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# Influence of zinc on yield and quality profile of ginger (*Zingiber officinale* Rosc.)

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## Abstract

Field experiments were conducted for three consecutive years (2008–09. 2009–10, 2010–11) in a Zn deficient soil to study the variation in quality and oil composition of ginger due to incorporation of Zn in the fertilizer schedule. The treatments consisted of recommended package of practice (POP) without zinc, POP + 5 kg Zn $ha^{-1}$, POP + 10 kg Zn $ha^{-1}$ as zinc sulphate. The results showed that application of Zn increased the fresh yield of ginger from 7.72 to 9.57 kg $3m^{-2}$ indicating an increase of 23%. Zinc application also increased the oil, oleoresin, β-sesquiphellandrene, farnesene, camphene and *Z*-citral contents of ginger oil. Contrarily, Zn application decreased zingiberene, α-pinene, α-curcumene and 1, 8 cineol contents of ginger oil. The quality components such as fiber content varied from 3.05% to 3.43%, oil content from 1.33% to 1.73%, oleoresin from 3.35% to 5.41%, zingiberene from 13.1% to 21.8%, α- pinene from 0.67% to 2.23%, β-sesquiphellandrene from 5.92% to 10.20%, farnesene from 5.58% to 11.1%, camphene from 3.06% to 5.36%, *Z*-citral from 3.73% to 6.54%, α-curcumene from 5.32% to 7.70%, 1,8 cineol from 2.70% to 5.29%, β-phellandrene from 1.87% to 4.18% and citral contents from 5.03% to 6.54%.

**Keywords:** ginger, ginger quality, zinc deficiency, zinc nutrition

Ginger (*Zingiber officinale* Rosc.) is one of the important and most widely used spices. India is one of the largest ginger producing country in the World. The productivity of ginger remains low in India due to constraints like diseases and improper management. Ginger is generally a heavy feeder and responds well to fertilizer application. Nowdays micronutrient deficiency is a common problem in ginger growing soils and application of micronutrient especially zinc (Zn) improves growth, yield and quality of this crop (Parthasarathy *et al.* 2010). Srinivasan *et al.* (2004) reported that Zn deficiency existed in 49% of soil samples collected from various ginger-growing regions of India and reported significant increase in yield due to Zn application.

Ginger is valued for its aroma and flavor and it has medicinal properties, which in turn is determined by the composition of its steam volatile oil. This is comprised mainly of sesquiterpene hydrocarbons, monoterpene hydrocarbons and oxygenated monoterpenes. The monoterpene constituents are believed to be the most important contributors to the aroma of ginger and they tend to be relatively more abundant in the fresh (green) rhizome than in the dried ginger (Zacharia 2008). Oxygenated sesquiterpenes are relatively minor constituents of the volatile oil but appear to be significant contributors to its flavor properties. Zn plays a key role in several critical cellular functions, such as protein metabolism, gene expression, structural and functional integrity of bio membranes, photosynthate, C metabolism, and Indole 3 acetic-acid (IAA) metabolism. So Zn deficiency may alter several physiological processes in plants. Keeping these points in view, experiments were conducted with the objective to study the quality and oil composition of ginger in relation to Zn fertilization.

The field experiment was conducted for three years (2008–11) at Indian Institute of Spices Research Experimental Farm, Peruvannamuzhi and in farmers plot at Wayanad District, Kerala. Ginger variety IISR Varada was planted in raised beds of size 3 m × 3 m. The soil of experimental field was *Ustic Humitropept* deficient in Zn (available Zn 0.56 mg $kg^{-1}$). The crop was manured as per the POP recommendation (KAU 2009). The treatments consisting of the recommended POP without Zn, POP+ 5 kg Zn $ha^{-1}$ as $ZnSO_4$, POP+ 10 kg zinc $ha^{-1}$ as $ZnSO_4$ were imposed at 45 DAP. The experimental design was RBD with seven replications. The crop was harvested after maturity and yield data was recorded. The rhizome samples were taken treatment wise peeled, dried and oil, fiber and oleoresin contents were estimated as per standard procedures (ASTA 1997).

Zn fertilization increased the yield to the tune of 23.0% (Table 1). Similar yield increase was earlier reported by Srinivasan *et al.* (2009) in ginger for zinc application. The quality parameters such as oil, oleoresin, α-sesquiphellandrene, farnesene, camphene, β-citral, α-curcumene and that of zingibeiene, α-pinene and 1-8 cineol contents decreased significantly due to Zn fertilization (Table 2). Whereas, Zn did not influence β-phellandrene and citral and fibre contents. Sadanandan & Hamza (1998) reported the increase in oil and

**Table 1.** Variation in yield (kg 3 $m^{-2}$), fiber, oil and oleoresin content (%) of ginger due to Zn application

| Parameter | 2008–09 | | | 2009–10 | | | 2010–11 | | | Mean of 3 years | | | CD (P=0.05%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Zn | 5kg Zn | 10kg Zn | No Zn | 5kg Zn | 10kg Zn | No Zn | 5kg Zn | 10kg Zn | No Zn | 5kg Zn | 10kg Zn | |
| Yield | 6.77 | 7.6 | 7.83 | 6.73 | 8.27 | 8.51 | 9.7 | 12.75 | 12.32 | 7.72 | 9.54 | 9.57 | 1.1 |
| Fiber | 3.4 | 3.3 | 3.1 | 3.05 | 3.25 | 3.1 | 3.1 | 3.23 | 3.43 | 3.18 | 3.26 | 3.21 | NS |
| Oil | 1.33 | 1.66 | 1.66 | 1.33 | 1.73 | 1.73 | 1.62 | 1.73 | 1.73 | 1.43 | 1.7 | 1.7 | 0.11 |
| Oleoresin | 3.35 | 4.9 | 4.83 | 3.71 | 4.57 | 5.25 | 4.4 | 5.41 | 5 | 3.82 | 4.95 | 5.03 | 0.39 |

**Table 2.** Variation in quality profile of ginger oil due to Zn application

| Compound | 2008–09 | | | 2009–10 | | | 2010–11 | | | Mean of 3 years | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Zn | 5kg Zn | 10kg Zn | No Zn | 5kg Zn | 10kg Zn | No Zn | 5kg Zn | 10kg Zn | No Zn | 5kg Zn | 10kg Zn | CD (P=0.05%) |
| Zingiberene | 21.8 | 14.1 | 19.3 | 15.4 | 16.4 | 15.4 | 19.4 | 13.1 | 15.7 | 18.9 | 14.5 | 16.8 | 1.20 |
| á-pinene | 2.05 | 2.23 | 2.18 | 1.8 | 1.44 | 1.12 | 1.09 | 0.67 | 0.98 | 1.65 | 1.44 | 1.43 | 0.11 |
| à-sesquiphellandrene | 7.87 | 7.76 | 9.28 | 7.71 | 9.56 | 10.2 | 6.27 | 5.92 | 6.57 | 7.28 | 7.74 | 8.66 | 0.45 |
| Farnasene | 10.1 | 10.9 | 11.1 | 10.5 | 10.3 | 11.1 | 6.54 | 5.58 | 6.62 | 9.03 | 8.91 | 9.61 | 0.48 |
| Camphene | 3.69 | 5.12 | 5.36 | 4.08 | 4.03 | 4.09 | 3.76 | 3.06 | 3.38 | 3.84 | 4.07 | 4.28 | 0.32 |
| Z - citral | 3.78 | 6.54 | 6.33 | 4.78 | 6.49 | 6.36 | 4.06 | 3.73 | 4.43 | 4.20 | 5.58 | 5.71 | 0.37 |
| á-curcumene | 7.70 | 5.85 | 5.32 | 5.77 | 7.29 | 6.82 | 6.80 | 7.39 | 6.64 | 6.75 | 6.83 | 6.26 | 0.45 |
| 1,8 Cineol | 5.29 | 3.63 | 3.09 | 4.00 | 3.45 | 3.06 | 2.96 | 2.83 | 2.70 | 4.08 | 3.30 | 2.95 | 0.23 |
| à-phellandrene | 3.52 | 2.25 | 2.93 | 3.91 | 3.18 | 4.18 | 2.39 | 1.87 | 3.24 | 3.27 | 2.43 | 3.45 | NS |
| Citral | 5.80 | 5.53 | 5.03 | 5.65 | 5.20 | 5.21 | 5.67 | 5.83 | 6.54 | 5.71 | 5.55 | 5.59 | NS |

oleoresin contents of ginger due to Zn fertilization.

The potential of ginger in culinary, non-culinary and medicinal fields is based on the chemistry of volatile oil and non-volatile pungent principles. The oil yield is about 2%–3% and the oil consists of 64% sesquiterpene hydrocarbons, 6% carbonyl compounds, 5% alcohols, 2% monoterpene hydrocarbons and 1% esters. The main compounds are zingiberene (29.5%) and sesquiphellandrene (18.4%) (Zachariah 2008). The composition of these constituents varies based on maturity, genotype and agroclimatic conditions (Zachariah *et al.* 1999; Gaston & Cyril 2005).

It is concluded that application of Zn was beneficial in increasing yield of ginger by 23% also it increased the oil, oleoresin content, β-sesquiphellandrene, farnesene, camphene and z-citral content of ginger oil. Zn fertilization also found to decrease zingiberene, α-pinene, α-curcumene and 1, 8 cineol content of ginger oil. It was found that fiber content varied from 3.05 to 4.40%, oil content from 1.33% to 1.73%, oleoresin from 3.35% to 5.41%, zingiberene from 13.1% to 21.8%, á- pinene from 0.67% to 2.23%, β sesquiphellandrene from 5.92% to 10.20%, farnasene from 5.58% to 11.1%, camphene from 3.06 to 5.36%, z-citral from 3.73% to 6.54%, α-curcumene from 5.32% to 7.70%, 1,8 cineol from 2.70% to 5.29%, β-phellandrene from 1.87% to 4.18% and citral from 5.03% to 6.54%.

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