



Research Article

Effect of Sowing Times and Nitrogen Application on the Growth and Production of Fennel (*Foeniculum vulgare*)

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Abstract | An experiment was carried out to investigate the effect of sowing times and nitrogen applications on the growth and production of fennel at the University of Agriculture, Peshawar, Pakistan. Experiment was laid out as Randomized Complete Block Design in split plots arrangement with two factors. Factor “A” was comprised of sowing times i.e. Autumn and Spring season while Factor “B” was nitrogen levels i.e. 0, 30, 40, 50 and 60 kg ha⁻¹. Fennel sown in autumn season (25th October) resulted in early germination (19.13), maximum plant height (146.07 cm), maximum days to 1st umbel appearance (132.27) and last umbel appearance (147.87), number of umbels plant⁻¹ (42.51), days to 1st umbel maturity (86.67), last umbel maturity (117.67) and seed yield (4590.79 kg ha⁻¹). While, fennel seeds sown on 25th February (spring) resulted in maximum days to germination (21.86), minimum plant height (96.67 cm), least days to 1st umbel appearance (83.33), last umbel appearance (95.87), minimum number of umbels plant⁻¹ (32.53), least days to 1st umbel maturity (38.73), last umbel maturity (58.73) and least seed yield (3540.71 kg ha⁻¹). Among nitrogen levels, nitrogen applied at 60 kg ha⁻¹ resulted in maximum plant height (134.83 cm), least days to 1st umbel appearance (104.50), more number of umbels plant⁻¹ (44.85), seed yield (4684.37 kg ha⁻¹) that was statistically at par with application of nitrogen at 40 and 50 kg ha⁻¹. It can be concluded that autumn sown crop was superior as compared to spring crop for better production of fennel, while nitrogen at 40 kg ha⁻¹ could be recommended for better growth and seed production of fennel.

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Keywords | Fennel, Autumn season, Spring season, Nitrogen, Seed production, Nutrient management, Medicinal plant



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Introduction

Fennel (*Foeniculum vulgare*) belongs to the family Umbelliferae. It's an important herbaceous medicinal plant mainly grown for its seeds. Fennel seed has good medicinal properties and is an important aromatic herb. Due to the high medicinal values and pleasant flavor of fennel seeds; it is cultivated all over the world. It is native to Southern Europe along the Mediterranean Sea and Asia (Muckensturm *et al.*, 1997). Pakistan has great potential for medicinal plants due to its various agro-climatic conditions. Despite great resources, Pakistan still imports about 90 percent of its medicinal plant requirement. Fennel is cultivated all over the country but for commercial purpose it is cultivated throughout Sindh, Mirpurkhas and Umerkot (Ashiq and Shah, 1993; Javed *et al.*, 2020). To compete in the international market there is dire need to increase the production of plant, therefore different production method and technologies need to be optimized (Yadav and Khurana, 2000).

Most commonly fennel is propagated from seeds and is usually grown in autumn and spring due to the favorable temperature. Fennel is perennial herb having feather like foliage. It grows up to the size of 1.5 to 2.5 m having weak slender stems often causing the problem of lodging. Fennel plant can be grown on various soil types ranging from pH 4.8 to 8.3. Fennel can be easily grown on ridges and flat beds, however flatbed is recommended for maximum production (Mohan *et al.*, 2001). Fennel flowers form in the terminal compound umbels. Seeds are small having blond green color. Fennel required little maintenance and can be grown even on marginal land with little application of fertilizers. (Ashiq and Shah, 1993). Two common fennel varieties are identified one is called piperitum which is bitter in taste and other is called vulgare having sweet taste both are of equal importance (Diaaz-Maroto *et al.*, 2006).

Fennel is medicinal herb used to treat various diseases i.e. cholera, diarrhea, constipation and gastrointestinal. It is used as a stimulant, sedative and carminative (Charles *et al.*, 1993). It has anti-inflammatory, anti-spasmodic, anti-septic, analgesic, anti-oxidant, anti-microbial, anti-carcinogenic and anti-ulcer properties (Leung and Foster, 1996). Its seeds are used in the manufacturing of cough syrup and in the making to standard green tea (Tea Zen) (Bhati *et al.*, 1988). Fennel seeds are used to prevent fungal growth, fennel

seed oil used in cosmetic industries and as a flavoring agent in food industries (Akbar, 2018). Plants use fertilizers to fulfill the energy requirement for their survival. Plant obtain mineral mainly from the soil to fulfill their requirement in various form. Healthy plant growth required optimum fertilizer requirement that directly affect the quality, growth and yield (Talei *et al.*, 2012). Nitrogen is an important plant nutrient that is required by the plant for vegetative growth of plant and more vital processes. Nitrate is the available form of nitrogen to the plant and is considered vital for the plant growth. Among different fertilizers, nitrogen is primary nutrient required by the plant in relatively larger quantity and is a part of amino acid, DNA and chlorophyll. Inappropriate doses of nitrogen cause abnormalities in plant (Khan *et al.*, 2004).

For growing any plants species, knowledge of sowing times is of primary importance. Fennel in Pakistan can be grown all over the year but spring and autumn season sowing is recommended due to the favorable temperature. Fennel sowing in autumn season mainly increases the production as compare to the spring season but it takes much time from sowing of seeds until final yield. Farmers don't have knowledge about the proper sowing times of fennel and they don't get the standard yield to compete in the international market for export (Ahmad *et al.*, 2004). Fennel can be grown through different methods such as direct sowing seeds and transplantation method (Yadav and khurana 1999).

A research was carried out to evaluate the effect of various sowing times and nitrogen levels on the growth and production of fennel with the objectives to find the best sowing time and nitrogen dose for obtaining the better growth and production of fennel under the agro-climatic conditions of Peshawar, Pakistan.

Materials and Methods

Research entitled "Effect of sowing times and nitrogen application on the growth and production of fennel" was carried out at Horticulture farm of Malakandher, University of Agriculture Peshawar, Pakistan. Experiment was conducted during the year (2020-2021). Experiment was laid out as Randomized Complete Block Design with split plot arrangement. There were two factors i.e. sowing times and nitrogen levels. Sowing times were assigned to main plot while nitrogen levels were to the sub-plot.

Sowing times includes autumn sowing (25th October) and spring sowing (25th February). Nitrogen levels included (0, 30, 40, 50, 60 kg ha⁻¹). Urea was used as source of nitrogen and nitrogen was applied in split doses. Plant to plant distance kept 20 cm and row to row distance was 40 cm. The experimental field was well prepared before seed sowing and all cultural practices were carried out uniformly. Seeds of local variety were sown in flat beds. Data were recorded on various parameters including plant height, days to first umbel appearance, days to last umbel appearance, days to first umbel maturity, number of umbels plant⁻¹ and seed yield. Day to first umbel appearance noted by counting days from sowing of seeds till 1st umbel appearance for all treatments of all replications and the average was taken. While days to last umbel appearance were recorded by counting days taken from seeds sowing till last umbel appearance. Data of 1st umbel maturity was recorded from date of 1st umbel appearance to the date of 1st umbel maturity of fennel in all treatments of each replication. The data were analyzed with the help of Statistical software Statistix (8.1). Least significant difference (LSD) test was done for means comparison (Steel *et al.*, 1997).

Results and Discussion

Plant height (cm)

Fennel seeds sown in autumn resulted in maximum plant height (146.07 cm) while, in spring crop minimum (97.67 cm) plant height was observed (Table 1). Among nitrogen levels, maximum plant height (134.83 cm) was observed in seed treated with 60 kg ha⁻¹, while least plant height (107.67 cm) was observed in control plants. Plants of autumn sown crop were taller because the plants were exposed to prolong

growing period and favorable temperature. Yadav and khurana, (1999) reported tallest plants when fennel were sown early due to prolong growing period. Nitrogen is important macro nutrient which help increased the vegetative growth of plant and synthesize amino acid and protein that increased the vegetative growth of plant. Our results are in line with Khan *et al.* (2004); they reported maximum plant height due to treatment of nitrogen.

Days to 1st umbel appearance

Mean (Table 1) shows that maximum days to 1st umbel appearance (132.27) were recorded in autumn crop while spring crop took minimum days to 1st umbel appearance (83.33). Whereas nitrogen applied at 60 kg ha⁻¹ resulted in minimum days to 1st umbel appearance (104.50) while control plants took maximum days (110.33). Fennel sown in autumn took more days since fennel is long day plant therefore, environment signals play important role to initiate reproductive growth. The plants produce flowering when they experience long days (photoperiodic signals) whereas spring sown crop had resulted in early flowering as compare to autumn crop. Findings of the current trait are in agreement with Ahmad *et al.* (2004). There were also significant variations in first umbel appearance due to nitrogen levels. Our findings are in line with that of Khan *et al.* (2004).

Days to last umbel appearance

According to (Table 1), maximum days (147.87) to last umbel appearance were recorded in plant of autumn sown crop while spring sown plants which took minimum days (95.87). Significant differences were observed in response to sowing times of fennel. The above results are in line with Ahmad *et al.* (2004).

Table 1: Effect of sowing times and nitrogen application on the growth and production of fennel.

Sowing times	Plant height (cm)	Days to 1 st umbel appearance	Days to last umbel appearance
Autumn season	146.07a	132.27A	147.87A
Spring season	97.67b	83.33B	95.87B
LSD (p≤0.05, p≤0.01%)	8.57	11.76	13.2
Nitrogen levels (kg ha ⁻¹)	Plant height (cm)	Days to 1 st umbel appearance	Days to last umbel appearance
0	107.67C	110.33 A	122.33
30	120.33B	109.00AB	121.67
40	124.83B	107.50C	121.17
50	121.67B	107.67BC	121.00
60	134.83A	104.50D	123.17
LSD (p≤0.01%)	4.17	1.45	NS

NS= Non Significant.

Table 2: *Effect of sowing times and nitrogen application on the growth and production of fennel.*

Sowing times	No. of umbels plant ⁻¹	Days to 1 st umbel maturity	Seed yield (kg ha ⁻¹)
Autumn season (25)	42.51a	86.67A	4590.79A
Spring season (S2)	32.53b	38.73B	3540.71B
LSD (p≤0.05, p≤0.01%)	5.65	3.180	446.82
Nitrogen levels (kg ha ⁻¹)	No. of umbels plant ⁻¹	Days to 1 st umbel maturity	Seed yield (kg ha ⁻¹)
0	31.60E	68.00	3515.42b
30	33.93D	64.17	3721.25b
40	36.05C	59.67	4169.69ab
50	41.15B	60.67	4238.02ab
60	44.85 A	61.00	4684.37a
LSD (p≤0.01%)	1.66	NS	790.65

NS= Not Significant.

Seeds sown in autumn grew more vigorously produced maximum shoots, attained more plant height and had prolonged booming period. Other reason could be the temperature at the time of flowering.

Number of umbels plant⁻¹

According to [Table 2](#), seeds sown in autumn season resulted in maximum number of umbels plant⁻¹ (42.51) and spring sown crops produced minimum umbels plant⁻¹ (32.53). While nitrogen applied at 60 kg ha⁻¹ resulted in highest number of umbels plant⁻¹ (44.85). No. of umbels plant⁻¹ was significantly affected by sowing times. Autumn crop grew healthy and produced more branches and exposed to prolong time, hence resulted in maximum number of umbels plant⁻¹. While the spring crop produced least vigorous, fewer branches and produced minimum number of umbels plant⁻¹. The results are in agreement with [Ahmad et al. \(2004\)](#). Nitrogen significantly enhanced plant growth and no. of umbels. Nitrogen resulted in better development of root and shoots, thereby resulted in maximum no. of umbel plant⁻¹. [Waskela et al. \(2017\)](#), also revealed that nitrogen application produced plants with maximum number of umbels plant⁻¹.

Days to 1st umbel maturity

Maximum days to 1st umbel maturity (86.67) were taken by autumn crop and spring crop took minimum days (38.73) ([Table 2](#)). Fennel seeds sown in autumn took more days which might be due to extended growing season; resulted in healthy plants with more no. of umbels and maximum days to 1st umbel appearance and hence took more days to 1st umbel maturity. These findings are in agreement with [Ahmad et al. \(2004\)](#); they also reported minimum days to first um-

bel maturity in fennel crop sown in spring season.

Seed yield (kg ha⁻¹)

Maximum seed yield kg ha⁻¹ (4590.75 kg ha⁻¹) was observed in autumn sown crop as compare to minimum seed yield (3540.71 kg ha⁻¹) in spring sowing crop. However nitrogen applied at 60 kg ha⁻¹ resulted in maximum seed yield (4684.37 kg ha⁻¹) that was statistically similar to the seed yield at 40 and 50 kg ha⁻¹. While in control (0 kg ha⁻¹) minimum seed yield (3515.42 kg ha⁻¹) was obtained ([Table 2](#)). The results are in line with [Ahmad et al. \(2004\)](#) and [Moosavi et al. \(2014\)](#); they also reported higher seed yield from autumn crop. Nitrogen levels applied to fennel crop significantly affected the seed yield of fennel. Nitrogen increased the vegetative growth of fennel as a result maximum number of branches were produced with more no. of umbels plant⁻¹ and hence produced maximum seed yield ([Waskela et al., 2017](#)).

Conclusions and Recommendations

Based on the significant findings, the following conclusions are made

Fennel seed sown in autumn on 25th October resulted in early germination, maximum plant height, more no. of umbels plant⁻¹, maximum seeds yield plant⁻¹ (g) and seed yield (kg ha⁻¹). While, fennel sown in spring (25th February) resulted in minimum days to 1st and last umbel appearance, took less days to 1st and last umbel maturity. Nitrogen applied at the rate of 60 kg ha⁻¹ resulted in maximum plant height (cm), least days to 1st umbel appearance, maximum number of umbels plant⁻¹, seed yield plant⁻¹(g) and seed yield (kg ha⁻¹).

Sowing of fennel in autumn (25th October) is recommended especially on marginal land. Nitrogen application at 60 kg ha⁻¹ is recommended for better growth and seed yield of fennel under the agro-climatic condition of Peshawar. Though sowing of fennel in autumn (25th October) significantly increased the production of fennel, however, it took more time i.e. 7 to 8 months from seed sowing to seed production as compare to spring crop which took less time i.e. 4 months from seed sowing to seed production. We can save 3 months and we can grow other short season crop in this period if we are able to get reasonably good yield from spring sown crop. Therefore spring crop could be exploited further by planting at different times (especially starting a bit earlier) and with improved cultural practices for its maximum potential seed yield under the agro-climatic conditions of Peshawar, Pakistan.

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Novelty Statement

This study provides the first comprehensive evaluation of the interactive effects of sowing time and nitrogen application on fennel growth and seed production under the subtropical conditions of Peshawar, Pakistan. Unlike previous studies that focused on either seasonal variations or fertilization independently, this research uniquely integrates both factors to determine the optimal agronomic practices for maximizing fennel yield.

Author's Contribution

Junaid Irfan: Conducted research, data collection and write-up

Masood Ahmad: Conceptualization, designing, supervision, write up and finalizing the manuscript

Sumbal Ayaz: Analysis of data and arrangement of tabulated data

Sultan Akbar Jadoon: Write-up and interpretation of data

Khwaja Junaid and M Reshteen Khattak: Collection of data and citations

Ateeq Ur Rehman and Sheraz Ahmad: Data collec-

tion and statistical analysis

Hamza Ali: Helped in format setting and citations

Conflict of interest

The authors have declared no conflict of interest.

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