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Effect of Different Levels of Nitrogen, Phosphorus and Potassium on N, P and K Content and Uptake of Isabgol (*Plantago ovata* Forsk.) under Middle Gujarat Conditions

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The field experiment was conducted to access the effect of different fertilizer levels on yield, nutrient content and uptake of seed and straw under middle Gujarat condition during *rabi* season of 2013-14 at Anand. There are total with three nitrogen levels (15, 30, and 45 kg N ha^{-1}), three levels of phosphorus (0, 15 and 30 kg P_2O_5 ha^{-1}) and two levels of potassium (0 and 30 kg K_2O ha^{-1}) with four replication. The result revealed that successive increasing of nitrogen, phosphorus and potassium levels significantly affect the nutrient content and uptake by seed and straw as well as seed and straw yields of isabgol. Application of 45 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} gives significantly highest N, P and K uptake and content as well as yields of seed and straw of isabgol. Response of potassium was found to be non-significant in case of nutrient content, uptake and yield of isabgol.

Keywords: Isabgol, Nitrogen, phosphorus and potassium.

Isabgol (*Plantago ovate* Forsk) has been used in medicines sice ancient times, but it has only been cultivated as a medicinal plant in recent decades (Choudhary *et.al*.2014). India with its varied agro-climatic conditions and topography has a large number of medicinal plant species. The herbal wealth constitutes about 5000 species of known medicinal and aromatic plants which are used in the various systems of Indian medicines *viz*., Ayurveda, Siddha and Unani, since time immemorial (Marketa, 2002). Isabgol (*Plantago ovata* Forsk.) is one of the most important medicinal plant with the foremost agricultural and commercial values in India.

In the India, Isabgol occupies 2.93 lack hector area and contribute about 36 % of total isabgol production of the world (Anonymous, 2007) and is grown in the state of Gujarat, Rajasthan, Madhya Pradesh and Uttar Pradesh. Blonde psyllium is an important medicinal crop of Gujarat. Due to low cost of production and higher return from the crop. Gujarat commands near monopoly in the production and export of isabgol seed and seed husk to the world market (More *et.al.*, 2014).

Isabgol (*Plantago ovate* Forsk.) is an annual herb of about 30-45 cm height with usually four to five tillers arising from the main stem. It has tap root system as in normal dicots. The most important part of isabgol is the mucilage, which is a polysaccharide coating on the seed. The separated husk is popular as "Sat Isabgol" (fetch price ` 280 kg^{-1}) in the Indian market. The husk from the seed is separated by physical process. It works as an anti-diarrhoea drug. It is also used for treating constipation and intestinal disorders. The dehusked seed is around 69 % by weight of total seed and is known to be rich in the starch and fatty acids (Atal *et al.*,1964). Refined husk is used in the food industry for manufacturing sausages, ice

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creams and sauces. It is also used in dyeing, calico printing, setting lotions and in cosmetics. Nitrogen, phosphorus and potassium shortly are the three primary elements of fertilizer. Deficiency of nitrogen has very marked effect on plant growth. Insufficient nitrogen may reduce the yield drastically and also deteriorates the quality of the produce. Phosphorus play beneficial role in the root development, nodulation and stimulation of the symbiotic nitrogen fixation. Plant require relatively large amount of potassium and often can use more than the soil can supply. Potassium is the third most likely nutrient element to limit plant. Potash plays a critical role in the regulation of plant physiological functions: It strengthens the cell walls, aids in water retention, improves disease resistance and boost nitrogen and phosphate absorption. Enhancing these functions results in improved plant quality and increased yields.

MATERIALS AND METHODS

A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to find out the "Response of different levels of nitrogen, phosphorus and potassium on yield and quality of isabgol (*Plantago ovata* Forsk.) under middle Gujarat conditions" during *rabi* season of 2013-14. The experiment consist of eighteen treatment combination comprise of three nitrogen levels (15, 30 and 45 kg N ha-$^{-1}$), three phosphorus levels (0, 15 and 30 kg P_2O_5 ha-$^{-1}$) and two potassium levels (0 and 30 kg K_2O ha-$^{-1}$). The field experiment was laid out in RBD (Factorial) with four replications.

The soil of experimental site was loamy sand in texture having good drainage capacity with pH 7.15. It was low in available nitrogen (242.50 kg ha^{-1}), medium in available phosphorus (32.56 kg ha^{-1}) and higher in available potash (284.20 kg ha^{-1}). Nitrogen was given as per treatment in the form of urea. The full dose of phosphorus and potassium were applied in the form of SSP and MOP, respectively and half dose of nitrogen applied as a basal and remaining half was applied after one month of sowing as a top dressing. Full dose of P and K were applied at the time of sowing below the seed in furrows. The isabgol crop was sown at a spacing of 30 cm using the seed rate of 4 kg ha^{-1}. The available nitrogen from soil was calculated by alkaline $KMnO_4$ method (Chopra and Kanwar, 1976) available phosphorous calculated by Olsen's method (Olsen *et.al.*,1954) and available potassium calculated by Flame photometric method (Jackson, 1973). Manual thining, weeding and hoeing were done at one month after sowing to provide an ideal environment to the crop. Light irrigation was given immediate after sowing ; however four to five irrigations were given as per requirement of crop. The values of "F" was worked out and compared with the value of table F at 5 % level of significance. The values of S. Em ±, C. D. and C. V. % were also calculated [Cochram and Cox (1967)].

RESULTS AND DISCUSSION

Effect of levels of Nitrogen

The results on seed and straw yields of isabgol (Table 1) indicated that the differences due to different nitrogen levels were found significant. An appraisal of data in Table 1 revealed that the seed and straw yields of isabgol displayed on increasing trend with increase in nitrogen levels from 15 to 45 kg N ha^{-1}. Significantly the maximum seed (1243 Kg ha^{-1}) and straw (6459 Kg ha^{-1}) yields were registered under the treatment N_3 (45 Kg N ha^{-1}). The increase in seed yield of isabgol under the treatments N_3 (45 Kg N ha^{-1}) and N_2 (30 Kg N ha^{-1}) were at the extent of 35.86 % and 21.86 %, respectively as compared to N_1 (15 Kg N ha^{-1}). The increase in straw yield of isabgol under the treatments N_3 (45 Kg N ha^{-1}) and N_2 (30 Kg N ha^{-1}) were at the extent of 28.64 % and 14.72 %, respectively as compared to N_1 (15 Kg N ha^{-1}). Significantly the lowest seed (915 Kg ha^{-1}) and straw (5021 Kg ha^{-1}) yields were found under the treatment N_1 (15 Kg N ha^{-1}). Yield of any crop plant depends on the source sink relationship and is the cumulative function of various growth parameter and yield attributing component of sink. The increase in seed and straw yields of isabgol due to different levels of nitrogen might be nitrogen is an essential constituent of plant tissue and involved in cell devision and cell elongation, its beneficial effect on growth and yield characters of plant. The positive role played by the nutrient on growth and metaboism of plants, which increased the accumulation of matter in plant. Other reason might be due to favourable influence of N on growth and

Table 1. Effect of different levels of nitrogen, phosphorus and potassium on yield and nutrients content of Isabgol

Treatment	Yield (kg ha^{-1})		Nitrogen Content (%)		Phosphorus content(%)		Potassium content(%)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Nitrogen levels (kg ha^{-1}) (N)								
N_1- 15	915	5021	1.17	1.43	1.49	1.30	1.50	1.42
N_2- 30	1115	5760	1.36	1.55	1.63	1.44	1.60	1.55
N_3- 45	1243	6459	1.66	1.77	1.79	1.71	1.70	1.72
S. Em. +	31	139	0.02	0.03	0.01	0.02	0.03	0.02
C.D. (P=0.05)	89	395	0.06	0.08	0.04	0.06	0.08	0.05
Phosphorus levels (kg ha^{-1}) (P_2O_5)								
P_1- 0	998	5427	1.33	1.53	1.59	1.44	1.57	1.51
P_2- 15	1096	5752	1.39	1.61	1.63	1.45	1.61	1.58
P_3- 30	1179	6062	1.47	1.61	1.70	1.55	1.62	1.60
S. Em. +	31	139	0.02	0.03	0.01	0.02	0.03	0.02
C.D. (P=0.05)	89	395	0.06	NS	0.05	0.06	NS	0.05
Potassium levels (kg ha^{-1}) (K_2O)								
K_1- 0	1054	5669	1.37	1.58	1.63	1.46	1.60	1.55
K_2- 30	1128	5824	1.42	1.59	1.64	1.50	1.60	1.58
S. Em. +	26	113	0.01	0.02	0.01	0.02	0.02	0.01
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Interactions	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	14.1	11.85	7.36	8.20	5.21	6.99	8.57	5.46

Table 2. Effect of different levels of nitrogen, phosphorus and potassium on nutrients uptake of Isabgol

Treatment	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	Seed	Straw	Seed	Straw	Seed	Straw
Nitrogen levels (kg ha^{-1}) (N)						
N_1- 15	10.71	71.85	13.67	65.58	13.71	71.65
N_2- 30	15.22	89.92	18.23	83.26	17.85	89.27
N_3- 45	20.75	114.60	22.31	110.63	21.12	111.53
S. Em. +	0.52	3.02	0.55	2.72	0.55	2.53
C.D. (P=0.05)	1.49	8.58	1.57	7.73	1.57	7.18
Phosphorus levels (kg ha^{-1}) (P_2O_5)						
P_1- 0	13.47	83.92	16.01	78.97	15.79	82.54
P_2- 15	15.45	93.57	18.03	85.05	17.66	91.98
P_3- 30	17.75	98.89	20.17	95.44	19.23	97.93
S. Em. +	0.52	3.02	0.55	2.72	0.55	2.53
C.D. (P=0.05)	1.49	8.58	1.57	7.73	1.57	7.18
Potassium levels (kg ha^{-1}) (K_2O)						
K_1- 0	14.75	90.60	17.35	84.14	16.94	88.96
K_2- 30	16.37	93.65	18.79	88.84	18.18	92.67
S. Em. +	0.74	2.46	0.45	2.22	0.45	2.06
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Interactions	NS	NS	NS	NS	NS	NS
C.V. %	16.53	16.05	14.96	15.42	15.46	13.64

yield attributes *viz.*, number of tillers per plant, effective number of spikes per plant and length of spike which were important growth and yield attributes having significant positive correlation with the seed yield. As the grain yield is a product of yield attributing character, increase in their values resulted in increased seed and straw yields. The results are in conformity with the findings of Kumavat *et al*. (2002), Yadav *et al*. (2003), Wankhede *et al.* (2005) and Mir *et al.* (2007).

Effect of different nitrogen levels was found significant on the nitrogen, phosphorus and potassium content of seed and straw of isabgol. Application of 45 kg N ha^{-1} (N_3) was recorded significantly the highest nitrogen content of seed (1.66 %) and straw (1.77 %), phosphorus content of seed (1.79 %) and straw (1.71 %) and potassium content of seed (1.70 %) and straw (1.72 %).

Data presented in Table-2 indicated that significantly the highest nitrogen uptake of seed (20.75 kg ha^{-1}) and straw (114.60 kg ha^{-1}), phosphorus uptake of seed (22.31 kg ha^{-1}) and straw (110.63 kg ha^{-1}) as well as potassium uptake of seed (21.12 kg ha^{-1}) and straw (111.53 kg ha^{-1}) was noted in treatment N_3 (45 kg N ha^{-1}).

Effect of levels of phosphorus

In Indian Agriculture, phosphorus is second in importance to nitrogen. Phosphorous is essential for growth and productivity of plants. It plays an important role in plants in many physiological activities such as cell division, photosynthesis and development of good root system and utilization of carbohydrate.

The results on seed and straw yields of isabgol (Table 1) indicated that the differences due to different phosphorus levels were found significant. It was apparently from the results that the seed and straw yields of isabgol displayed on increasing trend with the different phosphorus levels. The significantly maximum seed (1179 Kg ha^{-1}) and straw (6062 Kg ha^{-1}) yields were registered under the treatment P_3 (30 Kg P_2O_5 ha^{-1}), however it was at par with treatment P_2 (15 kg P_2O_5 ha^{-1}). The lower seed (998 kg ha^{-1}) and straw (5427 kg ha^{-1}) yields were observed with treatment P_1 (control) which was at par with treatment P_2 (15 kg P_2O_5 ha^{-1}) for straw yield. The increase in seed yield of isabgol under the treatments P_3 (30 Kg P_2O_5 ha^{-1}) and P_2 (15 kg P_2O_5 ha^{-1}) were at the extent of 18.14 % and 9.82 %, respectively as compared to P_1 (control). The increase in straw yield of isabgol under the treatments P_3 (30 Kg P_2O_5 ha^{-1}) and P_2 (15 kg P_2O_5 ha^{-1}) were at the extent of 11.70 % and 5.99 %, respectively as compared to P_1 (control). The increase in seed and straw yields of isabgol due to levels of phosphorus might be due to favourable influence of P on growth and yield attributes *viz.*, number of tillers per plant, effective number of spikes per plant and length of spike. Which were important growth and yield attributes having significant positive correlation with the seed yields. The higher yields of isabgol seed and straw obtained by application of 30 kg P_2O_5 ha^{-1}. The results are conformity with the findings of Jadav *et al.* (2000) and Utgikar *et al.* (2003).

Perusal of data presented in Table-1 indicated that significantly the highest nitrogen content in seed (1.47 %), phosphorus content in seed (1.70 %) and straw (1.55 %) and potassium content in straw (1.60 %) was noted in treatment P_3 (30 kg P_2O_5 ha^{-1}) over the rest of phosphorus levels.

Application of 30 kg P_2O_5 ha^{-1} (P_3) recorded significantly the highest nitrogen uptake of seed (17.75 kg ha^{-1}) and straw (98.89 kg ha^{-1}), phosphorus uptake of seed (20.17 kg ha^{-1}) and straw (95.44 kg ha^{-1}). Significantly higher potassium uptake of seed (19.23 kg ha^{-1}) and straw (97.93 kg ha^{-1}) compared to other phosphorus levels. The highest nutrient uptake obtained by application of 45 kg N ha^{-1} might be due to increase in nutrient content by isabgol crop and the results are conformity with the findings of Mann and Vyas (1999).

Effect of levels of potassium

The appraisal of mean data (Table-1) pertaining to the influence of different potassium levels on the seed and straw yields of isabgol indicated that there existed non-significant difference. However, maximum seed (1128 kg ha^{-1}) and straw (5824 kg ha^{-1}) yields of isabgol recorded at application of potassium at 30 kg ha^{-1}.Response of potassium was found to be non-significant in case of nutrient content and uptake by seed and straw.

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