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RESEARCH ARTICLE

Response of phosphorus and sulphur fertilization on content and uptake of blond psyllium (*Plantago ovata* Forsk)

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SUMMARY

An experiment conducted during *Rabi* season of 2002-03 to study the effect of phosphorus and sulphur on content and uptake of blond psyllium. Result revealed that all the phosphorus levels remained at par with each other in respect to nitrogen content in grain and straw. Application of phosphorus significantly increased phosphorus and sulphur content in grain and straw and nitrogen uptake by straw up to 20 kg P_2O_5 ha^{-1} whereas, nitrogen uptake by grain, phosphorus and sulphur uptake by grain and straw and total nitrogen, phosphorus and sulphur uptake up to 30 kg P_2O_5 ha^{-1}. Application of sulphur significantly increased phosphorus and sulphur content in grain and straw and nitrogen and phosphorus uptake by grain and straw, total nitrogen uptake and sulphur uptake by straw up to 20 kg S ha^{-1}, whereas, total phosphorus and sulphur uptake by grain up to 30 kg P_2O_5 ha^{-1}.

Key Words : Blond psyllium, Phosphorus, Sulphur, Content, Uptake

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At present blond psyllium crop has required the place "Dollar earner" in north Gujarat and southwestern Rajasthan (Modi *et al.*, 1974). As a whole, India holds near monopoly in production and export of blond psyllium to the world market and about 80-90 per cent produce is exported through, which about Rs. 100 crores are earned annually (Maiti and Mandal, 2000). During 2003-04 the area and production of blond psyllium in Rajasthan was 120954 hectare and 74147 tonnes respectively, with an average productivity of 613 kg ha^{-1} (Anonymous, 2003). Phosphorus is the key element in the process involving conversion of solar energy into plant food. It helps in early root development and also enhances maturity.

Application of phosphorus not only increases the crop yield but also improves the quality and imparts resistance against diseases. It is a constituent of nucleic acid, phytin and phospholipids. An adequate supply of phosphorus is required in entire life. It also increases nodulation, crop growth and quality of plant (Shrivastav and Ahlawat, 1993). Application of sulphur also plays an important role in crop production as it is an essential constituent of amino acids like cystine, cysteine and methionine and essential oils. It also helps in chlorophyll formation. In India 90 districts have been reported to be deficient in sulphur, of them three in Rajasthan *viz.*, Jaipur, Jodhpur and Udaipur (Tandon, 1991). Hence, proper emphasis must be given on phosphorus and sulphur requirement of blond psyllium.

MATERIAL AND METHODS

The experiment was conducted at S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season, 2002-03 on loamy sand soil. The soil pH was 8.2 and low in organic carbon (0.25%), available nitrogen (129.14 kg ha^{-1}), phosphorus (15.50 kg P_2O_5 kg ha^{-1}), sulphur (7.3 ppm) and medium in potash

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(152.7 kg ha^{-1}). The treatments consisted five levels of phosphorus (0, 10, 20 30 and 40 kg P_2O_5 ha^{-1} and four levels of sulphur (0, 10, 20 and 30 kg S ha^{-1}) were laid out in Randomized Block Design with three replications. An uniform dose of 40 kg N ha^{-1} through urea and DAP, phosphorus as per treatment through DAP and sulphur as per treatment through gypsum were applied at the time of sowing. The blond psyllium variety GI-2 was sown in rows 30 cm apart with 6.0 kg ha^{-1} seed rate on November 7, 2002.

The seed and straw samples were collected from each plot at harvest and dried in oven at 65^0C for 48 hrs. Thereafter, the samples were grinded to fine powder separately through electric grinder for the estimation of N, P and S content in grain and straw. Nitrogen content in both grain and straw was estimated by modified Kjeldahl's method using Nessler's reagent (Snell and Snell, 1949), phosphorus content in both grain and straw was estimated by ammonium venadate molybdate yellow colour method (Richards, 1968) and sulphur content in both grain and straw was estimated by turbidimetric method using barium chloride gelatin reagent (Tabatabai and Bremner, 1970). The uptake of each nutrient by seed as well as straw was computed by the following formula:

$$\text{Nutrtient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%) in grain of straw} \times \text{Seed or straw yield (kg ha}^{-1})}{100}$$

Total uptake of nitrogen, phosphorus and sulphur by the crop in each treatment was computed from nitrogen, phosphorus and sulphur concentration in grain and straw and the respective yield of grain and straw, using the following relationship:

$$\text{Uptake of N/P/S (kg ha}^{-1}) = \frac{\text{\% N/P/S x grain yield in grain (kg ha}^{-1}) + \text{\% N/P/Sx staw yield in straw (kg ha}^{-1})}{100}$$

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Effect of phosphorus :

It was observed that application of 30 and 20 kg P_2O_5 ha^1, significantly increased the nitrogen content in grain and straw over control (Table 1). The possible explanation would be that application of phosphorus increased availability of nitrogen to the plant consequently leading to higher nitrogen concentration in grain and straw. The nitrogen uptake increased up to 30 and 20 kg P_2O_5 ha^{-1} in grain and straw, respectively (Table 1). This increase in nitrogen uptake due to phosphorus application could be attributed to most obvious favourable effect of phosphorus on the rood system of plant.

Table 1: Effect of phosphorus and sulphur on content and uptake of blond psyllium

Treatments	N content (%)		P_2O_5 content (%)		S content (ppm)		N uptake (kg ha^{-1})			P_2O_5 uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Phosphorus (kg P_2O_5 ha^{-1})															
0	1.865	0.755	0.546	0.349	0.150	0.078	15.55	15.11	30.66	4.58	7.04	11.62	1.26	1.57	2.83
10	1.905	0.779	0.586	0.381	0.158	0.082	20.20	19.03	39.24	6.25	9.32	15.56	2.02	2.02	3.72
20	1.923	0.794	0.614	0.395	0.164	0.085	22.75	21.13	43.87	7.25	10.50	17.75	2.27	2.27	4.22
30	1.933	0.803	0.626	0.402	0.167	0.087	24.34	22.52	46.86	7.92	11.31	19.23	2.46	2.46	4.57
40	1.938	0.810	0.631	0.405	0.168	0.088	25.08	23.23	48.31	8.25	11.65	19.90	2.53	2.53	4.71
S.E.±	0.024	0.009	0.006	0.005	0.002	0.001	0.55	0.55	0.80	0.17	0.23	0.25	0.06	0.06	0.07
C.D. (P = 0.05)	0.068	0.027	0.018	0.013	0.006	0.003	1.58	1.57	2.29	0.48	0.66	0.71	0.18	0.18	0.19
Sulphur (kg S ha^{-1})															
0	1.880	0.778	0.556	0.349	0.146	0.078	17.74	17.30	34.37	5.10	7.80	12.90	1.75	1.75	3.08
10	1.910	0.786	0.598	0.383	0.162	0.084	21.24	19.97	41.21	6.69	9.76	16.44	2.13	2.13	3.94
20	1.926	0.792	0.620	0.401	0.168	0.087	23.62	21.38	45.00	7.64	10.84	18.48	2.35	2.35	4.41
30	1.934	0.797	0.629	0.411	0.171	0.088	24.40	22.18	46.58	7.97	11.36	19.43	2.45	2.45	4.61
S.E.±	0.021	0.008	0.006	0.004	0.002	0.001	0.49	0.49	0.72	0.15	0.21	0.22	0.06	0.06	0.06
C.D. (P = 0.05)	NS	NS	0.016	0.012	0.005	0.002	1.42	1.41	2.05	0.43	0.59	0.63	0.16	0.16	0.17

NS = Non-significant

It promotes the formation of lateral and fibrous roots, which increase root proliferation and absorbing surface for nutrient. This higher absorption capacity of nitrogen tended to improve nitrogen uptake. Similar results were also reported by Patel *et al.* (1996).

Successive increase in phosphorus levels up to 20 kg P_2O_5 ha^{-1}, being at par with higher levels (30 and 40 kg P_2O_5 ha^{-1}), significantly increased phosphorus and sulphur content in grain and straw. Whereas, increasing levels of phosphorus up to 30 kg P_2O_5 ha^{-1}, being at par with higher levels (40 kg P_2O_5 ha^{-1}), significantly increased phosphorus and sulphur uptake by grain and straw and total (Table 1). The possible explanation would be that higher availability application of phosphorus in soil solution with higher dose of applied phosphorus increased the phosphorus content and uptake of plant as high absorption of phosphorus may resulted through the developed root system. The significant and positive correlation between grain yield and uptake of phosphorus and sulphur also support the above view. Since the uptake of nutrients is a product of yield and its content, the increased yield with high sulphur content might have led to more uptake of sulphur. The results are in close agreement with the findings of Kumawat *et al.* (1998) and Choudhary (2000).

Effect of sulphur :

Non-significant increase in nitrogen content in grain and straw was noted due to application (Table 1). Increasing levels of sulphur up to 20 kg S ha^{-1} significantly increased phosphorus content and uptake by grain and straw over control and 10 kg S ha^{-1}, but remained at par with 30 kg S ha^{-1} (Table 1). The increased content of phosphorus in plants due to the application of sulphur could be explained by the role of SO_4 ions which maintain the turgor pressure in plants cells. As a consequence of lower hydration of SO_4 ions, the cell colloids get less swollen and results in reduction of osmotic pressure which increase transpiration leading to higher uptake of plant nutrients from soil. The uptake of phosphorus is the function content in plant and crop yield. The increase in uptake of phosphorus was also reported by Rattan *et al.* (1995) and Vyas *et al.* (1997).

An increase in sulphur content of grain and straw was observed due to sulphur fertilization @ 20 kg S ha^{-1} over lower levels (Table 1). This might be because of the fact that application of sulphur to the deficient soil increased the content of sulphur in soil solution which increased the sulphur availability for absorption by the plants. The uptake of sulphur increased significantly due to sulpher fertilization ((Table 1). The increase in sulphur content of grain and straw together with improved grain and straw yields might have resulted into greater uptake of sulphur (Yadav, 2001).

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