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The Influence of Sowing Dates and Nitrogen Fertilizer on the Productivity of *Plantago ovata*

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Abstract: The influence of sowing dates carried out on 5 April, 20 April, 5 May and 20 May as well as nitrogen-fertilizer applied in 0, 50, 100 and 150 kg ha^{-1} dosages were studied on the growth, seed yield and seed swelling factor of isabgol (*Plantago ovata*). The best time for sowing of isabgol in this region was 5 May and the suitable amount of nitrogen was 100 kg ha^{-1}. The stepwise multiple regression analysis verified that the seed yield among other characters studied showed a significant positive effect on seed swelling.

Key words: Isabgol, *Plantago ovata*, sowing dates, nitrogen- fertilizers, swelling factor, Zanjan, Iran

Introduction

Plants known as medicinal are rich in secondary metabolites have potential as drugs. The biosynthesis of the secondary metabolites, although controlled genetically, is affected strongly by environmental factors (Yanive and Palevitch, 1982; Omidbaigi, 2000). In this context, at Jammu, sowing between mid-October and mid-November is ideal. Late sowing, when winter rains are over, adversely tells upon seed yield due to short growth period (Koul and Sareen, 1999). However, Kalyansundram *et al.* (1984) reported that sowing of *Plantago ovata* during first week of December is considered ideal.

Isabgol has been used in medicine since ancient times, but it has been cultivated as a medicinal plant only in recent decades (Gupta, 1987; Wolver *et al.*, 1994; Handa and Kaul, 1999; Lal *et al.*, 1999). The seed of isabgol contains mucilage, fatty oil, large quantities of albuminous matter a pharmacologically inactive glucoside, namely Aucubin (C_{13} H_{19} O_8 H_2O) and a pentose sugar (Sharma and Koul, 1986; Jamal *et al.*, 1987; Chevallier, 1996). The seed husk has the property of absorbing and retaining water which accounts for its utility in checking diarrhoea. It is diuretic, alleviates kidney and bladder complaints, gonorrhea, arthritis and hemorrhoids (Zargari, 1990; Ansari and Ali, 1996).

Isabgol (*Plantago ovata* Forsk) is a 10-45cm tall stem less of short-stemmed annual herb belonging to the Plantaginaceae family. Isabgol abounding warm temperate region between 26 -36°N, latitude. The species is indigenous to Mediterranean region and west Asia extending up to west Pakistan (Koul and Sareen, 1999; Bagallian, 1999).

Concerning the effect of nitrogen on *Plantago ovata,* Koul and Sareen (1999) reported if the quantity of nitrogen applied is increased from 0-50 kg/ha, it induces reduction in nitrogen concentration and swelling factors of seeds.

Randhawa *et al.* (1985) reported an increase in seed yield following the increase in nitrogen application. In Tarai area, highest seed yield has been recorded by application of 40-80 kg ha^{-1} nitrogen (Singh and Nand, 1988).

Therefore, the purpose of this study was to find the suitable sowing date and the effect of nitrogen-fertilizer, which could be used for isabgol cultivation in order to improve the quantity and quality of isabgol productivity, and to clarify a relationship among measured characteristics.

Materials and Methods

Plants were grown in silty-clay soil with good drainage. The statistical design used was split-plot arrangement of randomized complete block design with three replicates in every treatment. The sowing dates were considered as the main plot. Each plot was of 7.5x 1.5m^2 area. The dates of sowing were 5 April, 20 April, 5 May and 20 May. Seeds of isabgol were sown in sub-plots in 30 cm apart rows and spaced 5cm apart. Effect of nitrogen fertilization was studied in sub- plots. An untreated control and three different nitrogen doses 50, 100 and 150 kg calculated to one hectare were used in the form of urea. Nitrogen received at two different times. Half of which were used 2 days before sowing the seeds and the rest at flowering stages. Hoeing and mechanical weeding were performed regularly. Irrigation was regularly provided during the vegetative period. All agronomic management practices were performed as needed. The effect of sowing date and nitrogen-fertilizer was measured by plant height, number of flowers and branches per plant, average seed weight and swelling factor.

To study the swelling factor, one gram of seed was put into beaker of 25 ml capacity. Then, 20ml-distilled water was added to it. The swelling of seeds was calculated after 24h.

The investigation was carried out in experimental station of Zanjan located in the north-west of Iran (Fig. 1) belonging to the Iranian Ministry of Agriculture. The station is situated in 1634 m above see level. The weather condition of the station can be characterized by semi-dry climate with 263 mm annual precipitation. The lowest temperature is around 3.9°C and the highest is 36°C. The main soil characteristics of the experimental station are as follows: sand = 17%, clay = 45%, silt = 40%, pH 7.6, K (ppm)= 334, P (ppm)= 7.8, total N= 0.08%, organic C= 0.82%. According to the soil analysis, we have applied 100 kg ha^{-1} triple super phosphate with 46% active substance uniformly to the soil.

To find out any relationship, we regressed the plant height, number of branches and flowers per plant, weight of 1000 seeds and seed yield as independent variable and seed swelling as dependent variable, using Minitab Statistical Software Package (Ryan *et al.*, 1985). The statistical mean comparisons were calculated according to Duncan's Multiple Range test.

Results and Discussion

Evaluating the results no interaction was found between the sowing date and nitrogen fertilization, neither on growth and seed yield nor on seed swelling. This is the reason why effect of two above mentioned factors are discussed separately.

Effect of sowing date: Seeds sown on 5 April were first grown normally but then under experimental site condition, chilling stress affected them and they no longer, grow. Hence we discuss the effects of sowing dates of 20 April, 5 May and 20 May.

On the basis of results (Table 1), sowing date had highly significant effect ($P< 0.001$) on plant height, number of branches and of flowers per plant, weight of 1000 seeds ($P< 0.05$), seed yield ($P< 0.001$). Higher values were consistently obtained from the third and the fourth sowing dates (5 and 20 May, respectively) followed by the second (20 April) one.

On seed swelling: There was a significant effect ($P< 0.01$) on seed swelling of third sowing date (5 May) (Fig. 2). The second (20 April) and the fourth (20 May) sowing dates produced a lower seed swelling (13.97 and 13.79 mm, respectively).

It could be concluded that sowing date has a very important role on the productivity of *Plantago ovata* (Koul and Sareen, 1999). Sowing of seeds in the early spring, chilling stress affected them and the plants were killed frost under environmental factors of our

Table 1: The means ± SE* of growth and seed characteristics of *Plantago ovata* from different sowing dates.

Sowing dates	plant height (cm)	No. of branches plant^{-1}	No. of flowers plant^{-1}	1000 seeds weight (g)	Seed yield (g m^{-2})
April 20	11.41b ± 0.32	3.23b ± 0.18	4.51b ± 0.25	5.90b ± 0.05	64.82b± 0.83
May 5	18.06a ± 0.46	5.67a ± 0.32	8.18a ± 0.53	6.20a ± 0.04	91.04a± 2.74
May 20	16.68a ± 0.17	6.34a ± 0.29	8.16a ± 0.38	6.05ab± 0.65	65.28b± 1.84

Means followed by the similar letters in each column - according to Duncan's multiple range test - are not significantly different from each other.
* SE = Standard error

Table 2: The means ± SE* of growth and seed characteristics of *Plantago ovata* in different N-fertilizer levels.

N– fertilizer (Kg ha^{-1})	Plant height (cm)	No. of branches plant^{-1}	No. of flowers plant^{-1}	1000 seeds weight (g)	Seed yield (g m^{-2})
0	14.13c ± 0.97	4.16c ± 0.40	5.46c ± 0.47	5.94b± 0.072	66.78d ± 3.44
50	15.21b ± 1.07	4.69b ± 0.48	6.49b ± 0.64	6.02b ± 0.043	71.22c± 4.07
100	15.67b± 1.02	5.97a ± 0.65	8.16a ± 0.81	6.27a ± 0.070	82.13a± 5.67
150	16.52a ± 1.11	5.51a ± 0.49	7.69a ± 0.73	5.98b ± 0.076	74.80b± 4.45

Means followed by the similar letters in each column-according to Duncan's multiple range test - are not significantly different from each other.
* SE = Standard error

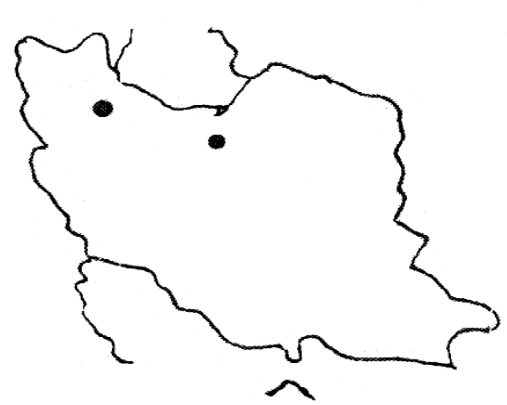

Fig. 1: Location of experimental station (Zanjan) comparing to Tehran

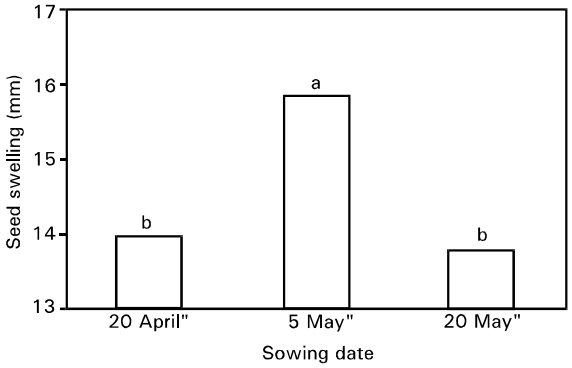

Fig. 2: Effect of sowing dates on seed swelling factor of *Plantago ovata*

experimental station. It seems that the best date for sowing of *Plantago ovata* to be within the first week of May (exactly 5th of May).

Effect of nitrogen - fertilizer: The plant height, number of branches and of flowers per plant and weight of 1000 seeds were influenced by nitrogen-fertilization (Table 2). The highest plant (16.52 cm), the largest, number of branches (5.97) and of flowers (8.16) per plant and the largest weight of 1000 seeds (6.27 g) were formed in the plot which received a N level of 100-150kg ha^{-1}.

Supplying nitrogen-fertilizer influenced the isabgol seed yield significantly ($P< 0.01$). Plant receiving 100 kg ha^{-1} nitrogen produced the highest seed yield (74.80g m^{-2}) as compared with other treatments.

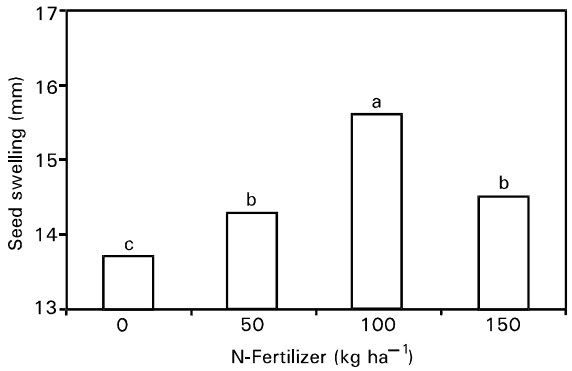

Fig. 3: Effect of nitrogen - fertilizer on seed swelling factor of *Plantago ovata*

On seed swelling: The results indicated (Fig. 3) that nitrogen-fertilizer had a significant effect ($P< 0.001$) on the seed-swelling factor of isabgol. The highest seed swelling (15.61 mm) was resulted from seeds treated with 100 kg ha^{-1} nitrogen, and there was no significant effect between the seed swelling of isabgol receiving 50 and 150kg ha^{-1} nitrogen.

Dealing with the effect of nitrogen fertilizer, it was evident that the level of nitrogen top dressing had a positive effect on the productivity of *Plantago ovata*. It could be concluded from the results that the best treatment for cultivation of *Plantago ovata* is to use 100 kg ha^{-1} nitrogen and apply it before seed sowing (50 kg ha^{-1}) and at flowering stage (50 kg ha^{-1}). Similar findings were reported by Ganpat *et al.* (1992); Singh and Nand (1988) and Ramash *et al.* (1989).

Relationship among measured characteristics: Plant breeders need production measurement of given traits in order to improve plant characteristics. Often, certain plant is hard to measure, therefore, relationship of desired traits among production variables is used as an indirect process. Hence, in order to formulize the relationship between five independent variables measured in our experiment, with a dependent variable, multiple regression analysis was carried out for the plant height, number of branches and flowers per plant, weight of 1000 seeds and yield as independent variables and seed swelling as a dependent variable. The multiple regression equation is shown as follows:

Seed swelling = 7.18 - 0.00185 (X1) + 0.0063 (X2) - 0.0031(X3) + 0.328 (X4) + 0.0824 (X5).

X1 = Plant height (cm)
X2 = No. of branches plant^{-1}
X3 = No. of flowers plant^{-1}
X4 = 1000 seeds weight (g)
X5 = Seed yield (g m^{-2})
Seed swelling (mm)
7.18 = Constant value

Furthermore, the stepwise regression analysis was also Carried out for the data obtained to test the significance of independent variables shown in the above equation affecting the seed swelling as a dependent variable. Therefore, the stepwise regression equation is shown as follows :

Seed swelling = 8.874 + 0.0765 (X5)
R^2 = 75.4%

This equation indicates that only the seed yield trait among other independent variables showed a significant positive effect ($P< 0.05$) on seed swelling. In other words, with increasing 1 g of seed yield, 0.0765 mm of seeds were swelled.

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