80 kg ha^{-1} and T_1: Dry surface seeding 80 kg ha^{-1},whereas T_3: Dry surface seeding 120 kg ha^{-1} (41.8 mg) at 60 DASresulted in minimum nodule dry weight plant^{-1}. This increase in nodules dry weight might be due to more proliferation of roots and more number of root nodules plant^{-1}. The above findings agree with Sarmadi *et al.* (2014) [23] and Mishra *et al.* (2017) that seed priming with KNO_3 significantly increased nodule dry weight than control. Vyas and Khandwe (2014) reported decline in nodule dry weight with the increasing seed rate.

Table 1: Influence of seed rate and seed priming on fieldpeaunder rice based utera cropping systemat different time intervals

Treatments	Plant population (Plants m^{-2})		Plant height (cm)				Number of leaves plant^{-1}	
	20 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS
T_1	59.3	48.3	15	35.7	50.1	53.1	30.9	81.3
T_2	67.7	55.7	16.7	40.6	56.2	58.3	30	77.8
T_3	78.7	66	18.7	45.1	59.2	62.8	28.9	74.1
T_4	62	51	15.2	40.4	54.8	56.9	32.2	84.2
T_5	73.1	64	18.8	47.1	61.4	66.7	32	83.8
T_6	80	68.7	19.9	48.6	64.9	67.2	31.1	76.8
T_7	63.7	54.7	17.2	44.1	58.1	61.2	35.8	89.8
T_8	74.3	65	20.1	49.1	65.9	68.3	32.9	88
T_9	82.1	73	20.8	51.6	67.9	69.8	31.8	83.1
SEm±	3.3	5.34	2.5	3	3.19	2.56	2.56	3.2
CD (P= 0.05)	9.9	16.01	NS	9.01	9.58	7.67	NS	9.61

Table 2: influence of seed rate and seed priming on fieldpeaunder rice based utera cropping system at different time intervals

Treatments	Number of nodules plant^{-1}		Dry weight of nodulesplant^{-1} (mg)		Leaf area plant^{-1} (cm^2)		
	30 DAS	60 DAS	30 DAS	60 DAS	30DAS	60 DAS	90 DAS
T_1	6.8	12.5	28.7	51.4	36.53	114.01	149.1
T_2	6.6	12.1	28.2	46.7	34.27	102.67	135.7
T_3	6.5	11.8	25	41.8	33.17	100.19	126.7
T_4	6.9	12.6	29.9	54.6	39.62	131.6	156.2
T_5	6.8	12.5	29.4	52.8	38.69	123	154.5
T_6	6.7	11.9	25.5	45.6	34.01	108.86	136.9
T_7	7.3	13	31.6	58.6	43.91	141.2	162.8
T_8	7	12.9	30.3	57.6	42.06	138.46	158.5
T_9	6.9	12.3	28.5	50.4	35.86	114.58	149
SEm±	0.3	0.18	3.47	3.09	3.13	9.04	8.78
CD (P= 0.05)	NS	0.55	NS	9.27	NS	27.1	22.45

3.8 Pod length (cm)
The length of pod was recorded at harvest and the results showed that the length of the pod ranged from 3.9 to 5.7 cm under different treatments. Pod length showed non-significant difference with respect to the seed rate and seed priming treatments (Table 3). However, maximum pod length was recorded under T_9: Seed priming (1% KNO_3) 120 kg ha^{-1} (5.7 cm) among all the treatments.

3.9 Number of pods plant^{-1}
The results revealed that the different seed rate and seed priming treatments significantly increased the number of pods plant^{-1} in fieldpea and it ranged from 7.4 to 11.9among different treatments (Table 3). Significantly maximum number of pods plant^{-1} (11.9) was recorded under T_7: Seed priming (1% KNO_3) 80 kg ha^{-1}, followed by T_4: Soaked seed surface seeding 80 kg ha^{-1} (11.3). While minimum number of pods (7.4) was recorded under T_3: Dry surface seeding 120 kg ha^{-1}. This increase might have been due to better utilization of available resources due to low intra and inter plant competition and also due to the fact that potassium plays a major role in synthesis of sugar and its efficient translocation for seed formation and development. Golezani *et al.* (2011) [8] and Asif *et al.* (2021) [2] also reported similar findings, they noted that pods plant^{-1}increased under seed priming especially with KNO_3. Also Ali *et al.* (2018) in fieldpea, found that number of pods plant^{-1} decreased with increasing seed rate or plant density.

3.10 Number of seedspod^{-1}
Data pertaining to number of seeds pod^{-1} of fieldpea are presented in Table 3. Number of seeds pod^{-1} showed non-significant difference due to different seed rate and seed priming treatment. The results revealed that numbers of seeds pod^{-1} ranged from 4.01 to 5.19 under different treatments. However, among the treatments, maximum number of seeds pod^{-1} was recorded under T_7: Seed priming (1% KNO_3) 120 kg ha^{-1} (5.19) and minimum number of seeds pod^{-1} was noted under T_3: Dry surface seeding 120 kg ha^{-1}.

Table 3: Influence of seed rate and seed priming on yield parameters of fieldpeaunder rice based utera cropping system

Treatments	Pod length (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}
T_1	3.9	9.7	4.82
T_2	4.5	8.9	4.21
T_3	5.2	7.4	4.01
T_4	4.5	11.3	5.09
T_5	5.3	9.3	4.95
T_6	5.6	8.3	4.19
T_7	5.1	11.9	5.19
T_8	5.3	10.1	5.09
T_9	5.7	9.0	4.32
SEm±	0.38	0.55	0.38
CD (P= 0.05)	NS	1.66	NS

4. Conclusion
The results of the study indicated a significant effect of seed priming and seed rate. Seed priming (1% KNO_3) with 80 kg seeds ha^{-1} was found to significantly improve the overall growth and yield parameters of field pea as compared to other treatments under rice-based utera cropping system because seed priming initiates the germination related metabolic activities and promotes rapid and synchronized emergence during moisture stress condition in rice-based utera cropping system.

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