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Effect of different varieties and fertility levels on growth characters, yield and economics of Isabgol (*Plantago ovata*) production

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Abstract

A field experiment was conducted in Experimental Area of Department of Soil Conservation and Water Management, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur during *Rab*i 2013-14 and 2014-15 to assess the effect of different varieties and fertility levels on Isabgol (*Plantago ovata)* production. Three varieties of Isabgol viz. GI-1, Niharika and Mayuri and three levels of nitrogen fertility (N_{20}, N_{40}, N_{60}) 20 kg ha^{-1}, 40 kg ha^{-1}, and 60 kg ha^{-1} comprises 9 treatment combinations. The experiment was laid out in Factorial Randomized Block Design and replicated thrice. The results of experiment revealed that maximum plant height was observed in Niharika followed by GI-1 and minimum in improved variety Mayuri. However, trend of all other growth characters viz. plant spread, number of tillers per plant, days taken to maturity and yield attributes viz. number of spikes per plant, length of spike, seeds per spike, test weight along with seed and husk yield was observed significantly highest with the application of 60 kg ha^{-1} N with Mayuri followed by 40 kg ha^{-1} N + Niharika while lowest was in GI-1. Economic analysis revealed that the highest net returns were recorded with 60 kg ha^{-1} N and Mayuri (Rs 61752.28 and 62407.88 ha^{-1}) followed by 40 kg ha^{-1} N and Mayuri (Rs 52766.68 and 53833.48) during both the years respectively. Also the highest benefit cost ratio was recorded with 60 kg ha^{-1} N and Mayuri (2.10 and 2.33). However, keeping in view the soil health and productivity as a whole, application of 60kg ha^{-1} N and Mayuri found best among all the treatments.

Keywords: Isabgol varieties, growth characters, yield, fertility and economics

1. Introduction

Isabgol thrives well in warm-temperate regions. It requires cool and dry weather and is sown during winter months. Sowing during first week of November gives best yield. Early sowing makes the crop vulnerable to downy mildew disease, whereas late sowing provides lesser period of growth in winter along with possibility of shattering of seed due to summer rains in April-May. Lekh Chand Dadheech, (2008) [1] observed that sowing dates, fertility levels and farmyard manure give favourable effects on growth and yield of Isabgol (*Plantago ovata*). At maturity, if the weather is humid, its seeds shatter resulting reduction in yield. Heavy dew or even a light shower will proportionately decrease the yield, at times leading to even total loss of the crop.

Isabgol (*Plantago ovata* Forsk) is a major medicinal plant in India. It is indigenous to the Mediterranean region and West Asia and introduced into India during Muslim settlement in the middle ages. It is also known as Psyllium, Isabgol or 'Spogel' seeds. In Sanskrit literature, it is mentioned as Shlakshanajira or Isabgol. The name Isabgol is derived from two Persian words 'isap' and 'ghol' meaning a horse ear, referring to the characteristic shape of its seed. It is a natural food that is cooling, soothing, softening, prevents acidity, heart attacks and constipation, and non-addictive to boot. From high-fiber breakfast cereals, breads and ice cream to medicines, Isabgol is now a popular ingredient for food product designers. The seeds and husk of *Plantago ovata* Forsk are used in 60 traditional and modern systems of medicine. Seeds are cooling, demulcent, useful in inflammatory and bilious derangement of the digestive system, applied as poultice to rheumatic and gouty swelling, good in dysentery and irritation of the intestinal tract, decoction is useful in cough diarizing. The husk from the seeds has the property of absorbing and retaining water and hence, it works as an anti-diarrhea drug. In the

Indian pharmacopeia, it is specified that husk should not contain more than 2% foreign organic matter, 2.9% ash and 0.45% acid insoluble ash, swelling factor of the husk is 40-90% as compared with 10.25 to 13.50% for seed. The outer seed coat contains hydro colloidal polysaccharides i.e. mucilage, cellulose fixed oil, sterols and proteins, starch, sugar etc. The mucilage of Isabgol is colloidal in nature, which is comprised of xylose, arabinose, galacturonic acid, rhamnose and galactose (Salyers *et al.* 1978) [2].

Plantago ovata can be grown on a variety of soils. It is an irrigated crop which grows well on light soils, but soil with poor drainage is not conducive for good growth of this crop. A silty-loam soil having a soil pH from 4.7 to 7.7 with high nitrogen and low moisture content is ideal for growth of plants and high yield of seeds. It does, not require high amount of chemical fertilizers and heavy irrigation. Moradi *et al.* (2010) [12] observed that Isabgol response to irrigation intervals and different fertility levels. However, the balanced application of nutrients improves yield and quality of seed husks.

2. Materials and Methods

A field experiment was conducted during two consecutive rabi seasons of 2013-14 and 2014-15 to assess the effect of different varieties and fertility levels on growth characters, yield and economics of Isabgol (*Plantago ovata*) production at Soil Conservation and Water Management Farm of C.S.A.U.A & T., Kanpur. Geographically Kanpur is located of 26.30° N Longitude of 80.37° E and above 125-9 meters above mean sea level. Three varieties of Isabgol viz. GI-1, Niharika and Mayuri and three levels of fertility (N_{2o}, N_{4o}, N_{6o}) comprises 9 treatment combinations. The experiment was laid out in Factorial Randomized Block Design and replicated thrice. The seed of isabgol @ 3-4kg ha^{-1} was sown in furrow by desi plough keeping row to row distance of 20 cm. The crop of isabgol was sown on 26.10.2013 and 28.10.2014 and harvesting was done on 08.04.2014 and 10.04.2015 during first and second year of investigation. The crop of isabgol was fertilized as per treatment requirement. The half dose of nitrogen and full dose of phosphorus and potash was applied at the time of sowing, remaining half dose of nitrogen was top dressed after 1st irrigation. The collected data on growth characters and yield was subjected to statistical analysis using the Fischer's method of analysis variance technique as given by Panse and Sukhatme (1967) [3].

3. Results and Discussion

i) Growth characters

Data pertaining to growth parameters viz., plant height (cm), plant spread (cm), number of tiller per plant, days taken to 50% flowering, days taken to crop maturity, number of spike per plant, length of spike, seeds per spike, and 1000 seeds weight of isabgol as influenced by different varieties and fertility levels during 2013-14 and 2014-15 have been presented in Tables (1), (2) and (3).

The height of plant was recorded at flowering stage. It appears from the table that there was significant effect of fertility levels (N) and varieties to enhance the plant height which varied from 23.10 to 29.18 cm and 22.34 to 25.13 cm. The maximum mean plant height was measured in Niharika (27.11 and 26.06 cm) followed by GI-1 (25.60 and 24.47 cm). While it was minimum in Mayuri (23.92 and 22.88 cm). Similarly, the application of higher level of 60 kg ha^{-1} N significantly increased the plant height (27.63 and 26.55 cm) followed by 40kg ha^{-1} N (25.90 and 24.83cm) while lowest plant height was in 20kg ha^{-1} N (23.10 and 22.03 cm) during 2013-14 and 2014-15, respectively. Similar results have also been reported by Maheshwari *et al.* (2000) [10] and Utgikar *et al.* (2003) [17]

Plant spread also effected by fertility leves. There was slight increase in plant spread due to increase in the level of fertility. Nitrogen application 60 kg ha^{-1} N gave highest spread and minimum spread was seen in 20 kg ha^{-1} N. Maximum spread exhibited by variety Mayuri (12.02 and 11.60 cm) followed Niharika (10.94 and 10.50 cm) While minimum in GI-1 (9.40 and 8.99 cm). Among all the treatments, Mayuri variety along with 60 kg ha^{-1} N was found best treatment combination in respect to plant spread (13.27 and 12.86 cm) as compared to other treatment combination during 2013-14 and 2014-15, respectively.

The number of tillers per plant was significantly affected by varieties of isabgol. The maximum number of tillers per plant (28.45 and 28.15) was recorded with Mayuri followed Niharika and minimum number was observed in the treatment. Similarly, the application of 60kg ha^{-1} N produced highest number of tillers followed 40 kg ha^{-1} N while minimum was counted in 20 kg ha^{-1} N during 2013-14 and 2014-15, respectively. Similar results have also been reported by Utgikar *et al.* (2003) [17]

The data indicated that the days taken to 50% flowering was significantly affected by different fertility and varieties. The minimum days (67.02 and 66.11day) was taken by the variety of Mayuri followed by Niharika (69.49 and 68.58 day). While late flowering was seen in GI-1. Among the levels of fertility, the maximum day taken to 50% flowering (71.46 and 70.54 day) was reported with the application of 60 kg ha^{-1} N. The interaction effect variety and fertility was non-significant during 2013-14 and 2014-15, respectively. Similar results have also been reported by Lal *et al.* (1999) [9]

The minimum days was taken for crop maturity by Isabgol variety Mayuri (108.62 and 105.69 day) and maximum period was recorded in GI-1 (128.61 and 125.67 day). It has been noticed that the application of higher dose of fertility 60 kg ha^{-1} N delayed the crop maturity (127.35 and 124.42 day) followed by 40 kg ha^{-1} N while minimum day was taken where with application of 20 kg ha^{-1} N fertilizers. It apparent from the data shown in table that days taken to crop maturity were significant affected by fertility and varieties during 2013-14 and 2014-15, respectively.

It is obvious from the data that the maximum number of spike per plant (20.67 and 20.21) was recorded in the variety of Mayuri followed by Niharika and lowest was founded in GI-1 (18.17 and 17.71). Among the levels of fertility, the maximum number of spike (21.37 and 20.91) was recorded with application of 60 kg ha^{-1} N. No significant differences were recorded in number of spike per plant due to interaction effect between fertility and variety during 2013-14 and 2014-15, respectively. Similar results have also been reported by Ramesh *et al.* (1989) [14] and Singh *et al.* (1994) [16]

The observations clearly revealed that the length of spike was significantly increased due to both fertility and varieties which varied from (2.60 to 4.35cm) and (1.52 to 3.27 cm). It is apparent from table 3 that maximum length of spike (4.00 and 2.93 cm) was recorded in Mayuri and lowest was in GI-1 (3.26 and 2.18 cm). Among fertility levels, the maximum length (4.15 and 3.03 cm) was recorded under 60 kg ha^{-1} N followed by 40 kg ha^{-1} N and minimum in 20 kg ha^{-1} N while the interaction effect was non-significant during 2013-14 and

2014-15, respectively. Similar results have also been reported by Lal *et al.* (1999) [9] and Maheshwari *et al.* (2000) [10]

The seeds per spike was significantly increased due to both fertility and varieties which varied from (69.10 to 84.50) and (67.19 to 82.05). The maximum average seed per spike (81.93 and 80.03) was recorded under Mayuri followed by Niharika (78.79 and 76.88) and lowest under GI-1 (75.21 and 73.30). Among the levels of fertility, the maximum seed per spike (82.96 and 81.05) was recorded at 60 kg ha^{-1} N followed by 40 kg ha^{-1} N but the difference between these was significant during 2013-14 and 2014-15, respectively. Similar results have also been reported by Utgikar *et al.* (2003) [17]

1000 seeds weight-

The test weight of Isabgol seed was significantly increased with variety in Mayuri. The maximum test weight of seed was obtained (2.00 and 1.92 g. per 1000 seeds) at higher level of 60 kg ha^{-1} N while it was lowest in GI-1. However, the interaction effect between variety and fertility were not significant during 2013-14 and 2014-15, respectively. Similar results have also been reported by Singh *et al.* (1994) [16] and Siani *et al.* (2011) [15]

Yield

The data on seed, seed husk yield (q ha^{-1}), and swelling of seed husk(cc water per gram) of isabgol as influenced by different varieties and fertility levels during 2013-14 and 2014-15 have been presented in Table (4).

The data reveal that the seed yield increased significantly with increasing the levels of fertility and varieties. The maximum seed yield (11.50 and 10.48 qha^{-1}) was recorded in Mayuri followed by Niharika and lowest yield was recorded in GI-1 (7.85 and 6.84 qha^{-1}). Similarly, higher fertility dose 60 kg ha^{-1} N gave maximum seed yield of Isabgol (10.84 and 9.8 qha^{-1}) followed 40 kg ha^{-1} N However lowest seed yield was recorded in 20 kg ha^{-1} N (5.84 and 6.84 q ha^{-1}). However, no significant interaction were observed between variety and fertility during 2013-14 and 2014-15, respectively. Similar results have also been reported by Singh *et al.* (1994) [16], Deore *et al.* (2002) [16], Utgikar *et al.* (2003) [17], Choudhary *et al.* (2014) [5] and Patel *et al.* (1996) [13]

The husk yield was significantly varied with changing the variety. The highest seed husk (2.26 and 2.02 qha^{-1}) was obtained in Mayuri (2.26 and 2.25 qha^{-1}) followed by Niharika (2.07 and 1.84 qha^{-1}) and lowest husk yield was obtained in GI-1 (1.84 and 1.57 qha^{-1}). The other hand, the application of 60 kg ha^{-1} N had responded better to higher seed husk yield (2.28 and 2.02 qha^{-1}) followed by 40 kg ha^{-1} N and lowest after application of 20 kg ha^{-1} N (1.81 and 1.59 qha^{-1}). Among all the treatments, the best combination was Mayuri and 60 kg ha^{-1} N as compared to other treatment combination during 2013-14 and 2014-15, respectively. Similar results have also been reported by Lal *et al.* (1999) [9]

Swelling of seed husk (cc water per gram)

The maximum swelling of seed husk (11.58 and 10.49) was recorded under Isabgol variety Mayuri followed by Niharika (10.74 and 9.65) and lowest in GI-1 (9.92 and 9.08). Similarly, the application of high level of fertility increased the swelling of seed husk 60 kg ha^{-1} N (11.30 and 10.22) and it was lowest in 20 kg ha^{-1} N (10.25 and 9.23). No remarkable interaction was observed between fertility and variety during 2013-14 and 2014-15, respectively. Similar findings have also been reported by Utgikar *et al.* (2003) [17]

iii) Economics

The data on total income (Rs ha^{-1}), net returns (Rs ha^{-1}) and benefit cost ratio of isabgol as influenced by different varieties and fertility levels during 2013-14 and 2014-15 have been presented in Table (5).

The highest total income (Rs 90650 and 89175 ha^{-1}) were obtained with the application of 60 kg ha^{-1} N and Mayuri variety of Isabgol followed by 40 kg ha^{-1} N and Mayuri (Rs 81410 and 80325 ha^{-1}). The lowest total income was observed with 20kg ha^{-1} N and GI-1 (Rs 47950 and 43425 ha^{-1}) during 2013-14 and 2014-15, respectively.

The highest net return was recorded with 60 kg ha^{-1} N and Mayuri variety of Isabgol (Rs 61752.28 and 62407.88 ha^{-1}) followed by 40 kg ha^{-1} N and Mayuri (Rs 52766.68 and 53833.48 ha^{-1}). The lowest net return was observed with 20 kg ha^{-1} N and GI-1 (Rs 19561.71 and 17209.08 ha^{-1}) during 2013-14 and 2014-15, respectively. Similar results have also been reported by Mann and Vyas (2001) [11], Wankhade *et al.* (2005) [18] and Kulmi and Tiwari (2005) [8]

Application of 60 kg ha^{-1} N and Mayuri variety of Isabgol recorded cost benefit ratio (2.10 and 2.33) followed by 40 kg ha^{-1} N and Mayuri (1.84 and 2.03). The minimumt cost benefit ratio was observed with 20 kg ha^{-1} N and GI-1 (0.68 and 0.66) during 2013-14 and 2014-15, respectively. Similar results have also been reported by Kattimani and Hindiholi (2009) [7] and Choudhary *et al.* (2013) [4]

Table 1: Effect of different fertility levels and varieties on plant height (cm), plant spreat (cm) and number of tiller plant^{-1} of Isabgol.

Treatment	Plant height (cm)						Plant spread (cm)						Number of tiller plant^{-1}					
	2013-14			2014-15			2013-14			2014-15			2013-14			2014-15		
Varieties																		
GI-1	25.60			24.47			9.40			8.99			24.83			24.89		
Niharika	27.11			26.06			10.94			10.50			27.18			26.82		
Mayuri	23.92			22.88			12.02			11.60			28.45			28.15		
Fertility levels (kg ha^{-1})																		
N_{20}	23.10			22.03			9.41			8.55			24.92			24.64		
N_{40}	25.90			24.83			11.05			10.64			27.26			26.90		
N_{60}	27.63			26.55			11.90			11.47			28.29			27.94		
	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V
SE(d)±	0.66	0.66	1.14	0.76	0.74	1.31	0.32	0.32	0.56	0.21	0.21	0.14	0.65	0.65	1.13	0.77	0.77	1.33
CD at 0.05	1.39	1.39	N.S	1.61	1.61	N.S	0.69	0.69	N.S	0.60	0.60	N.S	1.39	1.39	N.S	1.63	1.63	N.S

Table 2: Effect of different fertility levels and varieties on day to 50% flowering, day to maturity and Number of spike plant^{-1} of Isabgol

Treatment	Day to 50% flowering						Day to maturity						Number of spike plant^{-1}					
	2013-14			2014-15			2013-14			2014-15			2013-14			2014-15		
Varieties																		
GI-1	71.08			70.17			128.61			125.67			18.17			17.71		
Niharika	69.49			68.58			115.30			112.36			19.52			19.06		
Mayuri	67.02			66.11			108.62			105.69			20.67			20.21		
Fertility levels (kg ha^{-1})																		
N_{20}	66.48			65.57			106.46			103.52			17.49			17.04		
N_{40}	69.66			68.75			118.72			115.79			19.50			19.03		
N_{60}	71.46			70.54			127.35			124.42			21.37			20.91		
	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V
SE(d)±	1.46	1.46	2.53	1.49	1.49	3.59	1.52	1.52	2.64	3.06	3.06	5.29	0.56	0.56	1.02	0.13	0.13	0.09
CD at 0.05	3.10	3.10	N.S	3.17	3.17	N.S	3.24	3.24	N.S	6.48	6.48	N.S	1.25	1.25	N.S	0.38	0.38	N.S

Table 3: Effect of different fertility levels and varieties on number of length of spike (cm), seed spike^{-1}, and 1000 seed weight (g) of Isabgol.

Treatment	Length of spike (cm)						Seed spike^{-1}						1000 Seed weight (gm)					
	2013-14			2014-15			2013-14			2014-15			2013-14			2014-15		
Varieties																		
GI-1	3.26			2.18			75.21			73.30			1.76			1.68		
Niharika	3.69			2.61			78.79			76.88			1.92			1.84		
Mayuri	4.00			2.93			81.93			80.03			2.00			1.92		
Fertility levels (kg ha^{-1})																		
N_{20}	3.04			1.97			73.51			71.61			1.70			1.62		
N_{40}	3.76			2.68			79.46			77.55			1.92			1.85		
N_{60}	4.15			3.03			82.96			81.05			2.06			198		
	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V
SE(d)±	0.11	0.11	0.19	0.09	0.09	0.15	1.76	1.76	3.05	1.56	1.56	2.69	0.06	0.06	0.10	0.07	0.07	0.11
CD at 0.05	0.23	0.23	N.S	0.18	0.18	N.S	3.74	3.74	N.S	3.30	3.30	N.S	0.13	0.13	N.S	0.14	0.14	N.S

Table 4: Effect of different fertility levels and varieties on seed yield (qha^{-1}), seed husk yield (qha^{-1}) and seed swelling (cc water gm^{-1} of seed husk) of Isabgol.

Treatment	Seed yield (qha^{-1})						Seed husk yield (qha^{-1})						Seed swelling (cc water gm^{-1} of seed husk)					
	2013-14			2014-15			2013-14			2014-15			2013-14			2014-15		
Varieties																		
GI-1	7.85			6.84			1.84			1.57			10.16			9.08		
Niharika	9.32			8.32			2.07			1.84			10.74			9.65		
Mayuri	11.50			10.48			2.26			2.25			11.58			10.49		
Fertility levels (kg ha^{-1})																		
N_{20}	8.20			7.17			1.81			1.59			10.25			9.23		
N_{40}	9.63			8.66			2.08			1.82			10.92			9.83		
N_{60}	10.84			9.81			2.28			2.02			11.30			10.22		
	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V	F	V	F×V
SE(d)±	0.55	0.55	0.95	0.26	0.26	0.45	0.09	0.09	0.16	0.09	0.09	0.16	0.22	0.22	0.38	0.33	0.33	0.58
CD at 0.05	1.17	1.17	N.S	0.55	0.55	N.S	0.20	0.20	N.S	0.20	0.20	N.S	0.47	0.47	N.S	0.71	0.71	N.S

Table 5: Effect of different fertility levels and varieties on Total Income (Rs ha^{-1}), Net Returns (Rs ha^{-1}) and Benefit: Cost Ratio of Isabgol.

Treatment	Yield (q ha^{-1})		Cost of Cultivation		Total Income (Rs ha^{-1})		Net Returns (Rs ha^{-1})		Benefit : Cost Ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
N_{20}+Mayuri	9.93	8.85	28388.29	26215.92	69510	66375	41121.71	40159.08	1.44	1.53
N_{40}+Mayuri	11.63	10.71	28643.32	26.491.52	81410	80325	52766.68	53833.48	1.84	2.03
N_{60}+Mayuri	12.95	11.89	28897.72	26676.12	90650	89175	61752.28	62407.88	2.10	2.33
N_{20}+ Niharika	7.82	6.87	28388.29	26215.92	54740	51525	26351.71	25309.08	0.92	0.96
N_{40}+ Niharika	9.30	8.40	28643.32	26.491.52	65100	63000	36456.68	36508.08	1.27	1.38
N_{60}+ Niharika	10.86	9.71	28897.72	26676.12	76020	72825	47122.28	46057.88	1.63	1.72
N_{20}+ GI-1	6.85	5.79	28388.29	26215.92	47950	43425	19561.71	17209.08	0.68	0.66
N_{40}+ GI-1	7.98	6.88	28643.32	26.491.52	55860	51600	27216.68	25108.48	0.95	0.95
N_{60}+ GI-1	8.72	7.85	28897.72	26676.12	61040	58875	32142.28	32107.88	1.11	1.19

4. Conclusion
The experimental findings obtained in the present investigation would be more helpful in recommendation of optimal doses of chemical fertilizers for profitable cultivation of Isabgol during 2013-14 and 2014-15 under central plain zone condition of Uttar Pradesh. Variety mayuri and dose of nitrogen @ 60 kg ha^{-1} (N_{60}) proved better in all respect and more remunerative for central plain zone of Uttar Pradesh.

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