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Yield and nutrient uptake of isabgol (*Plantago ovata*) in response to sowing dates and spacing

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Isabgol (*Plantago ovata* Forksk) is one of the most important medicinal crops grown for its husk and seeds. India produces 9 million tonnes of isabgol which is 98% of the world's total production (Rajendaran 2009). The seed of Isabgol is mainly valued for mucilaginous rosy white husk and is used in ayurvedic, unani and allopathic systems of medicines. The mucilage present in its husk has medicinal properties and used against constipation, irritation of digestive track etc. Isabgol thrives well in warm-temperate regions and requires cool and dry weather during its crop season hence generally it is sown during winter months. Early sowing makes the crop vulnerable to downy mildew disease and too late sowing provides shorter growing period along with possibility of shattering of seed due to early summer rains in April–May. In Punjab, it can be grown successfully in winter (*rabi*) season and due to its low water requirement fits well in areas with low water availability. The south-western region of Punjab suffers from acute shortage of water and cotton is the main crop during rainy (*kharif*) season. Generally cotton crop vacates the field late and results in delayed sowing of succeeding *rabi* crop and ultimately results in lower yields. The yield of isabgol is low because it is mostly grown in nutritionally deficient soils. The reduction in yield of isabgol crops can be compensated by adopting improved agronomic manipulations, viz date of sowing, plant spacings, fertilizer management etc. The information about production technologies, especially effect of date of sowing and plant row spacings on seed yield and nutrient uptake in isabgol under semi-arid region of Punjab are not available. Therefore, an attempt has been made to study the effect of different date of sowing and plant spacings on yield, yield attributes and nutrient uptake of isabgol.

A field experiment was conducted to work out optimum date of sowing and row spacings for the 'HI 5' Isabgol at Regional Research Station, Bathinda during *rabi* seasons of 2006–07 and 2007–08. The station is situated at a longitude 74°58° F, latitude 30° 17'N and altitude of 211 msl. The *p*H of the experimental plot was 8.6 and the soil was loamy sand in nature. The bulk density, electrical conductivity (EC) and organic carbon in the different layers of soil profile up to 180 cm depth were in the range of 1.56–1.76 Mg/m, 0.272–0.364 dS/m and 0.096–0.425% respectively. The climate of the area remains extremely cold and dry during winter and warm during maturity of the crop in April. The experiment was laid out in split-plot design with 2 dates of sowing (15 November and 30 November) in main plots and 2 row spacings (22.5 cm and 30.0 cm) in subplots with 5 replications. One pre sowing irrigation of 10 cm depth was applied before sowing for seed bed preparation and after that four irrigations were given to the crop depending upon the requirement of the crop. The recommended dose of fertilizer (18: 6: 0 kg N: P_2O_5: K_2O/ha, respectively) was applied in all the treatments. The weeds were controlled manually. The yield and yield attributes, ie plant height, branches/plant, and spikelet length were recorded at the time of harvesting of the crop. The crop was harvested in first fortnight of April and all the observations of seed yield and yield-attributing characters were recorded at the time of harvest of the crop. The crop samples were oven-dried and grinded in the stainless steel willey mill and analyzed for uptake of nitrogen, phosphorus and potash as per standard laboratory procedure (Jackson 1973). The N, P and K up take in grain and straw were calculated as follows

$$\text{N, P and K uptake of grain (kg/ha)} = \frac{\text{N, P, K content in grain (\%)} \times \text{grain yield (kg/ha)}}{100}$$

$$\text{N, P and K uptake of straw (kg/ha)} = \frac{\text{N, P, K content in straw (\%)} \times \text{straw yield (kg/ha)}}{100}$$

The results of seed yield and its attributing characters for different dates of sowing for 2006–07 and 2007–08 are presented in Table 1. The plant height recorded in 15

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Table 1 Effect of sowing time and row spacing on yield and yield attributes in isabgol

Treatment	Plant height (cm)			Branches/plant			Spikelet length (cm)			Seed yield (tonnes/ha)		
	2006–07	2007–08	Mean	2006–07	2007–08	Mean	2006–07	2007–08	Mean	2006–07	2007–08	Mean
Date of sowing												
15 Nov.	35.6	36.1	35.8	9.9	9.6	9.8	4.32	4.10	4.21	0.74	0.76	0.75
30 Nov.	32.7	33.1	32.9	9.7	8.7	9.2	4.19	3.96	4.08	0.67	0.52	0.59
LSD (*P*=0.05)	1.85	2.86	-	NS	NS		NS	NS		NS	1.10	
Row spacing												
22.5 cm	33.3	34.9	34.1	9.9	9.6	9.7	4.29	3.86	4.07	7.32	7.46	7.39
30 cm	35.0	34.2	34.6	9.8	8.0	8.9	4.04	4.10	4.07	6.82	5.38	6.1
LSD (*P*=0.05)	NS	NS		NS	NS		NS	NS		0.36	1.83	

Table 2 Nutrient uptake by isabgol under different treatments

Treatments	N uptake (kg/ha)				P uptake (kg/ha)				K uptake (kg/ha)			
	Seed		Straw		Seed		Straw		Seed		Straw	
	2006–07	2007–08	2006–07	2007–08	2006–07	2007–08	2006–07	2007–08	2006–07	2007–08	2006–07	2007–08
Date of sowing												
15 Nov.	34.3	33.8	26.3	25.6	12.3	11.6	14.3	12.5	12.2	12.4	52.1	51.7
30 Nov.	32.4	32.3	24.0	22.8	11.1	10.9	13.1	11.6	11.6	10.6	49.2	48.9
LSD (*P*=0.05)	1.4	1.5	0.8	1.5	0.7	NS	0.3	0.4	NS	0.6	0.5	1.1
Row spacing												
22.5 cm	34.2	34.0	25.8	25.4	12.0	11.9	14.8	13.3	12.3	12.1	51.2	51.3
30 cm	32.5	32.1	24.5	23.0	11.4	10.6	12.6	10.8	11.5	11.0	50.2	49.3
LSD (*P*=0.05)	0.6	0.7	0.7	0.8	0.4	0.4	0.3	0.5	0.2	0.4	0.3	0.9

November sowing was significantly higher as compared to delayed sowing of 30 November. However, the differences in other yield attributes in various dates were non-significant. During both the years, the higher seed yield was recorded in 15 November sown crop as compared to 30 November sown crop. The significant reduction in yield of 30 November sown crop as compared to 15 November sown crop was recorded during 2006–07. However, the non-significant reduction in yield was recorded in 30 November sown crop as compared to 15 November sown crop during 2007–08. This may be due to sudden rise in the temperature and higher evaporative demand during the grain-filling and maturity period of the crop. The delayed sowing results in forced maturity and ultimately reduction in yield of the crop. The higher seed yield in early sowing may be due to taller plants and comparatively more number of branches/plant and more spikelet length. These results are in close conformity with findings of Pour and Moghaddam (2005), Chandra *et al*. (2006), Charak *et al*. (2004) and Bist *et al*. (2001). The significantly higher uptake of N, P and K in seed and straw

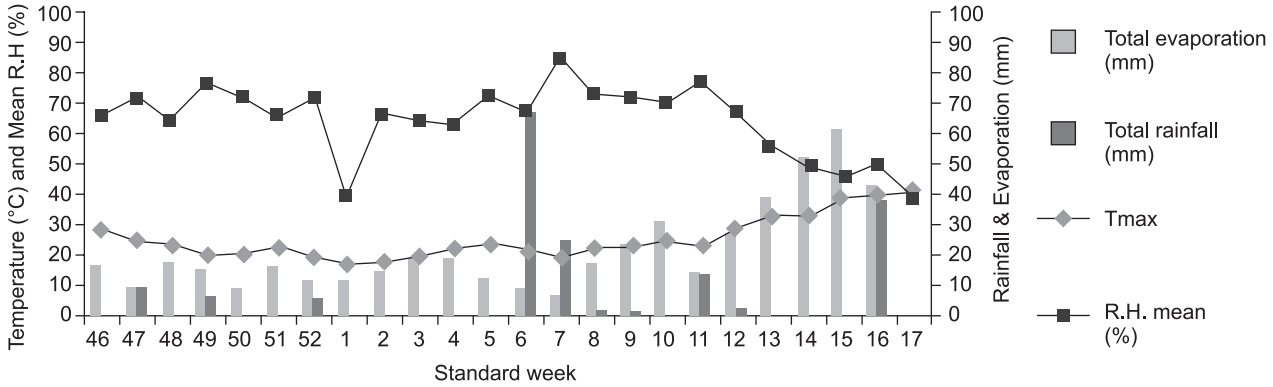

Fig 1 Meteorological data from November 2006 to April 2007

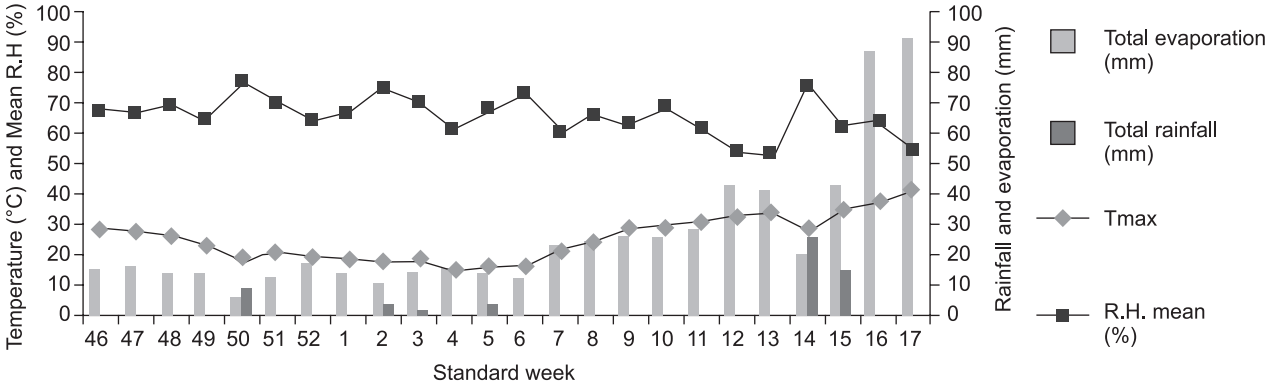

Fig 2 Meteorological data from November 2007 to April 2008

was recorded in 15 November sown crop as compared to 30 November sown crop during both years (Table 2).This may be due to less mobility and uptake of nutrients due to fall in temperature during the active vegetative growth period of 30 November sown crop.

The closer row spacing of 22.5 cm gave significantly higher seed yield as compared to wider spacing of 30 cm. However, the differences in various yield-attributing characters were found to be non-significant in both the spacings. The higher yield in closer spacing (22.5 cm) may be due to numerically more number of plants/unit area. Similarly, significantly higher uptake of N, P and K in seed and straw was also recorded in closer spacing of 22.5 cm as compared to wider spacing of 30 cm. This may be due to optimum utilization of applied nutrients by the crop and higher plant population/unit area**.** Theses findings were in conformity with Dwivedi *et al*. (2008).

The findings of the present investigation suggested that isabgol can be grown successfully under semi-arid region of Punjab up to 15 November with row spacing of 22.5 cm for getting higher yield and timely vacation of the field for succeeding *kharif* crop.

SUMMARY

A field experiment was conducted during winter season of 2006–08 to work out optimum date of sowing and row spacing for 'HI 5' Isabgol (*Plantago ovata* Forksk). The result showed that significantly higher seed yield was recorded in 15 November sown crop as compared to 30 November sown crop during 2006–07 and numerically higher yield in 15 November sown crop as compared to 30 November sown crop during 2007–08. This higher yield in 15 November sown crop may be due to more plant height, number of branches/ plant and more spikelet length. Similarly, significantly higher N, P and K uptake in seed and straw was also recorded in early sown crop as compared to late sowing. The closer row spacing of 22.5 cm gave significantly higher yield and N, P, K uptake as compared to wider spacing of 30 cm.

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