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Effect of priming on seed characters, disease incidence & yield in french bean (*Phaseolus vulgaris* L.)

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Abstract
An experiment entitled "Effect of priming on seed characters, disease incidence & yield in French bean (*Phaseolus vulgaris* L.)" was conducted during Rabi 2018-19 in the Vegetable Research field, Department of Vegetable Science, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar. The trial was conducted in Randomized Block Design with three replications and ten treatments. The treatments were T_1 (Hydro priming), T_2 (GA_3 50 ppm), T_3 (KCl 2%), T_4 (Sodium Molybdate 500 ppm), T_5 (Vitavax 2g/kg), T_6 (*Pseudomonas fluorescens* 10%), T_7 (*Trichoderma viride* 10%), T_8 (GA_3 50 ppm+ *T. viride* 10%), T_9 (Sodium Molybdate 500 ppm +*Pseudomonas fluorescens* 10%), T_{10} (Control). The seeds of French bean variety Harsha were taken and different priming treatments were done in the laboratory followed by growing the crop in the field as per recommended package of practices. Priming with (GA_3 50 ppm + *T. viride*10%) was found the best in reducing leaf anthracnose and root rot by 62.9% and 75.9% respectively. The vitavax 2g/kg was the next best priming treatment which reduces anthracnose and root rot by 53.2% and 63.8% respectively. The seed quality parameters as studied in laboratory revealed the highest germination of 84.2%, seedling length of 43.00 cm, vigour Index –I of 3620.6 and vigour Index –II of 72.41 in KCl @ 2%. From the present experiment it can be concluded that if KCl @ 2% is used for priming of French bean seeds it produces better yield attributing character & also recorded the better yield of 13.28 t/ha followed by 12.19t/ha with (GA_3 50 ppm+ *T. viride* 10%) and the lowest pod yield of 8.10 t/ha was obtained in unprimed control.

Keywords: Priming, germination, vigour, disease, yield

Introduction
Seed priming is a presowing treatment which leads to a physiological state that enables seed to germinate more efficiently. Seed priming is a technique which involves water uptake by seeds followed by drying to initiate the early events of germination up to the point of radicle germination, improved seedling vigour and growth under a broad range of environments resulting in better stand establishment and alleviation of phytochrome -induced dormancy in same crop. Seed priming is controlled hydration of seeds to a level that allow pre-germinative metabolic activity to continue, but interrupt the emergence of the radicle. Seed priming improves seed performance**,** ensures uniformity and better establishment**,** enhances the yield in diverse environments**,** greater tolerance to environmental stress and helps to overcome dormancy. Change in seed water content, cell cycle regulation, modification of seed ultrastructure, management of oxidative stress and reserve mobilization are the major physiological and biochemical changes takes places during seed priming.
During subsequent germination, primed seeds exhibit a faster and more synchronized germination and young seedling are often more vigorous and resistant to abiotic stresses than the seedlings obtained from unprimed seeds. Priming allows some of the metabolic processes necessary for germination to occur without germination. In priming, seeds are soaked in different solutions with high osmotic potential. This prevents the seeds from absorbing in enough water for radicle protrusion thus, suspending the seeds in the lag phase. Seed priming has been commonly used to reduce the time between seed sowing and seedling emergence and to synchronize emergence. In seed priming, the osmotic pressure and the period for which the seeds are maintained in contact with the membrane are sufficient to allow pre-germinative metabolic processes to take place within the seeds up to a level limited to that immediately preceding radicle emergence. Since germination and seedling establishment are critical steps in plant life, and the successful establishment of plant, not only depend on rapid and uniform germination of seed but depend on the ability of rapid germination of the seed under environmental conditions. For this purpose, seed pre-priming or priming methods are used to increase the qualitative and quantitative performances of seedlings.

Materials & Methods

The field experiment was carried out during Rabi season of the year 2018-19 in the Vegetable Demonstration plot of the Department of Vegetable Science, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. In case of hydro priming the seeds were immersed inside water for about 5 hrs. Then the seeds were taken out as well as air dried followed by sowing in prepared field. In case of GA_3 50 ppm, KCl (2%), Sodium molybdate (500 ppm), Vitavax (2g /1lit), *Pseudomonas fluoroscens* (10%), *Trichoderma viride* (10%), (GA_3 50 ppm+ *Trichoderma viride* 10%), (Sodium molybdate 500 ppm+ *Pseudomonas fluoroscens* 10%) solution was prepared and the same procedure was followed for treatment of the seeds. The laboratory test for germination of French bean seeds was conducted as per the ISTA Rules by adopting between paper method. Hundred seeds from each treatment were taken and put for germination in between two moist germination papers. The papers were rolled and kept in the germinator maintained at constant temperature of 25±1 ºC and 95 percent relative humidity. The first count was taken after five days and final count after seven day. On the day of final count, the numbers of normal seedlings were counted and the percent seed germination was calculated as follows.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds}} X\ 100$$

The harvested dried seeds, were collected at random and germinated in laboratory following paper towel method and the length of the seedlings were measured and expressed in cm. The shoot and root portion of the 10 normal seedlings after length measurement were dried in an air oven at 85 ± 1 ^{0}C temperature for 48 hours. Then dry weight was determined by an electronic balance and the seedling dry weight (mean of 10 seedlings) was expressed in mg. Vigour index values of seeds produced under different treatments were calculated as per the formula developed by Abdul Baki and Anderson (1973).

The seedling vigour index was computed by adopting the formula as given below:

Seedling Vigour Index - I= Germination% x Seedling length

Seedling Vigour Index - II= Germination% x Seedling dry weight

In order to study the effect of various priming materials on incidence of both foliar and soil borne diseases, observations were recorded using 0-5 scale (Mayee and Datar,1986) and described as follows.

Table 1: Description of Disease scale. (0-5)

Scale	Description
0	No symptoms on the leaf
1	0-5 percent leaf area infected and covered by spot
2	6-20 percent leaf area infected and covered by spot, some spots on petiole
3	21-40 percent leaf area infected and covered by spots, spots also seen on petiole and branches
4	41-70 percent leaf area infected and covered by spot, spots also seen on petiole, branches and stem
5	>71 percent leaf area infected and covered by spot, spot also seen on petiole, branch stem, and fruits

This work was carried out by using the following formula given by wheeler (1961).

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of individual ratings}}{\text{No. of observations X Maximum scale}} \text{X } 100$$

The observations were recorded at preflowering (40 DAS) & pod formation stage (60 DAS) The foliar disease were scored and disease severity were calculated by finding the PDI whereas the incidence of root rot and wilt like soil borne /seed borne disease were assessed by plant count basis. The total fruit yield per plot was converted to total fruit yield in (q/ha) for eachreplications to obtain yield /ha.

Statistical analysis

Analysis of variance (ANOVA) was carried out on mean values separately for each character adopting standard analysis of variance technique for RBD design. The analysis of variance for each of the character was carried out with the mean value of data collected from sample plants from each plot and the mean average data were used for the total variance into components due to replication, treatment and error. The "F" test was done for testing the significance of the findings. Approximate standard error for each factor was worked out to compare the treatment means and the critical difference (CD) was calculated at 5% level of significance using the following formula.

Table 2: Analysis of variance (ANOVA)

Source	Degree of Freedom (df)	Sum of Square (ss)	Mean Sum of Square (mss)	F test
Replication	r-1	Rss	Rss/r-1 = rms	rms/Ems
Treatment	t-1	Tss	Tss/t-1 = tms	tms/Ems
Error	(r-1) (t-1)	Ess	Ess/(r-1) (t-1) = Ems	

SE (m): $\sqrt{\frac{2Ems}{r}}$

CD =: SE (m) x t value at error degree of freedom

CV (%): $\frac{\sqrt{Ems}}{\text{Over all mean}} \times 100$

Results & Discussion

Table 3: Germination percentage, average seedling length, average dry weight of seedling, Vigour Index-I &II of french bean crop as influenced by different treatments

Treatments		Germination %	Average seedling length (cm)	Average seedling dry weight (mg)	Vigour Index -I	Vigour Index-II
T1	Hydro priming	76.2 (60.89)	37.0	0.78	2819.4	59.43
T2	GA_3 (50 ppm)	78.4 (62.37)	39.4	0.84	3088.96	65.85
T3	KCl (2%)	84.2 (66.79)	43.0	0.86	3620.6	72.41
T4	Sodium Molybdate500 ppm	73.4 (59.05)	37.2	0.76	2730.4	55.78
T5	Vitavax(2g/kg)	75.3 (60.68)	36.4	0.75	2740.9	56.47
T6	*P.fluorescens* (10%)	74.5 (59.78)	38.4	0.78	2860.8	58.11
T7	*T. viride* (10%)	76.5 (61.06)	35.1	0.74	2685.15	56.61
T8	GA_3 (50 ppm) + *T. viride* (10%)	80.1 (63.62)	42.1	0.82	3372.21	65.68
T9	Sodium Molybdate 500 ppm +*P. fluorescens* (10%)	74.2 (59.58)	32.0	0.68	2374.40	50.45
T10	Control	71.8 (58.08)	31.2	0.66	2240.16	47.38
SE (m) ±		2.44	1.82	0.26	167.32	2.81
CD5%		7.38	5.52	0.79	507.24	8.52
CV%		6.89	8.48	14.45	10.16	8.28

Table 4: Effect on disease incidence Observation on incidence and sevierity of disease, based on disease scoring and follow up recording of datas on percenet disease index (PDI) are presented in table 4.10

Treatments		Leafspot		Root rot & wilt		Leaf spot disease reduction	Root rot & wilt disease reduction	Yield per ha
		40 DAS	60 DAS	40 DAS	60 DAS			
T_1	Hydropriming	31.4 (34.08)	42.1 (39.95)	3.8 (11.23)	4.6 (12.31)	10.9	20.7	9.77
T_2	GA_3 (50 ppm)	28.6 (32.31)	38.3 (38.21)	3.4 (10.57)	4.3 (11.92)	19.0	25.9	11.86
T_3	KCl (2%)	25.4 (30.24)	34.6 (37.01)	3.1 (10.08)	4.1 (11.73)	26.8	29.33	13.28
T_4	Sodium Molybdate500 ppm	33.3 (35.24)	44.5 (41.84)	3.7 (11.02)	4.6 (12.36)	5.9	20.7	9.51
T_5	Vitavax (2g/kg)	17.6 (24.79)	22.1 (28.07)	1.6 (7.25)	2.1 (8.26)	53.2	63.8	10.49
T_6	*P. fluorescens* (10%)	23.3 (28.82)	31.6 (34.18)	2.3 (8.72)	3.6 (10.93)	33.1	37.9	9.13
T_7	*T. viride* (10%)	21.1 (27.33)	27.4 (31.53)	2.1 (8.40)	3.9 (11.34)	41.9	32.8	10.88
T_8	GA_3 (50 ppm) + *T. viride* (10%)	12.5 (20.61)	17.5 (27.66)	0.5 (6.56)	1.4 (5.57)	62.9	75.9	12.19
T_9	Sodium Molybdate 500 ppm +*P. fluorescens* (10%)	23.6 (28.91)	31.6 (34.30)	2.9 (9.78)	3.8 (11.24)	33.1	34.5	9.14
T_{10}	Control	41.8 (40.26)	47.3 (43.43)	4.1 (11.68)	5.8 (13.87)			8.10
	SE (m) ±	1.10	1.17	0.38	0.72	-	-	0.70
	CD5%	3.33	3.56	1.15	2.18			2.12
	CV%	6.29	5.75	6.88	11.37			11.62

*(Figures in parenthesis indicate angular transferred value)

The laboratory experiment results revealed that there was significant difference in percentage germination being the highest in T_3 (84.2) closely followed by T_8 (80.1) and T_2 (78.4) and they are statistically at par. It suggests the priming with KCl(2%), T_8 ($GA_3$50 ppm + *T. viride* (10%) and GA_3(50ppm) were more efficacious in increasing the germination percentage. However the unprimed control plot recorded the minimum 71.8 percent germination. These findings corroborates the findings of Barthwal and Prava (2018) [3], Khan *et al.* (2009) [10], Tufa and Nego (2016) [17] who experimented on different halo priming including KCl. Similarly Jyoti *et al.* (2016) [9] observed GA_3(50 ppm) performed maximum seed germination and suggested that GA_3 priming has important growth regulator to enhance the seed germination as well as seed vigour which stands true for the present investigation. The laboratory experiment revealed that the highest seedling length of 43.0 cm in T_3 followed by 42.1 cm in T_8 and 39.40 cm in T_2. The unprimed control treatment recorded lowest seedling length of 31.2 cm. Even hydro priming also resulted in significantly higher seedling length (37.0) cm when compared to untreated control. This result is also supported by the findings of Ahammad *et al.* (2014) [1], Dastanpoor *et al.* (2013) [5], Eskandari and Kazani (2011) [6] and Kumar (2014) [11]. Yazdani *et al.* (2011) [21] reported that hydro priming treatments significantly increased the complete characters of seedling of legumes like lentil, Soja bean, green bean and broad bean. Jyoti *et al.* (2016) [9], Ghobadi *et al.* (2014) [8] also reported maximum seedling length while experimenting with different hormo priming agents which supports the present findings. The dry weight of seedlings was the highest 0.86g in T_3 followed by T_2 (0.84g) and T_8 (0.82g) and the lowest seedling dry weight was recorded in T_{10} (0.66g). However there is no significant differences among the treatments with respect to dry weight of seedlings. But all the sole priming treatments or priming approach in combination resulted in higher seedling dry weight was also supported by findings of Barthwal and Prava (2018) [3], Pradhan *et al.* (2017) [15]. Bankji *et al.* (2018) experimented on *Cucurbita pepo* and reported that hydro priming and hormonal priming with GA_3 improved the seedling dry weight which agrees the present findings. The highest vigour Index -I was recorded in T_3 (3620.6) and the lowest was 2240.16 in unprimed control. However the treatments with KCl2%, GA_3 50ppm+ *T. viride* (10%) and GA_3 (50ppm) were at par with respect to their performance on Vigour Index -I. Thisfindings is also supported by the result of Barthwal and Prava (2018) [3], Khan *et al.* (2009) [10]. The highest vigour index –II was recorded with KCl (2%) that is 72.41 followed by T_2 (65.85) and T8 (65.68) and they are statistically at par. The vigour index –II was the lowest in

unprimed control (47.38). This findings corborates with the findings of Monalisa *et al*. (2017) [14] who experimented on bio priming of french bean seeds in Odisha condition. Barthwal and Prava (2018) [3] investigated on hormonal priming on French bean, Pradhan *et al.* (2017) [15] on halo priming and hormonal priming on maize seeds also found the positive effect of priming on Seed vigour both Vigour Index-I & Vigour Index –II, which supports the present findings. It may be suggested from the present study that different priming hydro, halo, hormo, bio priming and their combinations of the treatments showed significant effect on plant growth, phonological parameters, yield and its attributing traits, reduction of foliar and soil borne disease as well as quality parameters in seed viz germination, seedling growth and vigour. Seed priming with KCl (2%) & GA_3(50ppm) are the best priming approach which resulted a significant yield and plant growth parameters in french bean (*Phaseolus vulgaris* L.). During the period of experimentation incidence of leaf anthracnose caused by *Colletotrichum lindemuthianum* was observed and its natural occurance were observed scored and severity were calculated as per the methods described in materials and methods. Out of various priming approaches and their combinations it was observed the treatments with various bio agents and their combinations with hormo priming or halo priming performed better in reducing the disease incidence compared to control. The incidence of disease initiated around 25 days of crop growth, their incidence and sevierity were found out of 40 DAS and 60 DAS. During the crop maturity stage the lowest PDI was recorded in T_8 (*GA_3+ T. viride*) treatment (17.5) followed by 22.1 in T_5 (Vitavax @2g/kg), *Trichoderma viride* (10%) recorded PDI (27.4) where as *Pseudomanas fluroscens* (10%) attained a PDI was observed in control (47.3). Similarly the root rot and wilt incidence was detected to be caused by the pathogen *Sclerotium rolfsii*, soil borne in nature and had a wide variations among different treatments. The lowest incidence of 1.4% was noticed in T_8 which was significantly the lowest among all other treatments Here also other treatments like Vitavax @ (2g/Kg) recorded 2.1% incidence followed by T_6 (3.6), T_9(3.8) and T_7(3.9). Fath El-bab *et al.* (2013) [7] experimented under field condition and reported that bio priming with various *Trichoderma* species as well as fungicide treatment successfully suppress the root rot incidence in and improved the quality parameters in green pods of bean crop which supports the present findings. Yadav *et al.* (2013) [20] also reported all combinations comprising *Trichoderma* showed better result than other combinations and their individual application, which is in line with the present result. Chauhan and Patel (2017) [4] experimented on bio priming of *P. fluroscens* applied at imbibitions @ 10gm/Kg and found significantly superior over other treatments and reduce the PDI of damping off, anthracnose and wilt of Chilli which is in close agreement with the present findings. Monalisha *et al*. (2017) [14] reported decrease in seed rot and seedling blight in french bean by priming with *P. fluroscens*, *T. viride* and *T. harzianum* in Bhubaneswar condition which supports the present findings. The observation recorded on pod yield per hectare revealed the highest yield of 13.28 ton/ha in T_3 closely followed by 12.19 t/ha in T_8 and 11.86 t/ha in T_2 and they are statistically at par. The yield recorded was the least in unprimed control plot (8.10t/ha). Maiti *et al.* (2013) [13] recorded higher yield in vegetable seeds due to priming and Toklu *et al.* (2016) reported that PEG, KCl and hydro priming helped increase in yield in wheat which supports the present findings. Yadav *et al.* (2013) [20] reported that the bioagent Trichoderma showed better result in yield and yield attributing parameters compared to other bio inoculants which supports the present findings. Monalisa *et al.* (2017) [14] reported the increased pod yield in primed seeds when compared to control while experimenting on pumpkin seeds.

Conclusion

An experiment entitled "Effect of Priming on growth & development of French bean" was carried out during Rabi 2018-19 at the Vegetable Demonstration plot of College of Agriculture, OUAT, Bhubaneswar. The trial was conducted in Randomized block design with three replications and ten treatments. Result revealed that that Halo priming in KCl (2%) followed by combination of hormo-primig along with bio-priming (GA_3+ *T. viride*) as well as hormo-priming with GA_3 (50 ppm) resulted in better growth, influenced yield attributing characters and also the yield. Priming with *T. viride* as well as vitavax in some treatments also performed better with respect to yield parameter. Bio priming with GA_3 50ppm + *T. viride*. (10%) and fungicidal priming with Vitavax power (carboxyn 37.5%+ thiram 37.5%) reduced both leaf spot and root rot disease successfully. It can be concluded that application of KCl (2%) produced better yield (13.28 t/ha.) as compared to other treatments. It can be concluded that application of KCl (2%) was the best treatment and can go a long way in enhancing French bean production when practiced by the farming community of the state. However the experiment may be conducted at various locations over season to get more authentic information related to impact of priming on growth, development and pod yield of French bean.

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