International J. Seed Spices 6(2), July 2016:50-54

Response of blond psyllium (*Plantago ovata* Forsk) varieties to time of sowing and nitrogen fertilization under semi-arid conditions

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Abstract

A field experiment was carried out at S.K.N. College of Agriculture, Jobner (Rajasthan) during two consecutive *rabi* seasons on loamy sand soil to determine the response of blond psyllium varieties to sowing time and nitrogen fertilization for growth, yield attributes, yields, economics and quality. The experiment was laid out in split plot design with three sowing time (1st, 10th and 20th November) and two varieties (GI-1 and GI-2) in main plots and four nitrogen levels (0, 20, 40 and 60 kg ha^{-1}) in sub plots. The results indicated that plant height, tillers plant^{-1} and dry matter produced plant^{-1} at 60 DAS and at harvest, spikes plant^{-1}, seeds spike^{-1}, seed yield plant^{-1}, seed (12.69 q ha^{-1}), straw & biological yields and net returns (` 29555 ha^{-1}) were significantly increased by sowing of blond psyllium on 10thNovember as compared to first November sowing, whereas, growth parameters remained at par but yield attributes, yields and net returns were reduced significantly when the sowing of crop was delayed to 20th November. The seed yield and net returns in 10th November sown crop was 19.5 and 26.7% higher over Ist November sown crop, respectively. Variety GI-2 of blond psyllium produced significantly higher growth and yield attributes, seed (12.65 q ha^{-1}), straw & biological yields and net returns (` 29440 ha^{-1}) as compared to GI-1. Increasing nitrogen levels upto 40 kg ha^{-1} significantly enhanced the plant height, tillers plant^{-1} and dry matter accumulation plant^{-1} at 60 DAS and at harvest, seeds spike^{-1}, test weight, seed yield plant^{-1}, seed (12.51 q ha^{-1}), straw yields and net monetary returns (` 28861 ha^{-1}) over the preceding levels.Application of 40 kg N ha^{-1} increase the seed yield by 23.3 & 7.5% and net monetary returns by 28.8 & 9.0% over control and 20 kg ha^{-1}. However, spikes plant^{-1} and biological yield significantly increased up to 60 kg nitrogen.

Key words : Blond psyllium, husk, net returns, swelling capacity, yield attributes.

Introduction

Blond psyllium (*Plantago ovata* Forsk) is one of the most important medicinal crops grown for its seed and their mucilaginous husk (*bhussi*) used for medicinal purposes (Aishwath and Ram, 2008). It is an annual herb belonging to family plantaginaceae and most commonly grown in temperate region as cash crop for its export value. At present, blond psyllium has acquired the name “Dollar earner” in North Gujarat and South Western Rajasthan. As a whole, India commands a near monopoly in production and export of the seed and husk in the world market. India produces 98% blond psyllium of the world’s total production (Rajendaran, 2009). About 80-90% of the produce is exported to various countries. The seeds of blond psyllium are mainly valued for their mucilaginous rosy white husk. It contains about 30% mucilage and hemi cellulose that is mainly composed of xylose, arabinose, galacturinic acid, rhaminose and galactose. In addition to mucilage, the seeds contain semi drying fatty oils (5%), small amount of acubin and tannin. The mucilage present in its husk has medicinal properties and used in the treatment of constipation, dysentery and other intestinal complaints. Husk has a high water absorbing capacity and therefore, used as an anti-diarrhoea drug. Its seed and husk are used in Unani, allopathic and Ayurvedic medicines and they have cooling and demulcent effect. In addition to these medicinal uses, it is also used in dyeing, calico printing, in the ice cream as a stabilizer, confectionery and cosmetic industries (Thakur *et al*., 2012). The seed without the husk, which contain about 17-19% protein, is used as cattle feed.

The productivity of blond psyllium is low, however, it can be improved by adopting improved agronomic manipulations, viz., improved varieties, appropriate sowing time and nutrient supplementation etc. To make any crop successful in any area, it must have good varieties and improved production technology to achieve its higher yield potential. Yielding ability of various varieties vary due to their genetic make up. Weather conditions to which the crop is exposed during its life cycle is considered to be principal input parameters affecting its productivity, despite availability of other inputs and improved crop husbandry practices. Delay and early sowing causes poor growth and reduction in yield. Evolving appropriate sowing time

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and most suitable variety under prevailing conditions seem to be of paramount importance for achieving higher yield with least cost. Although, it does not make heavy demand of soil nutrients but it is well known fact that judicious application of fertilizer increase the crop yield. Most of the Indian soils specificaly light textured ones of Rajasthan are deficient in nitrogen, which is one of the basic plant nutrients. It is involved in formation of protein, nucleic acid, growth hormones and vitamins and is an integral part of chlorophyll. An adequate supply of nitrogen is associated with vigorous vegetative growth and dark green colour. The information about improved production technologies of blond psyllium under semi-arid region of Rajasthan are not available as it is one of the new crop for some parts of Rajasthan, still in the process of introduction, it is imperative to workout its specific cultural requirements under given set of conditions, particularly with respect to nitrogen fertilizer requirement, sowing time and growing of high yielding varieties. Keeping all these facts in view, the present investigation was undertaken to study the effect of sowing time and nitrogen on growth, yield attributes, yield, economics and quality of blond psyllium varieties.

Material and methods

The field experiment comprising of 24 treatment combinations replicated thrice, was laid out in split plot design with three sowing time (1st, 10th & 20th November) and two varieties (GI-1 & GI-2) in main plots and four nitrogen levels (0, 20, 40 & 60 kg ha^{-1}) in sub plots at Agronomy Farm, S.K.N. college of Agriculture, Jobner (Rajasthan) during rabi season. The soil was loamy sand in texture, alkaline in reaction (pH 8.2), higher in electrical conductivity (1.3 dS m^{-1}), low in organic carbon (0.25%), available nitrogen (130 kg ha^{-1}), available phosphorus (16.54 kg ha^{-1}) and medium in available potassium (155.4 kg ha^{-1}), having 1.51 Mg/m^3 bulk density, 2.54 Mg/m^3 particle density, 12.5% field capacity and 4.76% wilting point at the beginning of the experiment. The crop was sown in 30 cm rows using seed rate of 6 kg ha^{-1} at 1 to 2 cm depth. During the crop season five irrigations were given and need based cultural and plant protection operations were taken up to harvest good crop during both the years of experimentation. Five random plants were selected from each plot for taking observations on growth and yield attributes and for yield and the net plots were harvested. To determine the swelling factor, 1 g of seed was put into beaker of 25 ml capacity and 20 ml distilled water was added. The swelling of seeds was calculated after 24 hours (Sharma & Koul, 1986). Husk content in the seed was also determined according to the method suggested by Sharma & Koul (1986). Economics was worked out on the basis of prevailing market prices of inputs and outputs.

Result and discussion

Effect of sowing time

The two years pooled data presented in table1 showed that plant height, tillers plant^{-1} and dry matter produced plant^{-1} at 60 DAS & at harvest were significantly increased by sowing of blond psyllium on 10th November as compared to first November sowing, whereas, these parameters remained at par when the sowing of crops was done on 20th November. The overall improvement in growth of crop sown on 10th November could be ascribed to favorable internal environment of the plants as well as external environment to which it was exposed during its life cycle. The significant increase in growth may be due to larger canopy development, which might increase interception, absorption and utilization of radiant energy available for growth, and development of the crop. Significantly higher spikes plant^{-1} (24.77), seeds spike^{-1} (52.26), seed yield plant^{-1} (2.01 g), seed (12.69 q ha^{-1}), straw (34.88 q ha^{-1}) and biological yields (47.56 q ha^{-1}) were recorded when the crop was sown on 10th November as compared to first November, whereas, these parameters significantly reduced when the sowing of crops was delayed to 20th November (Table 2). The results revealed that sowing on 10th November would be beneficial for the better growth of the plants and sowing early and late would not be suitable for this crop. The marked variations in yield attributes of the crop due to sowing time may be attributed to variable exploitation of environmental resources by the crop above and below ground. Besides, adequate supply of growth inputs, the congenial climatic conditions seems to have helped the plant to exploit their potential for reproductive growth. The production of higher amount of photosynthates might have helped the plant to develop the larger sink in order to accumulate synthesized photosynthates. The seed yield in 10th November sown crop was 19.5 and 5.5% higher over Ist November and 20th November sown crop, respectively. Because of favourable climatic conditions, improvement in growth and yield attributing character, the crop sown on 10th November produced significantly higher yield. The reduced yield in 20th November sown crop 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. On the other hand, the reduction in the value of various yield attributes and yield in early sowing (1st November) was on account of poor crop ecology such as high temperature coincided to germination, tiller initiation and early growth stage of the crop resulting in reduced yield attributes and yield. The 10th November sown crop produced significantly the highest net returns (` 29555 ha^{-1}) which was 26.7% higher over first November sowing but delayed sowing to

Table 1. Effect of sowing time, variety and nitrogen on growth parameters of blond psyllium (Pooled data over 2 years)

Treatments	Plant height (cm)		Tillers plant^{-1}		Drymatter accumulation (g plant^{-1})	
	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest
Sowing time						
1st November	19.59	28.90	3.71	4.17	1.29	1.29
10th November	22.26	31.35	4.54	4.60	1.56	1.56
20th November	22.81	31.90	4.50	4.50	1.49	1.49
SEm±	0.32	0.39	0.06	0.07	0.03	0.03
CD (P=0.05)	0.94	1.15	0.19	0.20	0.08	0.08
Variety						
GI-1	21.09	30.22	3.81	3.99	1.37	1.37
GI-2	22.02	31.19	4.67	4.85	1.52	1.52
SEm±	0.26	0.32	0.05	0.05	0.02	0.02
CD (P=0.05)	0.77	0.94	0.15	0.16	0.06	0.06
Nitrogen (kg ha^{-1})						
0	16.91	26.24	3.30	3.45	1.20	1.20
20	21.21	30.31	4.23	4.35	1.44	1.44
40	23.82	32.98	4.65	4.86	1.56	1.56
60	24.27	33.32	4.81	5.03	1.59	1.59
SEm±	0.29	0.30	0.07	0.07	0.02	0.02
CD (P=0.05)	0.80	0.83	0.19	0.18	0.05	0.05

20th November reduced net returns by 7.2%. The reason for higher net returns in 10th November sown crop could be higher yield compared to Ist November & 20th November sown crop as no cost involved in sowing time because it is a non monetary input. The sowing time of the crop could not produced significant difference on test weight, swelling capacity and husk recovery. These results are in close conformity with the work done in *Plantago ovata* by Solanki and Shaktawat (1999), Bist *et al*., (2001), Charak *et al*., (2004), Pour and Moghaddam (2005), Chandra *et al*., (2006), Singh *et al*., (2010) and Das (2011). These scientists also reported that blond psyllium is a temperate season crop and it responds well to temperature, which is related to time of sowing. Therefore, the productivity of crop varies with different time of sowing.

Effect of varieties

The variety GI-2 of blond psyllium produced significantly higher plant height, tillers plant^{-1} and dry matter produced plant^{-1} at 60 DAS & at harvest, spikes plant^{-1} (24.69), seeds spike^{-1} (51.66), seed yield plant^{-1} (1.94 g), seed (12.65 q ha^{-1}), straw (33.62 q ha^{-1}) and biological yields (46.26 q ha^{-1}) and net returns (` 29440 ha^{-1}) as compared to genotypes GI-1 in pooled statistical analysis (Table 1 and 2).The variety GI-2 produced 15.9 and 21.5% higher seed yield and net returns over GI-1. The significant variation in behaviour of blond psyllium varieties with respect to plant height, number of tillers per plant and dry matter accumulation per plant could be explained by the variation in their genetic makeup, difference in their genotypic potential and adaptability to soil and climatic conditions. It is well known fact that higher growth rate and vigour attained by plants during vegetative growth stage results in accumulation of more dry matter, which in turn, diverts more quantity of photosynthates towards sink during reproductive phase. Thus, the variation in growth characters during vegetative growth stage due to varieties might be responsible for variation in yield attributes. Significant variation in growth and yield components was ultimately reflected in to seed, straw and biological yields. The test weight, swelling capacity and husk recovery could not alter with genotype of the crop. The findings are in close conformity with the work of Kumar and Jha (2000) who reported that blond psyllium genotypes differ in their growth, yield and quality.

Effect of nitrogen

Further interpretation of pooled statistical data (Table 1 & 2) revealed that increasing application of nitrogen up to 40 kg ha^{-1}, being at par with 60 kg ha^{-1}, significantly enhanced the plant height, tillers plant^{-1} and dry matter accumulation plant^{-1} at 60 DAS & at harvest, seeds spike^{-1} (52.83), test weight (1.88 g), seed yield plant^{-1} (1.99 g), seed (12.51 q ha^{-1}) and straw yields (34.24 q ha^{-1}) over the preceding levels. The significant increase in above growth characters might be due to better nutritional environment in the root zone as well as in plant system under the influence of nitrogen application which is the basis of fundamental constituents of all living cells and hence the most indispensable of all mineral nutrients

Table 2. Effect of sowing time, variety and nitrogen on yield, net returns and quality of blond psyllium (Pooled data over 2 years)

Treatments	Spikes plant^{-1}	Seeds spike^{-1}	Test weight (g)	Seed yield plant^{-1} (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Net returns (` ha^{-1})	Swelling capacity (cc g^{-1})	Husk recovery (%)
Sowing time										
1st November	21.52	44.12	1.84	1.66	10.62	29.92	40.54	23345	10.89	34.00
10th November	24.77	52.26	1.86	2.01	12.69	34.88	47.56	29555	10.85	34.30
20th November	24.02	49.75	1.84	1.90	12.03	33.47	45.50	27576	10.83	34.02
SEm±	0.39	0.71	0.01	0.04	0.20	0.46	0.51	620	0.07	0.15
CD (P=0.05)	1.14	2.09	NS	0.11	0.58	1.34	1.49	1744	NS	NS
Variety										
GI-1	22.18	45.76	1.84	1.77	10.91	31.90	42.80	24221	10.80	34.03
GI-2	24.69	51.66	1.86	1.94	12.65	33.62	46.26	29440	10.92	34.18
SEm±	0.32	0.58	0.01	0.03	0.16	0.37	0.41	510	0.06	0.12
CD (P=0.05)	0.93	1.70	NS	0.09	0.48	1.10	1.22	1433	NS	NS
Nitrogen (kg ha^{-1})										
0	18.57	39.44	1.77	1.55	10.15	28.85	39.00	22405	10.93	34.08
20	23.30	47.58	1.84	1.85	11.64	32.68	44.32	26472	10.88	34.15
40	25.28	52.83	1.88	1.99	12.51	34.24	46.75	28861	10.83	34.12
60	26.59	54.97	1.90	2.03	12.81	35.25	48.06	29560	10.78	34.08
SEm±	0.35	0.77	0.01	0.02	0.13	0.44	0.44	367	0.06	0.17
CD (P=0.05)	0.97	2.15	0.03	0.06	0.35	1.22	1.23	1022	NS	NS

for growth and development of the plant. The application of 40 kg N ha^{-1} increased the seed yield by 23.3 and 7.5% over control and 20 kg ha^{-1}. However, spikes plant^{-1} (26.59) and biological yield (48.06 q ha^{-1}) significantly increased up to 60 kg nitrogen in pooled data. Nitrogen plays a pivotal role in early formation of roots, their proliferation, increased microbial activity in nodules and symbiotic biological N-fixation process. During leaf senescence also, carbohydrates, nitrogenous compounds, phosphorus and other mobile nutrients are remobilized and translocated to current plant sinks which are very close to the source resulting into higher yield attributes. The overall improvement in growth due to nitrogen application coupled with increased net photosynthesis on one hand and greater mobilization of photosynthates towards reproductive structure on the other hand might have increased the yield attributes significantly. It might also be due to the increased supply of nitrogen and its higher uptake by plants which might have stimulated the rate of various physiological processes in plant and led to increased growth and yield parameters and ultimately resulted in increased seed, straw and biological yields. Significantly higher net monetary returns (Rs 28861 ha^{-1}) were obtained up to 40 kg N ha^{-1} which was 28.8 and 9.0% higher over control and 20 kg ha^{-1}, respectively (Table 2). This means higher quantity of fertilizer required for higher yield resulted in higher investment but ultimately gave higher returns as it is the function of yield. Swelling factor and husk recovery remained statistically same with the application of various levels of nitrogen application. These results corroborate with the result of the study conducted by Swarupa *et al*., (2003) and Wankhade *et al*., (2005) on blond psyllium also indicated that the crop responds to nitrogen fertilization for growth and yield as found in present investigation.

Conclusion

It is concluded that sowing of variety GI-2 on 10th November with 40 kg ha^{-1} nitrogen fertilization resulted in higher growth and yield attributes, yield and net monetary returns of the blond psyllium.

Acknowledgement

The author is highly thankful to National Medicinal Plants Board, Ministry of Health and Family Welfare, Government of India for providing financial assistance to conduct the research work.

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Received : December 2015; Revised : March 2016; Accepted : May 2016.