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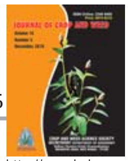

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Seed priming and foliar nutrition studies on relay grass pea after winter rice in lower Gangetic plain

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ABSTRACT

Recently rice fallow situations have been included as identified thrust area of national mandate. A two year field experiment was conducted at A-B' District Seed Farm, Bidhan Chandra KrishiViswavidyalaya, West Bengal, to analyze the response of seed priming with molybdenum in relay grass pea, variety Ratan (Bio L-212), grown with foliar fertilization with 2% Urea and 0.5% NPK(19:19:19) in a factorial RBD replicated thrice. Seed priming along with foliar spray of 0.5% NPK(19:19:19) at pre-flowering and 15 days after first spray resulted in better crop growth, root nodulation leading to highestper plant number of pods (71) and seed yield (1696.70 kg ha^{-1}) with maximum benefit-cost ratio (2.07). Combined application of seed priming with Ammonium molybdate @ 0.5 g kg^{-1} seed along with twice foliar spray of 0.5% NPK (19:19:19) proved to be a profitable technology for better crop hunbandry of relay grass pea under South Bengal plain situation.

Keywords: Foliar fertilization, grass pea, molybdenum, relay cropping, seed priming

Grass pea (*Lathyrussativus*L.) is a remarkable moisture stress withstanding crop (Gusmao *et al*., 2012; Kalita and Chakrabarty, 2017) that thrives with minimal external inputs (Nazrul and Shaheb, 2015). In practice, it is raised as arelay crop by utilizing the residual soil moisture left after *kharif* rice (Mondal and Ghosh, 2005; Gupta and Bhowmick, 2005; Bhowmick *et al*., 2014; Navaz *et al*., 2017) and is considered as 'poor man's pulse crop' (Parihar and Gupta, 2016) for its adaptability to unfavourable environments (Sarkar and Malik, 2001) like temperature extremes, very poor soil types (Dixit *et al*., 2016). Poor fertility status of soil and quick draining of soil moisture after *kharif* rice harvest are mainly responsible for major problem of lower productivity associated with the crops under *utera*system (Gupta and Bhowmick, 2005; Bhowmick *et al*., 2014). Moreover, at the time of sowing of pulses,the basal dose of fertilizers gets impeded bythe standing rice crop (Singh *et al*., 2014) which hampers their final yield. Under these circumstances, micronutrient seed priming can serve as an easy but cost-effective agronomic intervention uplifting the yield potential of rice-fallow pulse crops through fulfilment of the nutrition demand of the crop at intitial stages. Seed priming with Ammonium molybdate significantly increases the yield by inhibiting abscission of flowers and pods, modulating growth characters in terms of stem girth, early vigour and crop establishment, enhancing dry matter production and it's partitioning in addition to elevation in the numbers of pods per plant. Besides, foliar nutrition is more proficient specifically in indeterminate legumes, as it delays senescence and converts the late flushes of flowers into pods. Thus the source-sink relationship in pulse crops gets balanced. This technique curtails the nutrient loss and aids in fast hand allocation of plant nutrients to the site of photosynthesis (Bhowmick, 2008; Manonmani and Srimathi, 2009) along with quick supply of nutrients (Das and Jana, 2016) which ultimately cut short the requirement of fertilizers from a huge bulk to a handful (Bhowmick *et al*., 2014; Das and Jana, 2016). Instead of soil application, foliar fertilization may pose to be the best fit for alleviation of the nutrient deficiencies with special enforcement on nitrogen deficit under moisture stress condition (Haseeb and Maqbool, 2015). Scanty information prevails regarding technology in under rice-*utera*system, which is even less in lathyrus crop. The present research strategy was planned to find out the response of relay grass pea to seed priming with molybdenum along with standardization of the most effective foliar fertilization schedule with a view to uplift the production potential of relay sown grass pea.

MATERIALS AND METHODS

The field experiment was conducted at District Seed Farm, 'A-B' block, (22°93' N latitude, 88°53' E longitude and 9.75 m above mean sea level) of Bidhan Chandra KrishiViswavidyalaya, Kalyani, Nadia, West Bengal, India during two subsequent *rabi* seasons (October – March) of 2017-18 and 2018-19. The experimental soil was sandy loam in texture with pH 7.3, EC 0.18 dS m^{-1}, organic carbon 0.56%, available N 231.28 kg ha^{-1},P_2O_5 34.51 kg ha^{-1}, available K_2O 188.83 kg ha^{-1}. The experiment was laid out in a factorial randomized block design replicated thrice comprising two seed priming levels *viz*. S_1: No seed priming and S_2: Seed priming with Ammonium molybdate @ 0.5 g kg^{-1} seed and five

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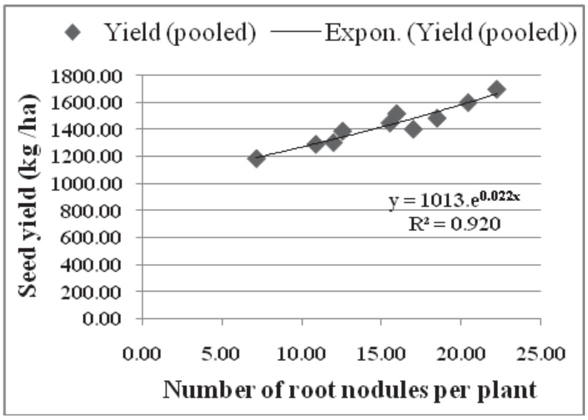

Fig. 1: Relation between number of root nodules per plant and pooled values of seed yield of grass pea

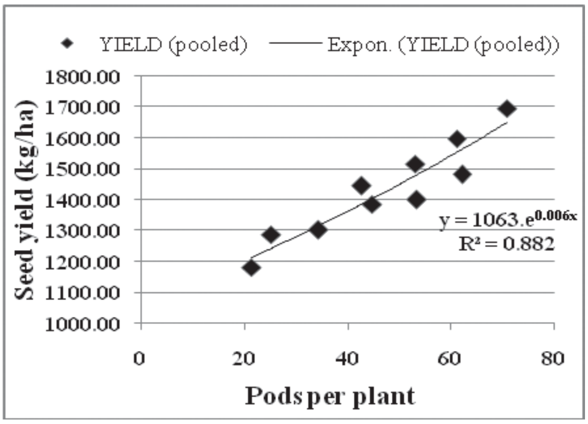

Fig. 2: Relation between pods per plant and pooled values of seed yield of grass pea

foliar spray levels *viz.* F_1: No foliar spray, F_2: 2% Urea spray at pre-flowering stage, F_3: 2% Urea spray at pre-flowering stage + 15 days after 1st spray, F_4: 0.5% NPK (19:19:19) spray at pre-flowering stage and F_5: 0.5% NPK (19:19:19) spray at pre-flowering stage + 15 days after 1st spray. After being treated with *Rhizobium* biofertilizer @ 20 g kg^{-1} of seed,grass pea [Variety Ratan (Bio L-212)] seeds were broadcasted @ 80 kg ha^{-1} on 2nd and 3rd week of October in the 1st and 2nd year respectively on standing rice [Variety Satabdi (IET 4786)]. Rice crop was harvested after about a week from sowing of grass pea in the last week of October in both the years under investigation. Application of basal dose of fertilizers and irrigation were completely excluded for grass pea cultivation. The crop was harvested on 4th week of February in both the years. Total rainfall receipts were 9.4 and 1.4 mm during the crop growth period, whereas the mean maximum temperature of 28.2 and 28.3°C and minimum temperatures of 16 and 15.2°C were recorded in first and second year of experimentation, respectively. Data collection on plant height was followed at 60 DAS and at harvest. Root nodule count was taken at 50 and at 75 DAS. Pod numbers per plant and seed yield were observed and treatment economics were estimated.

RESULTS AND DISCUSSION

Seed priming with Ammonium molybdate @ 0.5 g kg^{-1} seed markedly attributed to better performance than the non-primed plots with respect to growth and yield attributes of grass pea under relay cropping system during both years of investigation. Besides priming with molybdenum (Mo) also promoted higher count of root nodules per plant (17.01) at the time of active nodulation (50 DAS), which might be explained by the potential role of Mo in pulse crops to enable the *Rhizobium* to perform its function of fixing atmospheric nitrogen satisfactorily as well as for the reduction of nitrates (Campo *et al.*, 2008; Datta *et al.*, 2011, Yadav *et al.*, 2017) due to its role as a cofactor for both nitrogenase (NA) and nitrate reductase (NR) enzymes (Togay *et al.*, 2008; Alam *et al.*, 2015). Higher initial plant stand (113.13 plant m^{-2}) and final plant height (119.43 cm) along with important attributing characters like number of branches per plant (8.9), pods per plant (51), seeds per pod (3.1) and 100 seed weight (4.89) which in turn resulted in 11.74% higher seed yield of grass pea comparedto the plots without priming(Table 1 and 2). These findings were supported by the repotrs of Navaz (2017). He noticedthat Lathyrus (variety Prateek) responded better to seed treatment with Sodium molybdate @ 0.5 g kg^{-1} seed than no priming in terms of growth and yield attributing characters, final yield and production economics. Comparative advantage of seed priming may be owing to physico-chemical changes at cellular level along with better colloidalhydration, viscosity and protoplasmic elasticity etc. (Solaimalai and Subburamu, 2004) which might have contributed more robust seedlings with satisfactorydeveloped root systems and completion of life cycle earlier with higher yield than unprimed seeds, effectively escaping terminal stresses like drought and heat (Uddin *et al*. 2005; Bhowmick, 2018). Regarding the production economics, again the maximum values for gross realization ha^{-1} (Rs. 60,128.45), net realization ha^{-1} (Rs. 28,950.15) and benefit cost ratio (1.93) was measured in case of the seed primed treatments (Table 3).

Growth of grass pea plants in termsof height and number of root nodules per plant at active nodulation period was markedly improved by the provision of foliar spray of fertilizers as compared to the plots without spray.As the spray schedule started 45 DAS onwards, the initial plant population (at 30 DAS)did not show any significant variation. Foliar spray with 0.5% NPK

Table 1 : Growth attributes of Lathyrus at different growth stages as influenced by seed priming and different foliar sprays of nutrient during 2017-18 and 2018-19

Treatment	Plant height (cm) at different growth stages of lathyrus						Number of root nodules plant^{-1}					
	60 DAS			Harvest			50 DAS			75 DAS		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
A. Seed priming (S)												
S_1	57.84	62.52	60.18	103.42	107.56	105.49	13.45	13.42	13.44	12.06	12.14	12.10
S_2	62.56	65.81	64.19	119.83	119.02	119.43	16.75	17.27	17.01	13.45	13.84	13.65
SEm(±)	**1.34**	**1.22**	**0.99**	**2.20**	**2.53**	**2.03**	**0.30**	**0.28**	**0.15**	**0.07**	**0.16**	**0.07**
LSD (0.05)	**4.02**	**NS**	**2.98**	**6.59**	**7.58**	**6.09**	**0.89**	**0.84**	**0.46**	**0.22**	**0.49**	**0.21**
B. Foliar sprays of nutrient (F)												
F_1	49.58	48.18	48.88	87.33	79.57	83.46	9.31	8.72	9.02	6.99	6.65	6.82
F_2	60.88	65.30	63.09	104.70	107.21	105.96	12.59	14.93	13.76	9.56	10.23	9.90
F_3	61.72	66.99	64.36	119.57	127.35	123.46	14.61	13.90	14.26	12.63	13.28	12.96
F_4	63.77	69.78	66.77	113.75	117.14	115.45	17.79	19.65	18.72	15.83	16.18	16.00
F_5	65.03	70.57	67.80	132.78	135.17	133.97	21.19	19.54	20.37	18.78	18.62	18.70
SEm(±)	**2.12**	**1.94**	**1.57**	**3.48**	**4.00**	**3.22**	**0.4**	**0.44**	**0.24**	**0.12**	**0.26**	**0.11**
LSD (0.05)	**6.35**	**5.79**	**4.71**	**10.42**	**11.98**	**9.63**	**1.42**	**1.33**	**0.72**	**0.35**	**0.77**	**0.34**
Interaction												
SEm(±)	**3.00**	**2.74**	**2.22**	**4.92**	**5.66**	**4.55**	**0.67**	**0.63**	**0.34**	**0.16**	**0.36**	**0.16**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.49**	**NS**	**0.48**

Table 2:Yield attributes and grain yield of lathyrus as influenced by seed priming and different foliar sprays of nutrient during 2017-18 and 2018-19

Treatment	Plant population (plants m^{-2}) at 30 DAS			No. of pods pl^{-1}			Grain yield (kg ha^{-1})		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
A. Seed priming (S)									
S_1	108.80	106.80	107.80	40	47	43	1413.01	1303.40	1350.40
S_2	113.67	112.60	113.13	51	50	51	1532.00	1471.23	1508.99
SEm(±)	**1.01**	**0.79**	**0.58**	**1.2**	**0.31**	**0.40**	**38.00**	**4.61**	**2.81**
LSD (0.05)	**3.01**	**2.38**	**1.75**	**3.7**	**0.94**	**1.20**	**113.9**	**13.82**	**8.40**
B. Foliar sprays of nutrient (F)									
F_1	109.83	108.00	108.92	19	27	23	1267.00	1203.90	1235.20
F_2	108.33	107.83	108.08	41	37	39	1415.98	1331.48	1373.49
F_3	112.33	110.50	111.42	47	51	49	1481.10	1428.00	1451.26
F_4	112.67	111.67	112.17	57	58	57	1515.12	1438.77	1499.13
F_5	113.00	110.50	111.75	63	70	66	1682.00	1534.42	1589.39
SEm(±)	**1.59**	**1.26**	**0.92**	**2.0**	**0.49**	**0.63**	**60.10**	**4.61**	**4.44**
LSD (0.05)	**NS**	**NS**	**NS**	**5.9**	**1.48**	**1.89**	**180.00**	**13.82**	**13.28**
Interaction									
SEm(±)	**2.25**	**0.68**	**1.30**	**2.77**	**0.70**	**0.89**	**85.00**	**10.32**	**6.27**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**30.89**	**18.79**

Note : DAS-Days after sowing ; NS- Non-significant; S_1- No seed priming; S_2-Seed priming with Amm. molyb. @ 0.5 g/ kg seed;
F_1- No foliar spray; F_2- 2% Urea (once); F_3- 2% Urea(twice); F_4- 0.5% NPK 19:19:19(once); F_5- 0.5% NPK 19:19:19(twice)

Table 3: Productione conomics of lathyrus as influenced by seed priming and different foliar sprays of nutrient during 2017-18 and 2018-19

Treatment	Gross realization (Rs ha^{-1})			Net realization (Rs ha^{-1})			Benefit-cost ratio		
	2017-18	**2018-19**	**Pooled**	**2017-18**	**2018-19**	**Pooled**	**2017-18**	**2018-19**	**Pooled**
A. Seed priming (S)									
S1	51,799.37	56,080.63	53,940.01	22,583.77	23,059.64	22,821.71	1.77	1.69	1.73
S2	57,229.56	63,027.36	60,128.45	27,953.96	29,946.35	28,950.15	1.95	1.90	1.93
SEm(±)	**116.77**	**195.83**	**111.32**	**117.27**	**195.48**	**111.63**	**0.004**	**0.01**	**0.003**
LSD (0.05)	**349.63**	**586.34**	**333.32**	**351.12**	**585.31**	**334.25**	**0.01**	**0.02**	**0.01**
B. Foliar sprays of nutrient (F)									
F1	47,070.03	51,957.58	49,513.81	19,283.03	20,523.58	19,903.31	1.69	1.65	1.67
F2	52,429.67	57,230.07	54,829.86	23,604.66	24,626.07	24,115.37	1.82	1.76	1.79
F3	54,553.55	61,200.45	57,877.00	24,690.55	27,426.45	26,058.50	1.82	1.81	1.82
F4	57,721.93	61,730.13	59,726.03	28,541.93	28,771.13	28,656.53	1.98	1.87	1.93
F5	60,797.16	65,651.74	63,224.45	30,224.15	31,167.74	30,695.95	1.99	1.90	1.94
SEm(±)	**184.63**	**309.63**	**176.02**	**185.42**	**309.08**	**176.51**	**0.01**	**0.01**	**0.003**
LSD (0.05)	**552.81**	**927.09**	**527.02**	**555.17**	**925.45**	**528.50**	**0.02**	**0.03**	**0.01**
Interaction									
SEm(±)	**261.10**	**537.89**	**248.92**	**262.22**	**437.11**	**249.62**	**0.01**	**0.01**	**0.01**
LSD (0.05)	**NS**	**1311.12**	**745.32**	**NS**	**1308.78**	**747.42**	**NS**	**0.04**	**0.02**

(19:19:19) at pre-flowering and repeating it onceafter 15 days recorded tallest plants (133.97cm) at harvestand highest number of root nodules per plant (20.37) at 50 DAS in both the years under study (Table 1). Twice foliar spray of 0.5% NPK (19:19:19) recorded maximum values for yield attributes reflecting 28.7% in pooled estimation (Table 2) compared to no spray due to application of balanced nutrition. However, foliar spray of 2% urea at pre-flowering and 15 days after 1st spray registered yield advantage to the tune of 17.5%. The findings ofMaji *et al.* (2018) supported this finding. They reported that foliar feeding of 0.5 % NPK (19:19:9) at the same growth stages (pre-flowering and pod development stages) achieved superiorrelay lentil yield than the foliar application of 2.0 % urea. Reports of Mudalagiriyappa *et al*., 2016 prevail that foliar spray of chick pea @ 2.0 % of N:P:K (19:19:19) at flowering and pod development stagesresulted more secondary branches, total dry matter accumulation and yield components in terms of per plant podnumber and weight as well as final seed yield over control. Foliar spray of nitrogenous fertilizers at reproductive stages substantially improves grass pea productivity in rice fallows by slowing down the synthesisof abscisic acid, accelerating theproductionof cytokinin, increasing rate of photosynthetic, and facilitatingcurrent photosynthatestranslocationto reproductive organs. Active nodulation in legumes stops after 45-50 DAS (Sohrabi *et al*., 2012) as the demand for N is high at this period in pulse crops as the process gets slowed down due to switching over of the crop to its reproductive stage (Bhowmick *et al*., 2014). Inhibiting leaf senescence by foliar N remarkably promotes the apical dominance, cell elongation and shoot development in pulse crops (Attia and El-Dsouky, 2001; El- Kramany and Gobarah, 2005; El-Karmany*et al.*, 2003; Das and Jana, 2015; Das and Jana, 2016). Accordingly the highest monetory return and benefit cost ratio (1.94) were also obtained with the twice foliar spray of 0.5% NPK (19:19:19). Similar finding was reported by Navaz *et al*. (2017).

Interactions were significant only in seed yield, gross realization ha^{-1}, net realization ha^{-1} and benefit cost ratio, the factors seed priming and foliar sprays of nutrients interacted significantly during the both years as well as in the pooled estimation.

Based on the pooled values, seed yield of grass pea was found to be an exponential function of number of root nodules per plant and pods per plant (Fig. 1 and 2).

From the above findings, it can be concluded that an affordable combination of seed priming with Ammonium molybdate @ 0.5 g kg^{-1} seed along with foliar spray of 0.5% NPK (19:19:19) at pre-flowering stage and 15 days after the 1st spray may be recommended for is production of grass pea variety Ratan (Bio L- 212) under rice fallow situation in Lower Gangetic plains.

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