

Influence of Integrated Nutrient Management on Seed Quality of Field Pea (*Pisum sativum* L.)

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ABSTRACT: A study to assess the influence of integrated nutrient management comprising various combinations of manures (viz. FYM & Vermicompost), Biofertilizers (viz. Rhizobium & PSB) and inorganic fertilizers on seed quality of field pea revealed that rhizobium, PSB inoculation and 100% N dose produced better test weight, seed density, standard germination, seedling length, seedling dry weight, vigour index and electrical conductivity as compared to other treatments. Combined inoculation of biofertilizers along with 100% N proved most effective for producing maximum germination (98%) as compared to control (87%). Combined use of organic manure and inorganic fertilizers along with biofertilizers resulted in better seed quality of field pea.

Keywords: Field pea, Integrated nutrient management, Biofertilizers, Seed quality

Quality seed plays an important role in the agricultural production. Since the total cultivable area is decreasing due to fast growing population, the increased productivity is the only option to balance between demand and supply. The use of quality seeds may increase productivity of crop by 15-20 percent [1]. Field pea is a highly nutritive rabi season legume crop containing high percentage of digestible protein (21-25%), carbohydrates, vitamin A, C, calcium and phosphorus [2]. Dry shelled pea containing higher levels of amino acids, lysine and tryptophan with compared to cereal grains is marketed as human and livestock food. Being a legume crop it fixes nitrogen from the atmosphere by symbiotic relationship with *rhizobium* bacteria in the soil [3].

Integrated nutrient management (INM) helps maintaining soil fertility to an optimum level which is important to obtain maximum benefit for crop productivity. Further, application of excessive nutrients leads to declination of nutrient-use efficiency making fertilizer consumption uneconomical and it produce adverse effects on atmosphere [4] as well as groundwater quality [5]. While use of inorganic fertilizer alone is injurious to soil health and soil productivity, use of organic and bio-fertilizers enhances crop production and helps to sustain soil health [6]. INM is an essential step to address the twin concerns of nutrient excess and nutrient depletion [7-8]. Keeping in view the increasing demand of pulses, there is an urgent need to increase productivity. INM is not only a

great promise in crop productivity but also enhances the seed quality and its storability [9]. Therefore, it was felt important to study the effect of different combinations of organic and inorganic nutrient sources along with biofertilizers on seed quality of field pea.

MATERIAL AND METHODS

The field pea variety HFP 529 was grown at the research farm of Department of Seed Science & Technology, CCS Haryana Agricultural University under 23 treatment combinations of integrated nutrient management (Table 1). The details of treatments are as follow:

Recommended cultural practices were followed during the crop growth. The biofertilizers, *Rhizobium* and PSB @5ml/kg seed were used for seed treatment while 20 kg N and 40 kg P₂O₅/ha were used as recommended dose of inorganic fertilizer. FYM and vermicompost were used @20 t/ha and 5 t/ha, respectively.

The seed samples were taken from various treatment combinations and their seed quality was assessed by recording different parameters viz. test weight (g), seed density (g/cc), standard germination (%), seedling length (cm), seedling dry weight (g), seedling vigour index-I, seedling vigour index-II and electrical conductivity (mS cm⁻¹g⁻¹). All the experimentation was performed under Complete Randomized Design (CRD) and replicated thrice.

Table 1. Detail of different treatment combinations of Integrated Nutrient Management

Sr. No.	Treatment name	Treatment detail
1.	T ₀	Control
2.	T ₁	Vermicompost
3.	T ₂	Farm Yard Manure (FYM)
4.	T ₃	Recommended dose of Nitrogen
5.	T ₄	<i>Rhizobium</i> + 100% FYM
6.	T ₅	<i>Rhizobium</i> + 75% FYM
7.	T ₆	<i>Rhizobium</i> + 100% Vermicompost
8.	T ₇	<i>Rhizobium</i> + 75% Vermicompost
9.	T ₈	<i>Rhizobium</i> + 100% N
10.	T ₉	<i>Rhizobium</i> + 75% N
11.	T ₁₀	PSB + 100% FYM
12.	T ₁₁	PSB + 75% FYM
13.	T ₁₂	PSB + 100% Vermicompost
14.	T ₁₃	PSB + 75% Vermicompost
15.	T ₁₄	PSB + 100% N
16.	T ₁₅	PSB + 75% N
17.	T ₁₆	<i>Rhizobium</i> + PSB + 100% FYM
18.	T ₁₇	<i>Rhizobium</i> + PSB+ 75% FYM
19.	T ₁₈	<i>Rhizobium</i> + PSB + 100% Vermicompost
20.	T ₁₉	<i>Rhizobium</i> + PSB + 75% Vermicompost
21.	T ₂₀	<i>Rhizobium</i> + PSB + 100% N
22.	T ₂₁	<i>Rhizobium</i> + PSB + 75% N
23.	T ₂₂	RDF (Recommended dose of inorganic fertilizers)

The test weight was recorded by counting one thousand seeds and weighing them using digital balance. Average seed weight was expressed in grams. For seed density, one hundred seeds of each treatment in three replications were weighed and dipped in water separately. The volume of water displaced by the seeds was measured (cm³) and density was calculated following the formula:

$$\text{Seed density} = \frac{\text{Weight of 100 seeds (g)}}{\text{Volume of water displaced (ml)}}$$

The seeds from each treatment combination were tested for germination by adopting between paper towel method kept at optimum conditions of temperature (25°C) in four replications of 100 seeds [10]. The number of normal seedlings counted at the end of 7 days/number of seeds sown x 100 gave the seed germination percentage. The seedling length was recorded on 7th day by randomly selecting ten seedlings. The data were averaged and expressed in centimetres. These seedlings were then kept in a suitable paper packet and dried in hot air oven at a constant temperature of 80°C for three days. The dried samples were then cooled in desiccators and

weighed by using electronic balance and expressed in grams for obtaining data on dry weight. Seedling vigour index-I and II was calculated by multiplying germination percentage with seedling length and seedling dry weight respectively. In case of electrical conductivity, 50 normal and healthy seeds in three replications were soaked in 75 ml deionised water in 100 ml beakers. Seeds were immersed completely in water and beakers were covered with aluminium foil. Thereafter, these samples were kept at 25°C for 24 h. The electrical conductivity of the seed leachates was measured using a direct reading conductivity meter. The conductivity was expressed in mS/cm/seed.

RESULTS AND DISCUSSION

The combined application of inorganic and organic nutrients along with biofertilizers significantly influenced the seed quality. Data pertaining to test weight revealed significant treatment effects (Table 2). High test weight indicates bolder seed and consequently high seed vigour. The application of *Rhizobium*+ PSB+ 100% nitrogen (T₂₀) produced the maximum test weight (190 g) as compared to the other treatment combinations and control (150 g). The higher test weight may be due to availability of more amount of nitrogen and phosphorous due to inoculation of *rhizobium* and PSB leading to the accumulation of added metabolites in seeds as reported in chick pea [11] and moth bean [12]. A synergistic interaction emanating from the inputs in the effective treatments might have contributed to the higher test weight as previously recorded in pigeon pea [13] when seeds were inoculated with *Rhizobium*+ PSB+ FYM along with 100% RDF.

The same treatment T₂₀ produced the highest seed density (1.60 g/cc) also might be due to the accumulation of more food reserves in the seed as reported by Manzoor *et al.* [14]. The treatment T₂₀ recorded the highest mean for standard germination (98%) followed by T₂₁ (97.67%) and T₈ (97.33%). It was reported in urdbean that presence of higher level of metabolites in quality seeds helps robust embryonic growth during germination [15]. Also higher synthesis of seed germination hormone like gibberellins might trigger the activity of specific enzymes that promoted early germination, such as α -amylase that increase the availability of starch assimilation. The results are in accordance with previous findings in maize [16] and faba bean [17]. Considering seedling length again T₂₀ recorded the highest mean of 32.5 cm (Table 2). This might be a consequence of seed quality and test weight

obtained due to accumulation of higher quantities of seed constituents like carbohydrates, protein and other enzymes. Similar results were also reported in fenugreek [9] and mothbean [12]. Release of certain enzymes by metabolites which are responsible for conversion of macromolecules into micromolecules within the seed and increase in mobilization efficiency which lead to the increase in seedling length. The increase in seedling length was due to higher root and shoot length which in turn can be attributed to presence of higher amount of stored food material. The treatment T₂₀ yielded highest mean followed by T₂₁ which again might be due to highest and second highest mean obtained for the above characters in these treatments (Table 2). Higher vigour index might be ascribed to the better source to sink relationship which resulted in better development of seeds giving rise to higher germination and vigour index. Similar results were reported by in soybean [18].

Seedling vigour index is very important character as it determines the actual germinability of seed (planting

value) under field conditions. It also shows the vigour of seed to germinate under adverse soil and temperature conditions. Availability of macronutrients from inorganic sources and bio-inoculants had positive effect on germination and seed quality (bold seeds) that directly improves vigour index. The results are in close conformity with the previous finding in fennel [19]. The treatment T₀ (control) had the lowest seedling vigour which might be due to poor performance of seed related trials in the control which received no fertilizers.

Application of organic and inorganic fertilizers alone or in combination with biofertilizers significantly influenced the electrical conductivity of seed. Among the various treatment combinations, the lowest electrical conductivity (0.74 mS/cm/g) was recorded in T₂₀ (*Rhizobium*+ PSB+ 100% nitrogen) followed by T₂₁ (0.75 mS/cm/g). The highest electrical conductivity (0.95 mS/cm/g) was recorded in control (T₀). The inoculation of PSB and *Rhizobium* along with the inorganic nitrogen increased the availability of nutrients and their efficiency for the

Table 2. Mean Performance of Different Treatment Combinations for Seed Quality Parameters of Field Pea (*Pisum sativum* L.)

Treatments	Test weight (g)	Seed density (g/cc)	Standard germination (%)	Seedling length (cm)	Seedling dry weight (g)	Vigour Index-I	Vigour Index-II	EC (mS/cm/g)
T ₀ CONTROL	150.33	1.20	87.33	23.37	0.300	2041	26.00	0.950
T ₁ VERMICOMPOST	151.00	1.22	87.67	24.03	0.303	2107	26.59	0.940
T ₂ FYM	152.00	1.24	88.33	24.50	0.310	2164	27.24	0.930
T ₃ NITROGEN	153.67	1.27	88.67	25.10	0.310	2226	27.69	0.917
T ₄ R+FYM100	168.33	1.45	93.00	28.93	0.403	2691	37.70	0.820
T ₅ R+FYM75	164.33	1.43	92.33	27.87	0.380	2573	35.30	0.833
T ₆ R+VC 100	158.00	1.35	90.33	26.17	0.337	2364	30.35	0.880
T ₇ R+VC75	155.33	1.30	89.67	25.80	0.323	2313	28.99	0.893
T ₈ R+N100	187.67	1.58	97.33	31.50	0.490	3066	47.50	0.757
T ₉ R+N75	183.67	1.55	95.67	30.70	0.470	2937	45.19	0.780
T ₁₀ PSB+FYM100	166.33	1.44	92.67	28.40	0.393	2632	36.45	0.830
T ₁₁ PSB+FYM75	162.00	1.41	92.00	27.33	0.370	2515	33.86	0.840
T ₁₂ PSB+VC100	156.00	1.33	90.00	26.03	0.330	2343	29.55	0.890
T ₁₃ PSB+VC75	154.33	1.29	89.00	25.43	0.320	2264	28.39	0.900
T ₁₄ PSB+N100	185.67	1.56	96.67	31.27	0.480	3022	46.56	0.770
T ₁₅ PSB+N75	174.00	1.50	94.33	29.90	0.450	2821	42.39	0.800
T ₁₆ R+PSB+FYM100	181.00	1.53	95.00	30.43	0.460	2891	43.92	0.787
T ₁₇ R+PSB+FYM75	178.33	1.52	94.67	30.03	0.460	2843	43.45	0.793
T ₁₈ R+PSB+VC100	160.33	1.39	91.67	27.00	0.353	2475	32.58	0.850
T ₁₉ R+PSB+VC75	159.00	1.38	91.33	26.60	0.343	2430	31.30	0.860
T ₂₀ R+PSB+N100	190.00	1.60	98.00	32.50	0.500	3185	48.74	0.740
T ₂₁ R+PSB+N75	188.67	1.59	97.67	32.17	0.493	3142	48.28	0.750
T ₂₂ RDF	170.00	1.47	93.33	29.33	0.427	2738	39.73	0.810
C.D.	1.696	0.013	1.069	0.514	0.006	54.001	0.683	0.005
SE(m)	0.594	0.004	0.374	0.180	0.002	18.909	0.239	0.002
C.V.	0.614	0.543	0.701	1.112	0.922	1.260	1.138	0.351

growth of plant and seed development in T₂₁ which in turn increased the cell membrane stability and resulted in lesser leakage of solutes from the seeds. Similar findings were reported in chickpea [20]. Lowest EC of pea seeds in T₂₀ may be attributed due to higher membrane integrity because of high phosphorous content in plant system due to applied phosphorous solubilizers.

CONCLUSION

The present experiment emphasizes the positive effect of INM modules on seed quality. Biofertilizers both rhizobium and PSB in combination with nitrogen exhibited significant spectacular performance on seed quality of field pea as compared to the other INM treatment combinations applied in the present experiment.

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