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# Influence of Secondary Plant Nutrients (Ca and Mg) on Growth and Yield of Chamomile (*Matricaria recutita* L.)

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## ABSTRACT

Many researchers carried out study on *Matricaria* with respect to nitrogen, phosphorous, potassium and micro nutrient requirement and their influence on plant growth but there are no reports on influence of secondary nutrients on flower yield and oil quality of the crop. In the view of above fact an experiment was carried out on the response of *Matricaria* to calcium and magnesium vis-a-vis the influence of the nutrients on growth, yield and quality of essential oil in *Matricaria*. Treatment comprised of varying levels of Ca (0, 50, 100, 150 and 200 mg pot$^{-1}$ having 10 kg soil) and Mg (0, 50, 100, 150 and 200 mg pot$^{-1}$ having 10 kg soil) to elucidate yield parameters, oil yield and quality of *Matricaria*, during rabi season of 2009-10 at Central Institute of Medicinal and Aromatic Plants, Lucknow. Effect of magnesium was found to be more pronounced as compared to calcium in respect of plant height, number of branches per plant, width of flower, number of flowers per plant, fresh weight (g) of flower and oil content (%). The growth and yield parameters of *Matricaria* increased with increase in application rate of calcium and magnesium. The interaction effect of calcium and magnesium at the rate of Ca 200 + Mg 200 mg pot$^{-1}$ was maximum as compared to other combination resulting in the maximum plant height (60.5 cm), number of branches per plant (70), number of flowers per plant (362), width of flower (2.66 cm), fresh weight of flower per plant (26.94 g) and oil content (1.10%). This combination also resulted in the best quality of oil with respect to chemical constituents. The conjoint application of Ca and Mg both at the rate of 200 mg pot$^{-1}$ ($C_5M_5$) significantly influenced the yield, yield contributing character and oil content (1.10%) as compared to the rest of the treatments.

**Key words:** Matricaria (*Matricaria recutita* L.), secondary essential nutrient, chamazulene, flavoring agent, growth and quality

## INTRODUCTION

*Matricaria recutita*, earlier called as *Matricaria chamomile* and *Chamomilum nobile* belonging to family Asteraceae is popularly known as German chamomile, Roman chamomile, English chamomile, Camomilla and Flos Chamomile. It mainly grows indigenously in Europe, NW Asia, North Africa, North America and in other parts of the world (Wald and Brendler, 1998). This herb has been used as herbal remedies for thousands of years. *Matricaria* has been believed by Anglo Saxons as one of nine sacred herbs given to humans by the lord (Crevin and Philpott, 1990). One of the most commonly consumed single ingredient herbal tea is chamomile tea, prepared with dried flowers of *Matricaria recutita* L. The composite flower is white in colour with a yellowish orange colour in a centre. Infusions of essential oil from fresh or dried flower heads have aromatic, flavouring and colouring properties. Both are used in number of commercial products, including soaps, detergents, perfumes, lotions, ointments, hair products, backed goods, confectionaries, alcoholic beverages and herbal tea. Chamomile flowers contain 0.24 to 2.0% volatile oil that is blue in colour and also popular as blue oil (Wald and Brendler, 1998). Over 120 constituents have been identified in chamomile flowers (Pino *et al*., 2002). The main constituents of the oil include the terpenoids α-bisabolol and its oxides (≤78%), azulenes, including chamazulene which ranges between 1-15% (Pino *et al*., 2000; Mann and Staba, 1986; Matos *et al*., 1993; Stanev *et al*., 1996). The constituents of the flowers also include several phenolic compounds, primarily the flavonoids apigenin, quercetin, patuletin, luteolin and their glucosides coumarins and dicycloethers. Blue Oil of chamomile plant having anti inflammatory properties, is used as remedy in gastrointestinal troubles and in dentition problems besides being used as flavouring agent in fine liquors and in perfume compositions. It is used in flavour pomades, pain relieving balms and has a sizable demand worldwide and in India. In addition to this, dry flowers are the component in herbal tea for promoting the flow of gastric secretions and bile and in treatment of cough and cold. The infusion is common beverages in Europe, where it is used as mild sedative and digestive (Nidagundi and Hegde, 2007).

Many researchers carried out study on *Matricaria* with respect to nitrogen, phosphorous, potassium and micro nutrient requirement and their influence on plant growth but there are no reports on influence of secondary nutrients on flower yield and oil quality of the crop.

In the view of above fact an experiment was carried out on the response of *Matricaria* to calcium and magnesium vis-a-vis the influence of the nutrients on growth, yield and quality of essential oil in *Matricaria*. The experiment planned with an objectives to find out the effect of secondary essential nutrient on growth and oil quality of *Matricaria*.

## MATERIALS AND METHODS

A pot experiment was conducted at Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow (U.P.) India, located at 20°N latitude 79.5°E longitude and 24.4 m above mean sea level during Rabi seasons of 2009-10 to elucidate the response of *Matricaria* to calcium and magnesium with respect to yield and yield contributing characters. The soil of the experimental pot was sandy loam having pH (1:2.5 $H_2O$) 8.3, electrical conductivity 0.26 $dSm^{-1}$, organic carbon 0.42% and available NPK 95, 12.0 and 135 kg $ha^{-1}$, respectively.

**Experiment details:** Treatment details of the experiment is shown in Table 1.

Table 1: Treatment details of the experiment

| Treatment | $M_1$ (mg $pot^{-1}$) | $M_2$ (mg $pot^{-1}$) | $M_3$ (mg $pot^{-1}$) | $M_4$ (mg $pot^{-1}$) | $M_5$ (mg $pot^{-1}$) |
|---|---|---|---|---|---|
| $C_1$ (mg $pot^{-1}$) | Ca-0, Mg-0 | Ca-0, Mg-50 | Ca-0, Mg-100 | Ca-0, Mg-150 | Ca-0, Mg-200 |
| $C_2$ (mg $pot^{-1}$) | Ca-50, Mg-0 | Ca-50, Mg-50 | Ca-50, Mg-100 | Ca-50, Mg-150 | Ca-50, Mg-200 |
| $C_3$ (mg $pot^{-1}$) | Ca-100, Mg-0 | Ca-100, Mg-50 | Ca-100, Mg-100 | Ca-100, Mg-150 | Ca-100, Mg-200 |
| $C_4$ (mg $pot^{-1}$) | Ca-150, Mg-0 | Ca-150, Mg-50 | Ca-150, Mg-100 | Ca-150, Mg-150 | Ca-150, Mg-200 |
| $C_5$ (mg $pot^{-1}$) | Ca-200, Mg-0 | Ca-200, Mg-50 | Ca-200, Mg-100 | Ca-200, Mg-150 | Ca-200, Mg-200 |

**Statistical analysis:** Total treatment combinations were 25 which were replicated thrice timing in a Completely Randomized Block Design (CRD). Data was subjected to Analysis of Variance (ANOVA) and least significant difference (LSD) were calculated using F-method.

The planting materials were taken from Research Farm of Central Institute of Medicinal and Aromatic Plants, Lucknow and planted in experimental pots. Calcium and magnesium were applied through calcium sulphate and magnesium sulphate, respectively. The total treatment combinations were 25. The experimental pot was kept free from weeds, throughout the life-span of the crop. The calcium and magnesium were applied as per treatment in soil before transplanting of *Matricaria chamomilla*. Other agronomic practices viz. like irrigation, weed control, soil pulverization etc were adopted as per recommendation. *Matricaria* was planted in the month of December, 2009 in pots of 10 kg capacity (diameter 30 cm). The first picking of flower was done at 30 day after transplanting and subsequent picking were done when the flowers were ready for picking. Total five pickings were done during the life span of *Matricaria*. Observation were recorded on plant height (cm), number of branches per plant, number of flower per plant, width of flower (cm), fresh weight of flower and oil content (%). The oil extracted from the flowers of *Matricaria* was subjected to gas chromatography analysis for the principal constituents. The oil from *Matricaria* was extracted by hydro-distillation (Clevenger, 1928 apparatus,).

## RESULTS

**Plant height and No. of branches:** Data presented in Table 2, Application of calcium significantly influenced the plant height of *Matricaria*. The highest plant height (48.26 cm) was recorded under treatment $C_5$ (200 mg Ca pot$^{-1}$) followed by $C_4$ (150 mg Ca pot$^{-1}$, 43.78 cm), $C_3$ (100 mg Ca pot$^{-1}$, 39.46 cm), $C_2$ (50 mg Ca pot$^{-1}$, 35.70 cm) and the lowest (31.96 cm) in $C_1$ (control 0 mg Ca pot$^{-1}$). Among the magnesium levels treatments a significant difference was observed with respect to plant height. $M_5$-(200 mg Mg pot$^{-1}$) resulted in significantly higher plant height (52.04 cm) as compared to $M_4$ (150 mg Mg pot$^{-1}$, 45.66 cm), $M_3$ (100 mg Mg pot$^{-1}$, 41.86 cm), $M_2$ (50 mg Mg pot$^{-1}$, 32.6 cm) while minimum (27.00 cm) was recorded in $M_1$ (control 0 mg Mg pot$^{-1}$).

The interaction effect between calcium and magnesium significantly influenced the plant height. Application of 200 mg Ca pot$^{-1}$ + 200 mg Mg pot$^{-1}$ ($C_5M_5$) recorded the highest plant height (60.50 cm) as compared to others and it was lowest in $C_1M_1$ (Table 2).

Number of branches per plant as influenced by the treatments and their interaction also found to be the same as that of plant height; it was highest with $C_5M_5$ and lowest with $C_1M_1$ (Table 3).

Significantly highest number of branches per plant (46.2) were observed with Ca 200 mg pot$^{-1}$ ($C_5$) followed by $C_4$ , $C_3$, $C_2$ and lowest (28.8) found in $C_1$. Application of magnesium significant

Table 2: Effect of calcium and magnesium and their interaction on plant height (cm) of *Matricaria*

| Treatment | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ | Mean |
|---|---|---|---|---|---|---|
| $C_1$ | 20.50 | 25.20 | 30.80 | 37.80 | 45.50 | 31.96 |
| $C_2$ | 24.20 | 28.50 | 35.20 | 42.40 | 48.20 | 35.70 |
| $C_3$ | 26.80 | 32.80 | 42.40 | 44.50 | 50.80 | 39.46 |
| $C_4$ | 29.20 | 35.60 | 48.50 | 50.40 | 55.20 | 43.78 |
| $C_5$ | 34.30 | 40.90 | 52.40 | 53.20 | 60.50 | 48.26 |
| Mean | 27.00 | 32.60 | 41.86 | 45.66 | 52.04 | |
| Analysis | | C | | M | | C×M |
| Sem± | | 0.99 | | 0.97 | | 1.81 |
| LSD $_{(p = 0.05)}$ | | 3.01 | | 2.95 | | 5.45 |

Table 3: Effect of calcium, magnesium and their interaction on number of branches per plant of *Matricaria*

| Treatment | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ | Mean |
|---|---|---|---|---|---|---|
| $C_1$ | 15.0 | 18.0 | 28.0 | 35 | 48.0 | 28.8 |
| $C_2$ | 17.0 | 22.0 | 35.0 | 41 | 58.0 | 34.6 |
| $C_3$ | 19.0 | 24.0 | 40.0 | 48 | 62.0 | 38.6 |
| $C_4$ | 22.0 | 28.0 | 42.0 | 55 | 65.0 | 42.4 |
| $C_5$ | 23.0 | 32.0 | 45.0 | 61 | 70.0 | 46.2 |
| Mean | 19.2 | 24.8 | 38.0 | 48 | 60.6 | |
| Analysis | | C | | M | | C×M |
| SEM± | | 0.91 | | 0.68 | | 1.79 |
| LSD $_{(p=0.05)}$ | | 2.81 | | 2.01 | | 5.34 |

Table 4: Effect of soil supplied calcium, magnesium and their interaction on number of flower per plant of *Matricaria*

| Treatment | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ | Mean |
|---|---|---|---|---|---|---|
| $C_1$ | 74.66 | 147.00 | 215.33 | 239.33 | 271.33 | 190 |
| $C_2$ | 155.66 | 178.66 | 247.33 | 260.66 | 323.33 | 233 |
| $C_3$ | 162.33 | 248.66 | 248.00 | 288.66 | 341.33 | 258 |
| $C_4$ | 165.66 | 246.66 | 271.33 | 284.66 | 337.00 | 261 |
| $C_5$ | 172.66 | 258.00 | 273.33 | 302.66 | 362.66 | 274 |
| Mean | 146.00 | 216.00 | 251.00 | 275.00 | 327.00 | |
| Analysis | | C | | M | | C×M |
| SEM± | | 5.80 | | 4.52 | | 14.12 |
| LSD $_{(p=0.05)}$ | | 17.41 | | 13.65 | | 42.50 |

influenced the number of branches per plant and highest (60.6 branches) were recorded under the treatment of $M_5$. There was a significant interaction effect of Ca and Mg with respect to the number of branches per plant. The application of 200 mg per pot each of Ca and Mg recorded maximum number (70) of branches per plant as compared to others treatments while minimum (15) was noted under control (Table 3).

**Number of flowers per plant and flower width:** *Matricaria* plant treated with Ca at 200 mg pot$^{-1}$ ($C_5$) resulted in significantly higher number (274) of flower as compared to the rest of the treatment which decreased in the order of $C_4$>$C_3$>$C_2$ while minimum (190) was recorded in $C_1$. Significantly higher number of flower (327) were recorded with 200 mg Mg pot$^{-1}$ ($M_5$), followed by $M_4$ (275), $M_3$ (251), $M_2$ (216) and least in $M_1$-146 (Table 4).

The interaction of Ca and Mg recorded a significant influence with respect to number of flowers per plant. The treatment $C_5M_5$ produced the highest number (362.66) of flowers per plant which was significantly higher than rest of the interaction treatments while minimum (74.66) was noted under the control ($C_1M_1$). Similar trend was observed with respect to width of flower of *Matricaira* under the effect of soil supplied calcium and magnesium (Table 5).

Significantly maximum width of flower (2.18 cm) was observed with Ca 200 mg pot$^{-1}$ ($C_5$) followed by $C_4$ , $C_3$, $C_2$ and lowest (1.89) in $C_1$. Effect of magnesium also found significantly enhanced the width of flower and highest width (2.41 cm) was found under the treatment of $M_5$. Interaction effect of Ca and Mg was not found to be significant with respect to width of flower (Table 4).

Table 5: Effect of calcium, magnesium and their interaction on width of flower (cm.) of *Matricaria*

| Treatment | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ | Mean |
|---|---|---|---|---|---|---|
| $C_1$ | 1.63 | 1.83 | 1.86 | 2.00 | 2.13 | 1.89 |
| $C_2$ | 1.70 | 1.90 | 2.00 | 2.20 | 2.23 | 2.00 |
| $C_3$ | 1.73 | 1.90 | 2.03 | 2.23 | 2.50 | 2.07 |
| $C_4$ | 1.76 | 2.06 | 2.13 | 2.26 | 2.53 | 2.14 |
| $C_5$ | 1.86 | 2.03 | 2.00 | 2.36 | 2.66 | 2.18 |
| Mean | 1.74 | 1.94 | 2.00 | 2.21 | 2.41 | |
| Analysis | | C | | M | | C×M |
| SEM± | | 0.08 | | 0.06 | | 0.38 |
| LSD $_{(p=0.05)}$ | | 0.22 | | 0.19 | | NS |

Table 6: Effect of calcium, magnesium and their interaction on fresh weight of flower (g per plant) of *Matricaria*

| Treatment | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ | Mean |
|---|---|---|---|---|---|---|
| $C_1$ | 5.54 | 13.15 | 19.43 | 20.33 | 21.82 | 16.05 |
| $C_2$ | 11.61 | 13.28 | 18.90 | 20.36 | 23.94 | 17.61 |
| $C_3$ | 12.04 | 18.46 | 18.39 | 21.47 | 25.35 | 19.14 |
| $C_4$ | 12.34 | 18.34 | 20.11 | 21.16 | 25.01 | 19.39 |
| $C_5$ | 12.86 | 19.13 | 20.29 | 22.52 | 26.94 | 20.34 |
| Mean | 10.87 | 16.47 | 19.42 | 21.16 | 24.61 | |
| Analysis | | C | | M | | C×M |
| SEM± | | 0.45 | | 0.37 | | 0.86 |
| LSD $_{(p=0.05)}$ | | 1.37 | | 1.09 | | 2.56 |

**Fresh weight of flower:** Significantly highest flower yield of *Matricaria* was found under Ca applied at 200 mg per pot (20.34 g) followed by $C_4$ (19.39 g), $C_3$ (19.14 g), $C_2$(17.61 g) and the lowest was found in control (16.05 g). As in calcium the highest flower yield was recorded with the highest level of Mg ($M_5$) and it was significantly higher than the remaining levels; the minimum flower yield was recorded under control. As in other growth and yield attributing characters, the highest interaction effect with respect to flower yield was recorded with $C_5M_5$ and lowest with $C_1M_1$ (Table 6).

**Oil content (%):** Increase in calcium levels significantly increased in oil content. Application of Ca @ 200 mg pot$^{-1}$ ($C_5$) significantly increased the oil content in flowers as compared to the rest of the calcium levels and it was found to be approximately 43% higher as compared to $C_1$ (control). Increase in level of Mg application also significantly influenced the oil content. Soil supplied with Mg 200 mg pot$^{-1}$ ($M_5$) recorded significantly higher oil content (1.05%) as compared to $M_4$ (0.87%), $M_3$ (0.0.67%), $M_2$ (0.0.52%) while it was lowest (0.48%) under control ($M_1$). The oil content under $M_5$ was approximately 131% higher than that under control. The data presented in preceding sections indicates that all the growth and yield attributing characters of Chamomile was significantly influenced by both calcium and magnesium and their combinations particularly at the higher dose applied i.e., 200 mg per pot each of Ca and Mg. This indicates positive response to both the secondary nutrients on growth and oil yield of Chamomile. The conjoint application of Ca and Mg both @200 mg pot$^{-1}$ ($C_5M_5$) significantly influenced the oil content (1.10%) as compared to the rest of the treatments (Table 7).

Table 7: Effect of calcium, magnesium and their interaction on oil (%) of *Matricaria*

| Treatment | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ | Mean |
|---|---|---|---|---|---|---|
| $C_1$ | 0.42 | 0.44 | 0.54 | 0.79 | 0.97 | 0.63 |
| $C_2$ | 0.43 | 0.45 | 0.61 | 0.90 | 1.07 | 0.69 |
| $C_3$ | 0.46 | 0.47 | 0.65 | 0.85 | 1.07 | 0.70 |
| $C_4$ | 0.51 | 0.55 | 0.74 | 0.89 | 1.08 | 0.75 |
| $C_5$ | 0.60 | 0.71 | 0.84 | 0.93 | 1.10 | 0.84 |
| Mean | 0.48 | 0.52 | 0.68 | 0.87 | 1.06 | |
| Analysis | | C | | M | | C×M |
| $SEM_{\pm}$ | | 0.03 | | 0.02 | | 0.06 |
| $LSD_{(p = 0.05)}$ | | 0.07 | | 0.06 | | 0.18 |

## DISCUSSION

The results presented in the preceding a paragraphs indicate that combined application of calcium and magnesium significantly influenced the plant height, number of branches per plant, number of flower per plant, width of flower, fresh weight of flower and oil (%) content of *Matricaria*. Almost similar influence has earlier been reported in a calcareous soil by Patra *et al.* (2003). Patra *et al.* (2002) while growing Chamomile in sodic soil (pH 9.8, ESP 55), observed that application of gypsum ($CaSO_4$) as the soil amendment significantly influenced the dry flower and oil yield of Chamomile intercropped with lemon grass (*Cymbopogon flexuosus*). Their results also revealed that the response of Chamomile to Ca was more prominent than lemon grass, an essential oil bearing grass, suitable to be grown in high pH sodic and calcareous soils. The conjoint application of Ca and Mg both at 200 mg pot$^{-1}$ ($C_5M_5$) significantly resulted in maximum plant height (60.5 cm.), number of branches per plant (70), number of flowers per plant (362), width of flower (2.66 cm), fresh weight of flower per plant (26.94 g) and oil content (1.10%). This combination also resulted in the best quality of oil with respect to chemical constituents (data not shown). The experimental findings strongly support the results of Akhtar *et al.* (2009).

## CONCLUSION

Results from the present investigation showed distinct benefits of combined application of calcium and magnesium with respect to growth and yield of *Matricaria*. There was an indication of improvement in the quality of *Matricaria* oil due to integrated use of calcium and magnesium. The conjoint application of Ca and Mg both at 200 mg pot$^{-1}$ ($C_5M_5$) significantly influenced the yield, yield contributing characters and oil content (1.10%) of *Matricaria* as compared to the rest of the treatments.

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