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# INFLUENCE OF UMBEL POSITION ON SEED QUALITY OF ANISE (*PIMPINELLA ANISUM* L.): A MINOR SEED SPICE

**AMRIT LAMICHANEY*[1], SUDHIR KUMAR JAIN AND SOOGANNA**

*Division of Seed Science and Technology, Indian Agricultural Research Institute, New Delhi, India-110012*

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**Abstract**

Anise is a minor seed spice and a potentially under-utilized and under researched crop. The present study was made to investigate the quality differences in the seeds of anise *cv.* NRCSS AANI-1 harvested from different umbel order. Additionally, the primary and secondary umbels were divided into three parts: external, middle and internal, and seeds from each were examined for seed quality traits separately. The highest quality seeds as revealed by germination and vigour parameters were produced from primary and secondary umbel. Significant variation on seed quality was observed in the seeds localized in three examined parts of primary and secondary umbel. The seeds from the outer whorl of primary umbel recorded the maximum germination (87.25%). Maximum vigour index I (896.5) and vigour index II (1268.9) were observed in outer whorl of primary and secondary umbel, respectively.

Anise (*Pimpinella anisum* L.), is an important minor seed spice crop of India. The anise seed oil is used for flavouring soaps, mouth washes, toothpastes and in medicine as cough syrups, lozenges and carminative. Anise belongs to Apiaceae family, therefore like other members, is characterized by non synchronous flowering and gradually maturing umbels, whose positions on the mother plant determines the quality and vigour of seed (Gray 1979, Szafirowska 1994, Kelly and George 1998, Muhammad and Anjum 2001, Pereira *et al*. 2008, Panayotov 2010). There are two schools of thoughts as far as the effect of umbel order on the seed quality of members of Apiaceae is concerned. One that the seeds harvested from primary umbels is of better quality (Gray *et al.* 1983b, Satyaveer *et al.* 1994, Szafiriowska 1994, Corbineau *et al.* 1995, Muniz 1999, Shantha *et al.* 1999) whereas, second school of thoughts says that seeds from secondary umbels are of better quality than other umbel order (Thomas *et al.* 1979, Elballa and Cantliffe 1997). Only one variety of Anise (NRCSS-AANI-1) has been released in India till date therefore, the research on seed quality aspect is lacking. So far, no reports on the effect of umbel order on seed quality of an anise is available. Being an under researched crop the information on quality seed production must be generated. Hence the present study was undertaken.

The experiments were carried out in the experimental field of the Department of Seed Science and Technology, IARI, New Delhi, during 2012-2013. Upon maturity seeds were harvested from primary, secondary, tertiary and quaternary umbels (Fig. 1A) and examined for umbel diameter and umbelet/umbel. Further, the primary and secondary umbels were divided into three parts: external, middle and internal (Fig. 1B), and seeds from each part were examined along with seeds from tertiary and quaternary umbels for fruit length, fruit width, 1000-seed weight, germination per cent, seedling length, seedling dry weight, seedling vigour index-I and vigour index-II. The average sizes; length and width were determined for 10 seeds using digital caliper. The 1000-seed weight and germination percentage were recorded as per ISTA rules (Anon. 2011). Ten normal seedlings from each replication were selected randomly and the seedling length was measured

*Author for correspondence: <amritiarisst@gmail.com>. [1]Indian Institute of Pulses Research, Kanpur, Uttar Pradesh- 208 024, India.

from the tip of the primary root to the tip of the primary leaf. Subsequently, these seedlings were dried in a hot air oven maintained at 80 ± 2°C for 24 hours, cooled over silica gel and weighed to assess the biomass. Seedling vigour index (SVI) was calculated by formula suggested by (Abdul-Baki and Anderson 1973).

SVI-I: Germination per cent × seedling length (cm)

SVI-II: Germination per cent × seedling dry weight (mg)

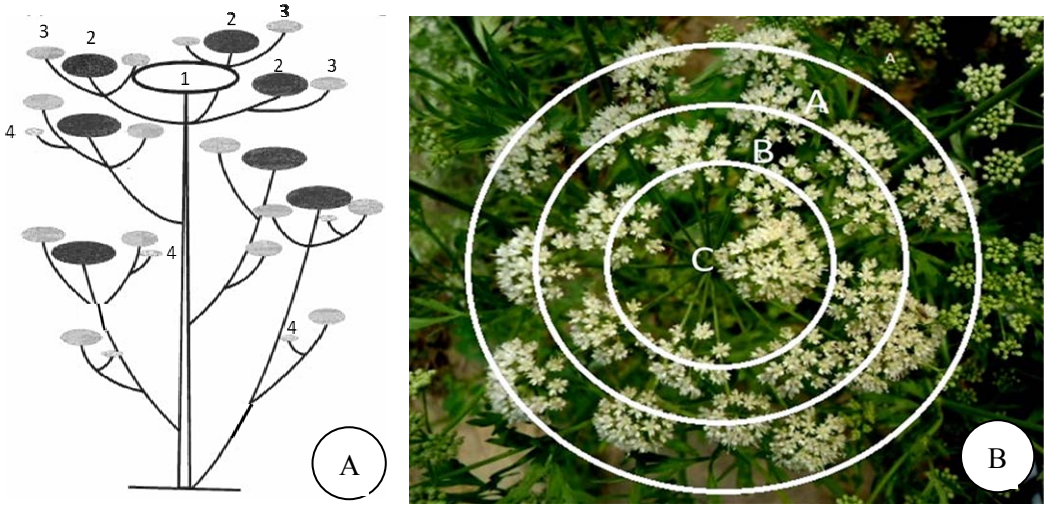


Fig. 1. Schematic representation of the umbel order and their position in *Pimpinella anisum* plant. Umbel orders: Primary (1), secondary (2), tertiary (3) and quaternary (4). The picture is taken from (Perglova *et al.* 2006) with minor modification (A) and primary umbel with its three designated parts (B): External A, middle B and internal C.

The effect of different umbel order on the umbel character and seed quality attributes of anise are described below (Tables 1 to 3). It was revealed from Table 1 that primary umbel produced the highest umbel with diameter (13.25 cm) followed by secondary (11.62 cm), tertiary (8.18 cm) and quaternary (6.85 cm). Similar pattern was found in the case of number of umbelets/umbel. The highest number of umbelets/umbel was recorded in primary umbels (19.50) and the lowest was in quaternary umbel (10.00), which was statistically at par with tertiary umbel (11.37).

**Table 1. Effect of umbel position on umbel diameter and number of umbelets/umbel of Anise.**

| Umbel position | Umbel diameter* (cm) | Number of umbelets/umbel* |
|---|---|---|
| Primary | 13.25[a] | 19.50[a] |
| Secondary | 11.62[b] | 16.25[b] |
| Tertiary | 8.18[c] | 11.37[c] |
| Quaternary | 6.85[c] | 10.00[c] |

*Average of three replicates of 10 umbel in each replicate. Similar letters within a row indicate non-significant differences between the values, following DMRT at 0.05 level of significance.

Table 2 shows that the maximum length of anise fruit was obtained from primary (middle: 3.7 mm) which was statistically at par with primary (outer: 3.6 mm) and secondary outer umbel (3.6 mm) while quaternary umbel produced fruits having shortest length. The outer and middle whorl of primary and secondary umbel produced fruits with maximum fruit width. However, statistically similar fruit width was obtained from inner whorl of primary and secondary, tertiary and quaternary umbel. The maximum 1000-seeds weight was obtained from the outer whorl of primary umbel which was statistically at par with outer whorl of secondary umbel. Tertiary umbel recorded the 1000-seed weight of 2.376 g which was statistically higher than those from quaternary umbel (2.261 g). The lowest values of 1000-seed weight was in the quaternary umbels. The better seed weight of primary and secondary umbel as compared to tertiary and quaternary umbel can be attributed to the fact that the flowering in primary and secondary umbel started earlier and seeds got a longer period to develop and accumulate the storage reserves imparting better size and weight. In general bigger fruits were produced by primary umbel followed by secondary, tertiary and quaternary umbels. Significant variation exist among the three designated parts i.e. outer, middle and inner whorls of primary and secondary umbel in fruit length, fruit width and 1000-seed weight. Outer and middle whorls produced bigger sized fruits than its inner whorl. However, our findings contradict the findings of Hołubowicz and Morozowska (2011) who reported no variation in the length and width of the seeds harvested from the outer, middle and inner whorl of the umbel in dill (Apiaceae).

**Table 2. Effect of umbel position on fruit length, fruit width and 1000-seed weight of Anise.**

| Umbel position | | Fruit length* (mm) | Fruit width* (mm) | 1000-seed weight (g) |
|---|---|---|---|---|
| Primary | Outer | $3.6^{a}$ | $2.3^{a}$ | $2.605^{a}$ |
| | Middle | $3.7^{a}$ | $2.3^{a}$ | $2.521^{ab}$ |
| | Inner | $3.2^{b}$ | $1.9^{b}$ | $2.525^{ab}$ |
| Secondary | Outer | $3.6^{a}$ | $2.3^{a}$ | $2.546^{a}$ |
| | Middle | $3.1^{bc}$ | $2.3^{a}$ | $2.426^{bc}$ |
| | Inner | $2.9^{bcd}$ | $1.6^{b}$ | $2.253^{d}$ |
| Tertiary | | $2.8^{cd}$ | $1.8^{b}$ | $2.376^{c}$ |
| Quaternary | | $2.7^{d}$ | $1.8^{b}$ | $2.261^{d}$ |

*Average of three replicates of 10 fruits in each replicate. Similar letters within a row indicate non-significant differences between the values, following DMRT at 0.05 level of significance.

Seed germination, seedling length, seedling dry weight and seedling vigour are the most vital component of seed quality. The results of present study in this respect are presented (Table 3). The highest germination per cent of seeds 86.50 (average of the germination value of three designated parts) followed by 79.58 (average of the germination value of three designated parts), 79.75 and 59.00 in primary, secondary, tertiary and quaternary umbels, respectively.

The seeds from the outer whorl of primary umbel recorded the maximum germination per cent (87.25) which was statistically at par with middle whorl of primary umbel (87.00). The germination per cent of primary inner whorl and secondary outer and middle whorl was statistically similar and significantly lower than primary outer and middle whorl. Hassell and Kretchman (1997) reported that in the members of family Apiaceae, the activity of germinating inhibitor substances were low in the seeds of primary and secondary umbels whereas, it was more in the seeds from tertiary and quaternary umbels. This might be the reason for better germination

of anise seeds obtained from primary and secondary umbels. The values of seed germination were found lowest in the seeds from the quaternary umbels. The results are in conformity with Corbineau *et al*. (1995) and Panayotov (2010) in carrot, who reported that seeds from primary and secondary umbels had better germinability and produced larger seeds than other seeds. The germination per cent of secondary umbel inner whorl is only 72.25%. Such a low germination per cent is the reason for lower average germination per cent of secondary umbel (79.58) than the tertiary umbel (79.75).

By estimating the seed vigour status estimates tells not only the ability of the seeds to germinate but also its potential to transform into normal and healthy seedlings or plant (Copeland and McDonald 2001). One of the many parameters describing the seed vigour is seedling growth or seedling dry weight. In general, the seeds from primary umbels had maximum seedling length and seedling dry weight followed by secondary, tertiary and quaternary umbels (Table . 3). However, the seeds from the outer whorl of secondary umbel produced the seedling with maximum dry weight (14.53 mg) which was at par with primary inner whorl (13.90 mg) but significantly higher than other whorls of primary and secondary umbels.

**Table 3. Effect of umbel position on seed germination and seedling vigour.**

| Umbel position | | Seed germination* (%) | Seedling length** (cm) | Seedling dry weight** (mg) | Seedling vigour index I | Seedling vigour index II |
|---|---|---|---|---|---|---|
| Primary | Outer | $87.25^{a}$ | $10.23^{a}$ | $13.06^{ab}$ | $896.5^{a}$ | $1142.0^{abc}$ |
| | Middle | $87.00^{a}$ | $9.70^{ab}$ | $12.63^{ab}$ | $846.7^{ab}$ | $1107.3^{abcd}$ |
| | Inner | $85.25^{ab}$ | $10.20^{a}$ | $13.90^{a}$ | $867.8^{a}$ | $1184.7^{ab}$ |
| Secondary | Outer | $86.25^{ab}$ | $8.94^{ab}$ | $14.53^{a}$ | $776.5^{abc}$ | $1268.9^{a}$ |
| | Middle | $80.25^{ab}$ | $8.33^{abc}$ | $9.93^{ab}$ | $670.5^{bcd}$ | $807.9^{bcde}$ |
| | Inner | $72.25^{c}$ | $7.56^{bc}$ | $9.60^{ab}$ | $552.2^{d}$ | $705.7^{cde}$ |
| Tertiary | | $79.75^{b}$ | $7.73^{bc}$ | $8.60^{b}$ | $615.3^{cd}$ | $682.6^{de}$ |
| Quaternary | | $59.00^{d}$ | $6.27^{c}$ | $8.25^{b}$ | $396.6^{e}$ | $525.7^{e}$ |

*Average of four replicates of 100 seeds in each replicate. **Average of three replicates of 10 seedlings in each replicate. Similar letters within a row indicate non-significant differences between the values, following DMRT at 0.05 level of significance.

Seedling vigour index predicts the vigour status of the seed. Delouche and Baskin (1973), Schimdt (2000) consider vigour indices as a better alternative to describe the status of the seed than standard germination test. As expected, the vigour index-I and II were highest in primary umbel (870.33 and 1144.66, average of the three designated parts), followed by secondary (666.4 and 927.5 average of the three designated parts), tertiary (615.3 and 682.6) and quaternary (396.6 and 525.7) umbels. Within the three localized region in primary umbel, the vigour index-I of seeds from outer and inner whorl was significantly higher than middle counterpart. Lower germination per cent of the secondary inner whorl was reflected in calculating vigour index-I, thus a lower vigour index-I for seeds from secondary inner whorl than seeds from tertiary umbel. Regarding seedling vigour index-II, significant variation exists in the seeds harvested from the different parts of same umbel (within umbel) order or from different umbel (between umbel) order. Vigour index-II of the seeds from the outer whorl (1268.9) of secondary umbel was significantly higher than rest of the seeds. A similar conclusion, that the primary umbels developed seeds with high vigour was made by Muhammad and Anjum (2001), Mor *et al*. (2009).

It is inferred that the quality of anise seeds depends upon its position on mother plant. Seeds obtained from primary and secondary umbels are of better quality than seed from tertiary and quaternary umbels. So it is better to harvest anise seeds separately, depending on their position on the mother plant, and divide them into individual lots with different qualities.

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