



Yield and Quality of Isabgol (*Plantago ovata* Forsk) as Influenced by Planting Geometry and Nutrient Levels under Eastern Dry Zone of Karnataka

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was laid out in a Factorial Randomized Block Design with sixteen treatments and replicated three times. The result indicated that the spacing of 22.5cm recorded significantly maximum number of spikes (36.50), seed yield (1221 kg /ha), husk yield (305 kg/ha), swelling factor (13.70 cc /g) and protein content (11.91%) in the seeds. Among the different nutrient levels, maximum number of spikes (35.79), seed yield (904 kg /ha), husk yield (225 kg/ha), swelling factor (13.93 cc /g) and protein content (12.24 %) of seeds were obtained with the application of 75 % RDF (37.5:18.75:22.50 + 7.5 t FYM.) and the interaction of row spacing of 22.5 cm and 75% RDF recorded maximum yielded and quality parameters found non significant.

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1. INTRODUCTION

Due to its diverse ecosystems, India is the world's bowl of medicinal and aromatic plants. Isabgol (*Plantago ovata* Forsk) is an important medicinal crop from the plantaginaceae family. Only two species of genus *Plantago* are under cultivation viz., *P. ovata* and *P. psyllium*. The seed husk of *P. ovata* is superior in terms of swelling qualities, colourlessness, better pharmaceutical and cosmetic importance and therefore, it has replaced the *P. psyllium* from the world market.

The plant is native to Persia and West Asia, stretching from the Sulej to Sind and West Pakistan. The plant has adapted well to the climates of Mexico and the Mediterranean.

Isabgol is stem less or short stemmed highly cross pollinated annual herb attains a height of 30 to 40 cm, has alternate leaves, clasping the stem, strap-like recurved, 2.5 to 7.5 cm long, narrow, varying from 6.0 mm to 12.0 mm in width, tapering to point, three nerved, entire or toothed, coated with fine hairs. The flowers are white, tiny, and divided into four sections. The capsule is ovate, 8.0 mm long, 2-celled, the top half lifting up when ripe, releasing the smooth, dull, ovate seeds, 1.8 to 3.8 mm long, pinkish-grey brown or pinkish white with a brown streak on the convex surface. The seeds are covered by a clear, odourless, and tasteless membrane known as husk [1].

In English, Isabgol is known as "Blond Psyllium," and in Sanskrit, it is known as "Shlakshnajira Shignabya." Its seed and husk (bhussi) are both used in traditional medicine. Isabgol seeds are admired for their mucilaginous husk, which contains about 30% mucilage and hemicellulose, which is primarily made up of xylose, arabinose, galacturinic acid, rhaminose, and galactose. Reserve carbohydrates, mostly pantosans, make up the mucilage [2]. The seeds also contain semi-drying fatty acids (5%), a small amount of acubin, and tannin, an active ingredient with an acetyl chlorine-like action. It is used as an anti-diarrhea medication because of its high water absorbing ability. Since it is a natural medicine with no side effects, its popularity as a household medicine in the United States and other Western European countries is growing. It's a cervical dilator that's used to end a pregnancy. [3]. It is also used in the dyeing calico printing and in ice cream industry as a stabilizer [4]. The seed

stabilizer husk is used as a cattle feed and contains 17-19 per cent protein.

2. MATERIALS AND METHODS

The study was laid out in FRCBD with sixteen treatment combinations having three replications having T₁- 22.5 cm Row spacing + 75% RDF (37.5:18.75:22.50 + 7.5 t FYM), T₂- 22.5 cm Row spacing + 100% RDF (50:25:30 + 10 t FYM), T₃- 22.5 cm Row spacing + 125% RDF (62.5:31.25:37.50 + 12.5 t FYM), T₄- 22.5 cm Row spacing + 100% RDN through FYM + 10 t FYM, T₅- 30 cm Row spacing + 75% RDF (37.5:18.75:22.50 + 7.5 t FYM), T₆- 30 cm Row spacing + 100% RDF (50:25:30 + 10 t FYM), T₇- 30 cm Row spacing + 125% RDF (62.5:31.25:37.50 + 12.5 t FYM), T₈- 30 cm Row spacing + 100% RDN through FYM + 10 t FYM, T₉- 37.5 cm Row spacing + 75% RDF (37.5:18.75:22.50 + 7.5 t FYM), T₁₀- 37.5 cm Row spacing + 100% RDF (50:25:30 + 10 t FYM), T₁₁- 37.5 cm Row spacing + 125% RDF (62.5:31.25:37.50 + 12.5 t FYM), T₁₂- 37.5 cm Row spacing + 100% RDN through FYM + 10 t FYM, T₁₃- 45 cm Row spacing + 75% RDF (37.5:18.75:22.50 + 7.5 t FYM), T₁₄- 45 cm Row spacing + 100% RDF (50:25:30 + 10 t FYM), T₁₅- 45 cm Row spacing + 125% RDF (62.5:31.25:37.50 + 12.5 t FYM), T₁₆- 45 cm Row spacing + 100% RDN through FYM + 10 t FYM.

2.1 Methods of Imposing the Treatments

One week prior to sowing, a full dose of FYM was added and thoroughly mixed with the soil. Nitrogen was applied in the form of urea, phosphorous was applied in the form of single super phosphate, and potash was applied in the form of muriate of potash. Fifty percent nitrogen, as well as the maximum doses of phosphorous and potassium, were added to the plot at a depth of 7-10 cm in the lines just before seeding, and the remaining fifty percent nitrogen was top dressed 45 days after sowing.

The seeds were harvested from the net plot area (7.20 m²), and the husk from the seeds was separated and weighed separately. The yield per hectare was calculated using the net plot yield.

2.2 Procedure for Estimation of Swelling Factor and Protein Content in Seeds

One gram of seed husk placed in 50 ml centrifuge tube and added with 40 ml water. The

contents were kept overnight after thorough mixing. The contents of the tube were centrifuged for 5 minutes at 5000 rpm the next day. The volume of the gel and swollen seeds were measured and expressed in cubic centimetres per gram after the gel settled down and clear liquid separated on top.

The seed's protein content was calculated by multiplying the nitrogen content by a factor of 6.25 and expressing the result in percentages.

3. RESULTS AND DISCUSSION

3.1 Yield Parameters

Plants with a row spacing of 22.5 cm produced the most spikes (36.50), followed by plants with a

row spacing of 30 cm. The optimal spacing may have resulted in more spikes being generated per plant. This may be due to the optimal space available for each plant to be exposed to light, resulting in proper spike growth. Shivran [5] and Khan et al. [6] in isabgol and Abbaszadeh et al. [7] in *Satureja sahendica* found similar results. The plants supplied with 75% RDF (37.5:18.75:22.50 + 7.5 t FYM) recorded maximum number of spikes (35.79) followed by plants supplied with 100% RDF (50:25:30 + 10 t FYM). The increase in number of spikes may be due to the fact that NPK and FYM application accelerated the enhanced of leaf number, which are positively correlated with the number of spikes. Similar results were reported by Degra [8], Utgikar et al. [9] and Maheshwari et al. [10] in isabgol. The row spacing of 22.5 cm and 75%

Table 1. Influence of planting geometry and nutrient levels on yield parameters in Isabgol

Treatment	Number of spikes	Seed yield	Husk yield
Spacing (S)			
S ₁ (22.5 cm)	36.50	1221	305
S ₂ (30 cm)	36.11	902	225
S ₃ (37.5cm)	31.97	661	165
S ₄ (45 cm)	27.55	496	123
S.Em ±	0.31	6.08	1.33
CD @ 5%	0.89	17.58	3.86
Nutrient levels (N)			
N ₁ -75 % RDF (37.5:18.75:22.50 + 7.5 t FYM)	35.79	904	225
N ₂ - 100 % RDF (50:25:30 + 10 t FYM)	34.47	866	216
N ₃ -125 % RDF (62.5:31.25:37.50 + 12.5 t FYM)	32.81	803	200
N ₄ -100% RDN through FYM + 10 t FYM)	29.05	706	176
S.Em ±	0.31	6.08	1.33
CD @ 5%	0.89	17.58	3.86
Interaction (SXN)			
S ₁ N ₁	39.28	1348	337
S ₁ N ₂	37.98	1311	327
S ₁ N ₃	36.98	1199	299
S ₁ N ₄	31.79	1028	257
S ₂ N ₁	39.16	1006	251
S ₂ N ₂	38.21	976	244
S ₂ N ₃	35.67	868	216
S ₂ N ₄	31.41	758	189
S ₃ N ₁	34.57	705	176
S ₃ N ₂	33.91	683	170
S ₃ N ₃	31.85	668	167
S ₃ N ₄	27.57	588	147
S ₄ N ₁	30.17	556	138
S ₄ N ₂	27.83	496	123
S ₄ N ₃	26.76	478	119
S ₄ N ₄	25.46	452	113
S.Em ±	0.62	12.17	2.67
CD @ 5%	1.79	35.16	7.72

Note: DAS= Days After Sowing, RDF= Recommended Dose of Fertilizers, RDN= Recommended Dose of Nitrogen, FYM= Farm Yard Manure

Table 2. Influence of planting geometry and nutrients on swelling factor (cc/g) and protein content in seeds (%) in Isabgol

Treatment	Swelling factor(cc/g)	Protein content in seeds (%)
Spacing (S)		
S ₁ (22.5 cm)	13.70	11.91
S ₂ (30 cm)	13.70	11.81
S ₃ (37.5cm)	13.43	11.61
S ₄ (45 cm)	13.19	11.43
S.Em ±	0.08	0.08
CD @ 5%	0.25	0.25
Nutrient levels (N)		
N ₁ -75 % RDF (37.5:18.75:22.50 + 7.5 t FYM)	13.93	12.24
N ₂ - 100 % RDF (50:25:30 + 10 t FYM)	13.62	11.99
N ₃ -125 % RDF (62.5:31.25:37.50 + 12.5 t FYM)	13.36	11.57
N ₄ -100% RDN through FYM + 10 t FYM)	13.08	10.93
S.Em ±	0.08	0.08
CD @ 5%	0.25	0.25
Interaction (SXN)		
S ₁ N ₁	14.05	12.51
S ₁ N ₂	13.86	12.19
S ₁ N ₃	13.75	11.75
S ₁ N ₄	13.16	11.19
S ₂ N ₁	14.10	12.37
S ₂ N ₂	13.86	12.13
S ₂ N ₃	13.66	11.68
S ₂ N ₄	13.17	11.07
S ₃ N ₁	13.82	12.19
S ₃ N ₂	13.69	11.93
S ₃ N ₃	13.11	11.51
S ₃ N ₄	13.13	10.82
S ₄ N ₁	13.79	11.93
S ₄ N ₂	13.11	11.76
S ₄ N ₃	12.96	11.37
S ₄ N ₄	12.90	10.69
S.Em ±	0.17	0.17
CD @ 5%	NS	NS

Note: DAS=Days After Sowing, RDF= Recommended Dose of Fertilizers, RDN= Recommended Dose of Nitrogen, FYM= FarmYard Manure, NS= Nonsignificant

RDF (37.5:18.75:22.50 + 7.5 t FYM) recorded maximum number of spikes per plant (39.28) and was *on par* with the 22.5 cm row spacing +100% RDF (50:25:30 + 10 t FYM), 30 cm row spacing + 75% RDF (37.5:18.75:22.50 + 7.5 t FYM) and 30 cm row spacing + 100% RDF (50:25:30 + 10 t FYM). The minimum number of spikes (25.46) per plant was recorded with 45 cm row spacing + 100% RDN through FYM. This increase may be attributed to optimum plant density and supplied balanced nutrients and their combined synergetic effects. The row spacing of 22.5 cm has recorded significantly maximum seed and husk yield (1221 and 305 kg/ha). The lower seed and husk (496 and 123 kg/ha) was recorded at the

wider row spacing of 45 cm. The seed and husk yield of isabgol was more at optimum plant population. The maximum seed and husk yield might be due to higher plant population per unit area as compared to wider spacing and adequate supply of NPK and FYM to plants in balanced proportion increased seed and husk yield. These results are in accordance with the findings of Shivran [5], Phatak et al. [11] in glory lily and Agba et al. [12] in *Mucuna flagellipes*.

Application of optimum levels of NPK through 75% RDF (37.5:18.75:22.50) + 7.5 t FYM, significantly increased seed and husk yield. The increased seed and husk yield might be due to

better nutritional status of the crop in the soil as evidenced by their uptake in the plant. The optimal supply of NPK and FYM, as well as their higher absorption by plants, may have accelerated various physiological processes in the plant, resulting in increased growth and yield parameters, as well as increased seed and husk yield. The findings of this study agree with Singh and Sharma [13], Utgikar et al. [9] and Tripathi et al. [14] in isabgol, and Phatak et al. [11] in glory lily.

The maximum seed and husk yield (1348 kg /ha and 337 kg/ha) was recorded with 22.5 cm Row spacing + 75% RDF (37.5:18.75:22.50 + 7.5 t FYM). This increase may be attributed to optimum plant density and balanced nutrients and their combined effects. The results of present investigation are in conformity with those of Bature et al. [15] in mucuna, Mary et al. (2018) in chia and Meena et al. [16] in fenugreek.

3.2 Quality Parameters

The higher swelling factor (13.70 cc /g) was recorded with row spacing of 22.5 cm, which was *on par* with the spacing 30 cm (13.70 cc /g). The minimum swelling factor was found with 45 cm (13.19 cc /g). The protein content (11.91%) in the seeds was maximum with 22.5 cm spacing, which was *on par* with the row spacing of 30 cm ((11.81%). The lower protein content (11.43%) was recorded with 45 cm. These observations are in agreement with the findings of Patil and Laloraya [17] in *solanum viarum*, Nandi and Chatterjee [18] in senna and Joy et al. [19] in *curculigo orchioides*. Significant increase in protein concentration from 10.69 to 12.51 per cent and swelling factor from 12.90-14.05 cc/g with 75% RDF (37.5:18.75:22.50 + 7.5 t FYM) has been observed. Increased nitrogen availability to plants may explain the higher nitrogen concentration in seed. Furthermore, higher nitrogen concentrations may be the result of increased nitrate reductase enzyme activity. More nitrogen concentration in seed is directly responsible for higher protein because it is a primary component of amino acids which constitutes the basis of protein. The use of organic and inorganic fertilisers significantly increased the mucilage yield of isabgol, which can increase the available nutrients for plant roots and boost the photosynthesis process. As a result, a higher percentage of seed mucilage can lead to increased swelling potential in isabgol [20]. These findings in isabgol are similar to those of Massoud et al. [21] and Utgikar et al. [8].

Non- significant results were obtained for protein content and swelling factor in the seeds due to interaction of planting geometry and levels of nutrients.

4. CONCLUSION

The present investigation revealed that, 22.5 cm row spacing +75% RDF (37.5:18.75:22.50+7.5 t FYM) has resulted in better yield and quality .Therefore, it may be recommended for commercial cultivation of isabgol under Eastern dry zone of Karnataka.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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