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New agro-technology to increase productivity of chamomile (*Matricaria chamomilla* L.)

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ABSTRACT

A field experiment was conducted to standardize an economic and efficient method of fertilizer application in chamomile (*Matricaria chamomilla* L.) cultivation during rabi season in two consecutive year 2013–14 and 2014–15. For this purpose, four methods of fertilizer application were evaluated as site specific plant nutrient management (SSPNM) and their responses were ascertained with respect to yield attributes, flower yield, and essential oil yield of chamomile. The two year experiment results revealed that different fertilizer application methods, the T_4 (100:60:40 kg NPK ha^{-1} incorporated in surrounding soil of the plant: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 days after transplanting and 40–45 days after transplanting) recorded significantly highest attributes like; plant height (63–64 cm), dry flower yield (4.11–4.14 Mg ha^{-1}), oil content (0.91%), and oil yield (37.32–37.84 kg ha^{-1}) as compared to T_3, and $T_{2;}$ and the lowest value of plant height (44–46 cm), dry flower yield (2.15–2.16 Mg ha^{-1}), oil content (0.70%), and oil yield (15.05–15.12 kg ha^{-1}) were recorded in control (no fertilizer) during both the years.

1. Introduction

Matricaria chamomilla belonging to family Asteraceae is popularly known as German chamomile, Roman chamomile, English chamomile, Camomilla and Flos Chamomile. Chamomile is a well-known medicinal plant often referred to as the “star among medicinal species”. It mainly grows indigenously in Europe, NW Asia, North Africa, North America, and in other parts of the world (Wald and Brendler, 1998; Upadhyay and Patra, 2011). Chamomile (*Matricaria chamomilla* L.) is native to southern and eastern Europe. It is also grown in Germany, Hungary, France, Russia, Yugoslavia, and Brazil. It was introduced to India during the Mughal period, now it is grown in Punjab, Uttar Pradesh, Maharashtra, and Jammu and Kashmir. Hungary is the main producer of the plant biomass. In Hungary, it also grows abundantly in poor soils and it is a source of income to poor inhabitants of these areas. Flowers are exported to Germany in bulk for distillation of the oil (Svab, 1979). Chamomile has been used in herbal remedies for thousands of years, known in ancient Egypt, Greece, and Rome. It is an ingredient of several traditional, unani, and homeopathy medicinal preparations (Das et al., 1998; Lawrence, 1987; Mann and Staba, 1986). As a drug, it’s used in flatulence, colic, hysteria, and intermittent fever (Tyihak et al., 1962). The flowers of chamomile contain the blue essential oil from 0.2 to 1.9% which finds a variety of uses (Mann and Staba, 1986). Chamomile is used mainly as an anti-inflammatory and antiseptic, also antispasmodic and mildly sudorific (Mericli, 1990). Externally, the drug in powder form may be applied to wounds slow to heal, for skin eruptions, and infections, such as shingles and boils, also for hemorrhoids and for inflammation of the mouth, throat, and the eyes (Fluck, 1988). Tabulated products from chamomile flower extracts are marketed in Europe and used for various ailments. The international demand for chamomile oil has been steadily growing. As a result, the plant is widely cultivated in Europe and has been introduced in some Asian countries like India, Pakistan, etc. for the production of its essential oil. Presently; world is facing large gap between demand and supply of both flowers and oils of the chamomile. It is mainly due to lack of good agricultural practices with minimum input. Nowadays crop production cost is increasing tremendously; because more costly inputs like fertilizer, pesticides, etc, as well as these agrochemicals also pollute our soil, water, and ecosystem due to excessive use of agrochem-

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ical in crop production. It also increases cultivation cost of the crops. Aforesaid problems may be solved by judicious, precise, site specific use of agro-chemicals and fertilizers in crop production without any additional monetary input, and helps to us keep safe our ecosystem in sustainable manner. So; there is needed to develop agro-technology for high value crop with special reference to precision farming.

Keeping above fact in mind, the present experiment planned to reduce the agro-chemical pollution in soil, water, and environment, as well as to increases the fertilizer use efficiency via site specific plant nutrient management (SSPNM) approach. SSPNM approach may become a milestone for the cultivation of high economic value crops without additional monetary input, and may reduce the unit cost of production.

2. Materials and methods

2.1. Experimental site

A field experiment was conducted at the research farm of CSIR-Central Institute of Medicinal and Aromatic Plants, Research Centre, Pantnagar (Udham Singh Nagar) Uttarakhand, India during *Rabi* season 2013–14 and 2014–15. The experimental site is located between 29°N latitude and 79.38°E longitude and at an altitude of 243 m above mean sea level. The maximum temperature ranges between 35–45 °C, and minimum between 2–5 °C. The experimental soil was sandy-loam in texture, neutral in reaction (7.3 pH), medium in organic carbon (0.55%), low in available nitrogen (141 kg ha^{-1}), and medium in available phosphorus (14 kg ha^{-1}) as well as in potassium (149 kg ha^{-1}).

2.2. Transplanting material

The crop is propagated by seeds. About 0.75 kg clean seeds of chamomile with a high germination percentage were required for raising nursery for transplanting one hectare area.

2.3. Raising of nursery

The area required for raising the nursery to produce transplants for one hectare of chamomile was 300 m^2. The seeds of chamomile were sown on 25th October 2013 and 2014 in well pulverized field at 1–2 cm depth in row. The size of each bed was 3×1 m^2 with inter row spacing of 8.0 cm, seeds were covered by fine soil of the field and provided light irrigation just after covering. Nursery beds were irrigated as per the need of crop.

2.4. Field preparation

The well pulverized and leveled field was used for transplanting of chamomile. Good quality farmyard manures at 10 t ha^{-1} was applied in the field 30 days before transplanting during both the years. Soil was fertilized with nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) at 100:60:40 kg ha^{-1}, respectively. The methods of fertilizers vary with different treatment as per SSPNM viz; T_1—Control, T_2—100:60:40 kg NPK ha^{-1} top dressed: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 days after transplanting (DAT) and 40–45 DAT, T_3—100:60:40 kg NPK ha^{-1} applied on surrounding soil of the plant: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 DAT and 40–45 DAT, and T_4 (100:60:40 kg NPK ha^{-1} incorporated in surrounding soil of the plant: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 DAT and 40–45 DAT).

Table 1
Treatment details of the experiment.

Treatment	Treatment details
T_1	Control
T_2	100:60:40 kg NPK ha^{-1} top dressed: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 DAT and 40–45 DAT
T_3	100:60:40 kg NPK ha^{-1} applied on surrounding soil of the plant: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 DAT and 40–45 DAT
T_4	100:60:40 kg NPK ha^{-1} incorporated in surrounding soil of the plant: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 DAT and 40–45 DAT

2.5. Experimental design and details of treatments

The field experiment was laid out in a Randomized Block Design with four treatments and three replications. The details of the treatments are represented in Table 1. The numerical data of all the components were subjected to analysis of variance (ANOVA) using randomized block design. Statistical analysis of data was done following standard procedures (Snedecor and Cochran, 1967).

2.6. Transplanting of the crop

The good and healthy 35 days old seedlings of chamomile (cv. CIM-Sammohak) were transplanted at 50×50 cm with inter-row and intra-row spacing, respectively on 30th November, 2013 and 2014 in the experimental field. Two weeding were done on 25 and 45 days after transplanting. Chamomile field were irrigated as per the need of crop during both the years of experiment.

2.7. Growth and yield analysis

The observations pertaining to plant height (cm), dry flower yield (Mg ha^{-1}), oil content (%), and oil yield (kg ha^{-1}) were recorded at the time of harvest. Essential oil yield (kg ha^{-1}) was calculated by multiplying dry biomass yield of flower and oil content (%). The flowers of chamomile were harvested in four pickings at fortnightly interval; starting from 75 DAT, and continued up to 120 DAT. The harvested flowers were dried in cool and dry place.

2.8. Essential oil extraction

Dry flowers of chamomile were hydro-distilled in a Clevenger type apparatus for 4 h (Clevenger, 1928). The essential oil was measured directly in the extraction burette and content (%) was determined as volume (mL) of essential oil per 100 g of a dry flower.

3. Results and discussion

3.1. Plant height

The data pertaining to the plant height of chamomile (Table 2) recorded during 2013–14 and 2014–15 clearly showed significant difference in chamomile crop during both the years. Application of fertilizers as 100:60:40 kg NPK ha^{-1} incorporated in surrounding soil of the plant: 1/3rd N and full dose of P_2O_5 and K_2O as basal, and 1/3rd N each at 25–30 DAT and 40–45 DAT (T_4) resulted in significantly higher plant height 63.0 cm and 64 cm as compared to T_3 (56.0 cm and 57.0 cm), T_2 (53.0 cm and 54.0 cm), and lowest plant height 44.0 cm and 46.0 cm was found in T_1 during 2013–14 and 2014–15 respectively.