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Effect of levels of NPK on growth and yield of Isabgol (*Plantago ovata* Forsk)

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Abstract

An experiment was conducted at Horticulture Experimental Farm, College of Horticulture, Mandsaur (Madhya Pradesh, India) to study the effect of different levels of nitrogen, phosphorus and potassium on growth and yield of Isabgol (*Plantago ovata* Forsk) using randomized block design with 3 replications. There were 9 treatments in the experiment *viz.,* 30:15:10 kg NPK ha^{-1}, 30:15:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 60:30:10 kg NPK ha^{-1}, 60:30:20 kg NPK ha^{-1} and absolute control. Results revealed that application of 60:30:20 kg NPK ha^{-1} gave significantly higher value of growth, and yield attributes and economics as compared to other treatments.

Key words: Growth, Isabgol, nitrogen, phosphorus, potassium, yield

Introduction

Blond psyllium (*Plantago ovata* Forsk.) commonly known as "Isabgol" is one of the important medicinal plant. It's an important winter season crop belongs to the family plantaginaceae. It comprises about 200 species of which 10-14 are native of India. But only three species *P. ovata, P. psyllum* and *P. indica* are economically important. India has the monopoly in production and export of the seed and husk in the world market (Farooqi and Sreeramu, 2001). About 80-90 per cent of the produce is exported to various countries. In India, Isabgol is commercially cultivated in the states of Madhya Pradesh, Gujarat and Rajasthan. In Madhya Pradesh, it is largely grown in Neemuch and Mandsaur districts, covering an area of 6400 ha, with a total production of 8960 tonnes and productivity of 1.4 mt (Anonymous, 2015). India produces 9 million tonnes of blond psyllium which is 98% of the world's total production.

The response and requirement of various nutrients differ widely on the agro-climatic condition and management practices. Among the nutrients, the application of nitrogen, phosphorus and potassium have been found to play significant role in improving the yield potential and quality of seed and husk of Isabgol under variable range of soil and agro-climatic conditions and their application in proper amount and in proper time will go for higher crop production. Availability of nitrogen is of prime importance for growing plants as it is a major and indispensable constituent of protein and nucleic acid molecules (Troug, 1973). The increased nitrogen supply is known to accelerate the synthesis of chlorophyll and amino acid resulting in increased vegetative growth. 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. It is constituent of nucleic acid, phytin and phospholipids (Jajoria *et al.,* 2013). Potassium application increases the plant's growth and yield because it participates in the mechanism of stomatal movement, photosynthesis and helps in osmo-regulatory adaption of plant due to water stress (Patel *et al.,* 2012). Adequate potassium nutrition has been shown to enhance disease resistance in plants. Keeping all these in mind, a study on effect of different levels of nitrogen, phosphorus and potassium on growth and yield of Isabgol (*Plantago ovata* Forsk) was conducted.

Materials and methods

The field experiment was conducted during Rabi season of 2015-16 at the Horticulture Experimental Farm, College of Horticulture, Mandsaur (Madhya Pradesh) on light black loamy soil having pH 7.8, EC 0.65 dS/m, 175 kg available nitrogen ha^{-1}, 11.2 kg available phosphorus ha^{-1} and 355 kg available potassium ha^{-1}. The average annual rainfall was 744 mm. The experiment was conducted using randomized block design with three replications. There were 9 treatments in the experiment *viz.,* 30:15:10 kg NPK ha^{-1} (T_1), 30:15:20 kg NPK ha^{-1} (T_2), 30:30:10 kg NPK ha^{-1} (T_3), 30:30:20 kg NPK ha^{-1} (T_4), 60:15:10 kg NPK ha^{-1} (T_5), 60:15:20 kg NPK ha^{-1} (T_6), 60:30:10 kg NPK ha^{-1}, 60:30:20 kg NPK ha^{-1} (T_8) and control (T_9). The Isabgol *cv.,* JI-4 was sown in each plot. Treatments were applied in the form of urea, SSP and MOP. Full dose of phosphorus and potash were applied prior to sowing. Nitrogen was applied in two split doses at 40 and 55 days after sowing (DAS).

Data recorded for various growth and yield parameters were statistically analyzed using the analysis of variance as described by Panse and Sukhatme (1985).

Result and discussion

Plant height: Plant height was significantly affected by application of different levels of nitrogen, phosphorus and potash. The highest significant plant height was recorded at 30, 60 and 90 DAS (12.50, 26.58 and 40.11 cm, respectively) under the treatment 60:30:20 kg NPK ha^{-1}, which was 75.31, 79.59 and 77.71 percent higher over absolute control, respectively. However, the statistically at par value of plant height were observed between treatment 60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1}, 30:15:20 kg NPK ha^{-1}and 30:15:10 kg NPK ha^{-1}. The difference in plant height of Isabgol may be due to the better nutritional environment in the root zone as well as in the plant system which enhanced meristematic activity leading to increased plant height and dry matter accumulation. These results are in close conformity with the findings of Utgikar *et al.* (2003), Reddy (2014) and Patel *et al.* (2015)

Leaves per plant : Data reveals that application of 60:30:20 kg NPK ha^{-1} significantly increased the number of leaves per plant at 30, 60 and 90 DAS. The significant maximum number of leaves plant^{-1} recorded at 90 DAS (36.30) in treatment application of 60:30:20 kg NPK ha^{-1} as compared to other treatments, which was 111 percent higher over absolute control. While, the number of leaves per plant observed due to 60:15:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1} and 30:15:20 kg NPK ha^{-1} were statistically at par with each other. The increase in number of leaves might be due to the production of more dry matter with the application of balanced dose of nitrogen, phosphorus and potash. The response of NPK fertilization is further supported by the fact that the soil of experimental field was low in nitrogen and medium in phosphorus status and as a result of its early supply to the crop, corrected the deficiency and improved overall crop growth considerably. These results are in close conformity with the findinings of Singh *et al.* (2000), Omidbaigi and Mohebby (2002), Wankhade *et al.* (2005), Ashraf *et al.* (2006), Chouhan *et al.* (2006) and Patel *et al.* (2015) in Isabgol.

Tillers per plant: A perusal of data presented in Table 1 indicated that tillers per plant were significantly affected by different levels of nitrogen, phosphorus and potash. On the basis of mean data recorded at 90 DAS, significantly higher total number of tillers per plant (4.41) was recorded under treatment 60:30:20 kg NPK ha^{-1} which was 12.5, 16.05, 18.48, 22.84 and 60.94 percent higher as compared to 60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1} and absolute control, respectively. Increase in number of tillers per plant might be due to increased growth of plant in the form of height and number of leaves, which accumulated more photosynthates and thereby increased number of tillers per plant. These findings are in the close conformity with the findings of Utgikar *et al.* (2003) in Isabgol.

Spikes per plant: The application of nitrogen phosphorus and potash significantly affected the number of spikes plant^{-1} recorded at 60 and 90 DAS. Application of 60:30:20 kg NPK ha^{-1} gave significantly higher number of spikes plant^{-1} *i.e.* 31.13 at 90 DAS, which was 9.15, 21.17, 26.90 and 77.98 percent higher as compared to 60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1} and absolute control, respectively. Increase in number of spikes may be due to the fact that NPK application accelerated the development of leaf number, which is positively correlated with the number of spikes. Similar results were also reported by Utgikar *et al.* (2003), Waghmare *et al.* (2010), Narolia *et al.* (2013), Jajoria *et al.* (2013) and Patel *et al.* (2015).

Length of spike: An examination of data shows that treatment 60:30:20 kg NPK ha^{-1} gave significantly highest length of spike *i.e.* 3.80 cm and 5.98 cm at 60 and 90 DAS, respectively which was 52.43 and 51.97 percent higher as compared to absolute control, respectively. Further, it was observed that 60:15:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1}, 30:15:10 kg NPK ha^{-1} were statistically at par with each other with respect to length of spike. Increase in length of spikes may be due to the fact that NPK application increased leaf number, which is positively correlated with the length of spikes. Similar results were also reported by Utgikar *et al.* (2003), Waghmare *et al.* (2010), Narolia *et al.* (2013), Jajoria *et al.* (2013) and Patel *et al.* (2015).

Seeds per spike: A critical examination of data in Table 1 showed that the application of NPK significantly affected the number of seeds per spike. Application of 60:30:20 kg NPK ha^{-1} gave significantly higher number of seeds spike^{-1} (62.40) which was 2.71, 3.81 and 31.64 percent higher as compared to

Table 1. Effect of different levels of nitrogen, phosphorus and potash on growth and yield attributes of Isabgol

Treatments N:P:K kg ha^{-1}	Plant height (cm)	Leaves plant^{-1}	Tillers plant^{-1}	Spikes plant^{-1}	Length of spike (cm)	Seeds spikes^{-1}	Test weight (g)
30:15:10	28.14	22.93	3.12	20.08	3.54	51.70	1.59
30:15:20	29.89	23.20	3.54	21.27	3.65	53.86	1.63
30:30:10	30.49	24.50	3.59	23.07	3.89	54.76	1.68
30:30:20	32.48	23.34	3.72	24.53	4.07	56.50	1.79
60:15:10	35.35	27.10	3.80	25.08	4.70	59.07	1.83
60:15:20	36.91	29.11	3.84	25.69	4.87	59.37	1.89
60:30:10	37.14	33.17	3.92	28.52	5.45	60.22	1.98
60:30:20	40.11	36.30	4.41	31.13	5.98	62.40	2.09
Control	22.57	17.20	2.74	17.49	2.90	47.40	1.44
S. Em. ±	0.95	0.81	0.12	0.84	0.17	0.27	0.02
CD at 5%	2.87	2.44	0.36	2.53	0.51	0.83	0.08

Table 2. Effect of different levels of nitrogen, phosphorus and potash on yield and economics of Isabgol

Treatments N:P:K kg ha^{-1}	Seed yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
30:15:10	6.50	22.10	28.60	22.73	52000	31680	1.56
30:15:20	6.95	22.70	29.65	23.47	55600	35010	1.70
30:30:10	7.50	23.60	31.10	24.11	60000	38975	1.86
30:30:20	8.40	24.17	32.57	25.79	67200	45905	2.15
60:15:10	9.50	25.70	35.20	27.00	76000	55360	2.69
60:15:20	9.75	26.62	36.37	26.81	78000	57090	2.73
60:30:10	10.50	28.20	38.70	27.13	84000	62730	2.95
60:30:20	11.43	30.72	42.15	27.11	91440	69900	3.25
Control	5.46	19.45	24.91	21.91	43680	25230	1.37
S. Em. ±	0.24	0.84	0.99	0.70	1957	1957	0.09
CD at 5%	0.73	2.51	2.98	2.10	5867	5867	0.28

60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1} and absolute control, respectively. However, the seeds spike^{-1} under the treatment 60:15:20 kg NPK ha^{-1} and 60:15:10 kg NPK ha^{-1} were statistically at par with each other. Increase in the number of seeds per spike might be due to the fact that N P K is expected to hasten plant development and longer period for movement of photosynthates from source to sink. Similar results were also augmented by Owla *et al.* (2004), Wankhede *et al.* (2005), Narolia *et al.* (2013), Ahirwar *et al.* (2014), Mor *et al.* (2014) Patel *et al.* (2015) and Shivran (2016) in Isabgol.

Test weight: The significantly highest test weight of 2.09 g was recorded with treatment 60:30:20 kg NPK ha^{-1} and the increment was 45.13 percent as compared to absolute control. The test weight due to treatment 60:15:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1}, 30:15:20 kg NPK ha^{-1} and 30:15:10 kg NPK ha^{-1} were statistically at par with each other. NPK plays an vital role in the process of grain filling, increase in leaf area of crop result in increased dry matter production by intercepting more sunlight. Similar results have been also reported by Patel *et al.* (2015) in Isabgol.

Seed yield: Application of different levels of nitrogen, phosphorus and potash significantly affected the seed yield of Isabgol. Treatment 60:30:20 kg NPK ha^{-1} gave significantly higher seed yield (11.43 q/ha) which was 8.85, 17.23, 36.07 and 109.34 percent higher as compared to treatment 60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1} and absolute control, respectively. Significant increment in seed yield of Isabgol may be due to the increase in the tillers per plant, spikes per plant, seeds per spike, test weight with the fact that N P K is expected to hasten plant development and longer period for movement of photosynthates from source to sink. Ultimately, these characters had beneficial effect on higher seed yield. Similar result was also reported by Ashraf *et al.* (2006), Ahirwar *et al.* (2014), Kumar *et al.* (2015), Patel *et al.* (2015) and Shivran (2016).

Straw yield: The data presented in Table 2 reveals that the application of nitrogen phosphorus and potash significantly affected the straw yield of Isabgol. Treatment 60:30:20 kg NPK ha^{-1} gave significantly higher straw yield (30.72 q/ha) which was 8.93, 27.09 and 57.94 percent higher as compared to 60:30:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1} and absolute control, respectively. The straw yield of Isabgol due to treatment 60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1}, 30:15:20 kg NPK ha^{-1} and 30:15:10 kg NPK ha^{-1} was statistically at par with each other. Probably, increment in plant height, more tillers per plant and higher dry matter accumulation due to application of NPK resulted in ultimate higher straw yield of Isabgol. Similar result was also reported by Solanki and Shaktawat (1999), Ashraf *et al.* (2006), Ahirwar *et al.* (2014), Kumar *et al.* (2015), Patel *et al.* (2015) and Shivran (2016).

Biological yield: Data showed that biological yield of Isabgol was significantly affected by different levels of nitrogen phosphorus and potash. The highest biological yield (42.15 q ha^{-1}) was recorded under treatment 60:30:20 kg NPK ha^{-1}, which was 8.91, 29.41 and 69.20 percent higher as compared to 60:30:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1} and absolute control, respectively. The biological yield was statistically at par with each other among the treatment 60:30:10 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1}, 30:30:20 kg NPK ha^{-1}, 30:30:10 kg NPK ha^{-1}, 30:15:20 kg NPK ha^{-1} and 30:15:10 kg NPK ha^{-1}. Significantly higher seed and straw yield of Isabgol due to balanced dose of NPK ultimately increased the biological yield of Isabgol. Similar result was also reported by Ashraf *et al.* (2006), Ahirwar *et al.* (2014), Kumar *et al.* (2015), Patel *et al.* (2015) and Shivran (2016) in Isabgol.

Harvest index: A perusal of data presented in Table 2 reveals that harvest index was influenced due to different levels of nitrogen, phosphorus and potash. The significant highest harvest index (27.13 %) was recorded under treatment 60:30:10 kg NPK ha^{-1} but it was statistically at par with 60:30:20 kg NPK ha^{-1}, 60:15:20 kg NPK ha^{-1}, 60:15:10 kg NPK ha^{-1} and 30:30:20 kg NPK ha^{-1}, respectively.

Economics: The maximum gross return (Rs. 91440 ha^{-1}), net return (Rs. 69900 ha^{-1}) and B:C ratio (3.25:1) was recorded in the treatment 60:30:20 kg NPK ha^{-1}. While, minimum gross return (Rs 43680 ha^{-1}), net return (Rs 25230 ha^{-1}) and B: C ratio (1.37:1) was registered in absolute control.

The study revealed that different levels of nitrogen, phosphorus, and potassium influenced growth and yield of Isabgol. The application of 60:30:20 kg NPK ha^{-1} resulted in significantly higher values of growth, yield attributes, and economics.

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