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Effect of Potassium and Zinc on Yield and Yield Attributes of Isabgol (*Plantago ovata* Forsk.)

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ABSTRACT: A successful cultivation of any crop envisages sufficient knowledge about the nutritional requirement of plant. The response and requirement of various nutrients differ widely on the agro-climatic condition and management practices. A field study was conducted during rabi 2021-22 at the Instructional Farm of the Rajasthan College of Agriculture, Udaipur to study the effect of different levels of potassium and zinc on growth, productivity and quality of isabgol using randomized block design with 3 replications. The experiment consisted of 12 treatments comprising of fertilizers combinations *viz*., 40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 + 20 kg ha^{-1} K_2O, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 and control. The results revealed that application of 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn resulted in significantly higher yield and yield attributes of isabgol.

Keywords: Potassium and Zinc on Yield, Yield Attributes of Isabgol.

INTRODUCTION

Isabgol (*Plantago ovata* Forsk.) is an important herb that has been used in health care for many centuries in South Asia, whereas it is now widely used for its medicinal properties all over the world. India has the monopoly in production and export of the seed and husk in the world market (Farooqi and Sreeramu 2001). Isabgol is a major contributor to the export earnings. The crop covers 336327 hectares with the production of 193702 tonnes and average productivity of 576 kg ha^{-1} (Agriculture Statistics, 2018-19) in Rajasthan. The seeds of isabgol are composed of many different types of chemicals that are used as medicine. It contains mucilage, fatty oil, proteins, carbohydrates, mineral element, etc. Seed oils are used to make soap, paint, printing inks, and other industrial supplies. Potassium 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. 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). Zinc is an essential element for plant that act as a metal component of various enzymes, involved in RNA metabolism and ribosomal content in plant cells, stimulation of carbohydrates, proteins synthesis, DNA formation, cell division, maintenance of membrane structure and function and sexual fertilization. It also helps in the utilization of phosphorus and nitrogen in plants. Response to applied zinc for better growth and yield of several important field crops has been reported from almost all corners of the country.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* season of 2021-22 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) on clay loam soil

having pH 7.8, EC 0.75 dS m^{-1}, 283.44 kg available nitrogen ha^{-1}, 22.2 kg available phosphorus ha^{-1} and 279.3 kg available potassium ha^{-1}. The average annual rainfall was 637 mm. The experiment was conducted using randomized block design with three replications. There were 12 treatments in the experiment *viz*., 40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 + 20 kg ha^{-1} K_2O, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 and control. The Isabgol *cv*., UI-124 was sown in each plot. Treatments were applied in the form of urea, SSP, MOP and $ZnSO_4$. Full dose of phosphorus, potash and zinc were applied prior to sowing. Nitrogen was applied in three equal doses *viz*. 1/3rd at sowing, 1/3rd after hoeing and 1/3rd at flower initiation. 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

The data related to yield attributes are presented in Table 1.

Total tillers plant^{-1}. A perusal of data reveals that significantly higher number of total tillers were found with the application of T_7 - 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (8.36) which was at par with application of T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn). It was observed that subsequent addition of fertilizer resulted in increased number of tillers while minimum numbers were observed under unfertilized plot.

Effective tillers plant^{-1}. An examination of data clearly establishes that the application of plant nutrients in the form of fertilizers significantly increased number of effective tillers plant^{-1} compared to control. Significantly high number of effective tillers (7.52) were obtained when crop was supplied with 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (T_7). Minimum effective tillers in isabgol crop were reported in no application of nutrients.

No. of spikes plant^{-1}. The number of spikes plant^{-1} was found significantly higher under application of 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (T_7) which was at par with T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn). It was found 8.19 per cent higher over control.

Spike length plant^{-1}. A perusal of data reveal that with application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) significantly higher spike length plant^{-1} (4.42) was found. Minimum spike length was found under unfertilized plot (3.01).

No. of seeds spike^{-1}. A significantly high no. of seeds spike^{-1} (42.80) was found under the treatment T_7 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) which was found at par with rest of the treatments involving higher dose of nutrients. The minimum number was found under control (36.50).

Test weight (g). The data show that test weight of isabgol was significantly enhanced by applying nutrients through various sources. While application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) resulted in significantly higher test weight (1.82 g), its effect was at par except application of T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn). Minimum test weight was recorded under the control (1.44 g).

Yield and Harvest Index. The data related to yield and harvest index are presented in Table 2.

Seed Yield. The data show that application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) significantly increased seed yield (1225 kg ha^{-1}) over T_6 (20 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn) by 11.26 per cent, however, it was found at par with T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn). The minimum seed yield was recorded under control (672 kg ha^{-1}).

Straw Yield. An examination of data shows that isabgol crop supplied with nutrients in different combination produced significantly higher straw yield over control. Application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) produced significantly high straw yield (1931 kg ha^{-1}) which was 38.32 per cent higher over control but it was at par with application of higher doses of potassium and zinc. Lowest yield was recorded in no application of nutrients i.e., control (1396 kg ha^{-1}).

Biological Yield. Enhancement of 13.53 to 59.23 per cent was recorded in terms of biological yield of isabgol by applying various treatments to supply nutrients over control. The significant increase in biological yield was observed with application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) which was at par with higher application of nutrients.

Harvest index. Application of various treatments to isabgol reveals that application of 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn resulted in maximum harvest index than higher doses of potash and zinc. However, minimum harvest index was recorded under control.

This might be due to the vigorous vegetative growth resulting in higher photosynthate production and translocation from source to the sink which is apparent on reproductive growth *viz.*, number of tillers plant^{-1}, number of spikes plant^{-1}, number of seeds spike^{-1} and 1000 seed weight which were the important yield attributes having significant positive effect on seed yield. Increase in number of tillers plant^{-1} 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 plant^{-1} (Sahu *et al.,* 2021). The similar results were found by Davara *et al.* (2019). Likewise, increase in yield attributes and yield with increasing zinc levels was reported by Shivran *et al.* (2016) and Mishra *et al.* (2016).

Table 1: Effect of nutrient management on yield attributes of isabgol.

Treatment	Total tillers plant^{-1} (no.)	Effective tillers plant^{-1} (no.)	No. of spikes plant^{-1} (no.)	Spike length plant^{-1} (cm)	No. of seeds spike^{-1} (no.)	Test weight (g)
T_1 - Control	5.28	4.10	41.01	3.01	36.50	1.44
T_2 - N:P (40:20)	5.74	4.61	41.96	3.68	37.30	1.51
T_3 - N:P:K (40:20:20)	6.36	5.16	42.15	4.22	38.20	1.69
T_4 - N:P:K:Zn (40:20:20:20)	6.78	5.38	42.34	4.16	38.90	1.74
T_5 - N:P:K:Zn (40:20:20:25)	6.66	5.71	42.56	4.22	40.70	1.76
T_6 - N:P:K:Zn (40:20:20:30)	7.12	6.13	42.77	4.29	41.20	1.77
T_7 - N:P:K:Zn (40:20:30:20)	8.36	7.52	44.37	4.42	42.80	1.82
T_8 - N:P:K:Zn (40:20:30:25)	8.48	7.54	44.42	4.57	43.10	1.83
T_9 - N:P:K:Zn (40:20:30:30)	8.53	7.61	44.57	4.65	43.50	1.85
T_{10} - N:P:K:Zn (40:20:40:20)	8.75	7.64	45.64	4.62	44.20	1.87
T_{11} - N:P:K:Zn (40:20:40:25)	8.78	7.69	45.86	4.71	45.60	1.89
T_{12} - N:P:K:Zn (40:20:40:30)	9.00	7.76	46.20	4.74	46.10	1.91
SEm±	0.284	0.223	1.131	0.142	1.430	0.03
CD (P=0.05)	0.834	0.655	3.317	0.418	4.194	0.09

Table 2: Effect of nutrient management on yield and harvest index of isabgol.

Treatment	Yield (kg ha^{-1})			Harvest index (%)
	Seed	Straw	Biological	
T_1 - Control	672	1396	2068	32.54
T_2 - N:P (40:20)	786	1562	2348	33.53
T_3 - N:P:K (40:20:20)	886	1769	2655	33.50
T_4 - N:P:K:Zn (40:20:20:20)	963	1853	2816	34.22
T_5 - N:P:K:Zn (40:20:20:25)	1046	1864	2909	35.93
T_6 - N:P:K:Zn (40:20:20:30)	1101	1870	2972	37.03
T_7 - N:P:K:Zn (40:20:30:20)	1225	1931	3156	38.80
T_8 - N:P:K:Zn (40:20:30:25)	1227	1982	3209	38.19
T_9 - N:P:K:Zn (40:20:30:30)	1253	2024	3277	38.24
T_{10} - N:P:K:Zn (40:20:40:20)	1235	1941	3176	38.78
T_{11} - N:P:K:Zn (40:20:40:25)	1243	1991	3234	38.47
T_{12} - N:P:K:Zn (40:20:40:30)	1257	2036	3293	38.16
SEm±	44.23	56.16	72.35	1.12
CD (P=0.05)	129.74	164.70	212.18	3.28

CONLUSION

From the present investigation, it is concluded that isabgol crop must be supplied with 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn along with 40 kg ha^{-1} N and 20 kg ha^{-1} P_2O_5 as soil application to get higher productivity and improved quality in prevailing agro-climatic conditions of zone IVa (Sub-Humid Southern Plain and Aravali Hills) of Rajasthan.

FUTURE SCOPE

Adequate potassium nutrition is required for many vital processes and to increase disease resistance in plants. Micronutrients play an important role in increasing yield, quality and chlorophyll content of crop by bringing about many vital changes in nutrition of plants. Hence, they must be applied in the required amount to improve the overall productivity and quality of the crop.

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