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POTASSIUM FERTILIZATION IMPROVES GROWTH, FLOWER YIELD AND OIL CONTENT OF GERMAN CHAMOMILE (*Matricaria chamomilla* L.)

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ABSTRACT

A field experiment was conducted during 2006-07 and 2007-08, to examine the effect of different rates of potassium application (25, 50, 75 and 100 kg K/ha) on vegetative growth and flower yield of German chamomile. Potassium (K) was applied as muirate of potash in the soil at the time of transplanting of chamomile seedlings. While non-significant effects of potassium application on plant growth parameters and chlorophyll contents observed, but significant differences were recorded among control and K treated plants for yield attributes, particularly for fresh flower yield and oil content. This effect was more pronounced at higher levels of applied K i.e. 75-100 kg K/ha in comparison to other rates. Thus, K application @100kg K/ha was found to be superior in enhancing flower and oil yield of German chamomile under field conditions of Punjab.

Key Words : *Potassium, flower yield, oil content, German chamomile.*

Matricaria chamomilla L., also known as German chamomile or scented mayweed, is the most frequently used aromatic and medicinal herb. The crop is extensively cultivated for its flower heads (inflorescences), which upon steam distillation yield deep blue coloured oil. Both flower anthodia and blue oil are used in expensive perfumes, herbal and homeopathic medicines. The blue oil is also used therapeutically as an expectorant, carminative, anti-helmintic, sedative, diuretic, anti-phlogistic and for teething troubles in infants. Oil of chamomile is used in hair dyes to prevent allergic contact dermatitis, in antiseptic ointments and creams for wound healing and even in rheumatism (1). Apart from the medicinal value, this drug plant is found to be useful in mosquito repellence, biological control of pests and in biological weed control (2).

Chamomile crop has a wide adaptability to different agro-climatic conditions. It is grown as a winter crop in plains and as a summer crop in hills. Due to its ability to grow in any type of soil (even sodic soil of pH 8.0 to 9.5) and higher economic value, it can acts as a remunerative crop for Punjab where rice-wheat monocropping system resulted in soil degradation, declining ground water tables and air pollution. Chamomile crop requires only 3-4 irrigations during the crop cycle. Regarding nutritional requirement of this crop, considerable reports were available in response to nitrogen (N) application, which resulted in yield improvement (3,4). However a few studies were carried out on potassium and phosphorus (P) nutrition of this crop (5). Being one of the macronutrients required for optimal plant growth, potassium (K) plays a significant role in plant-water relations, osmoregulation, enzyme activation both under normal and abiotic stress (drought or salinity) conditions,which effects both primary and secondary metabolism of plants. Studies on different aromatic crops demonstrated that aromatic crops like citronella, lemon grass, scented geranium, coriander, davana, palmarosa etc., demanded high soil K for growth (6). Furthermore, perennial crops remove more soil K than the annuals. In this context, positive effects of potassium fertilization (along with N and P as basal dose) on oil and herb yield of different aromatic crops such as french basil (7), geranium (8), palmarosa (9), lemongrass (10) have also been reported in previous studies. In order to augment the production of *M. chamomilla* in Punjab, development of suitable package of practices for this plant is necessary particularly in response to potassium because moderate to higher levels of K occur in Punjab soils. Keeping this in view, the present research was carried out sto study the performance of chamomile crop in prevailing soil conditions of Punjab. Moreover effects of different rates of potassium application on growth, flower yield and oil content of chamomile were evaluated.

MATERIALS AND METHODS

Seeds of *Matricaria chamomilla* L. cultivar Vallary were obtained from Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow. In order to avoid poor and patchy germination, seedlings were firstly raised in nursery. The basic level of fertility in field was increased by green manuring using jantar crop. For the nutrition of crop, nitrogen, phosphorus and sulphur was applied at the rate of 100 kg N/ha, 40 kg S/ha and 40 kg P_2O_5/ha as described in previous studies. Field experiments were conducted during the growing seasons of 2006-07 and 2007-08 in experimental area of Dept. of Botany, Punjab Agricultural University (PAU), Ludhiana, India. The region is characterized by a sub-tropical and semi-arid climate with a cool, dry winter (October–February) and hot dry summer (March–June). Forty days old seedlings were transplanted in the field during second fortnight of December at a distance of 30 x 30 cm^2. The experiment was laid out in a random block design in which each treatment (i.e. applied K) was tested by three replications with a plot size of 4 x 2 m^2. Potassium was applied to soil in the form of muriate of potash (60-62.5% K_2O) at different rates (25, 50, 75 and 100 kg K/ha) at the time of transplanting. In control plots, irrespective of soil available K (estimated as 80 kg K/ha on soil test basis), no external application of K was done. Chamomile crop was provided with 3-4 irrigations (each of 5-10 cm depth) during its life cycle.

Fully developed flowers were harvested at successive time intervals from the month of February to April and were then shade dried before their oil extraction. Data on growth (plant height and number of branches/plant) and yield parameters (stover yield, fresh flower yield, dry flower yield and oil content) were recorded from each treatment. Blue oil was extracted from dry flowers through steam distillation method and was then separated from aqueous extract using hexane as a solvent. For biochemical estimations, youngest fully expanded pinnati-fid leaves from 10 random plants were excised at two growth stages i.e. at 50 and 90 days after transplanting (DAT) which represented the period of maximum flower yield. However, protein and K levels were also measured in leaves at maturity. Chlorophyll content was estimated from fresh leaf tissues using acetone method (11). Total protein content was measured spectro-photometerically using folin's reagent (12) and calculated on dry weight basis. Content of potassium (% in plant sample) was determined using wet digestion method by flame photometer at selected growth stages from dried leaf tissues.

Statistical analysis : All measurements were recorded on three replications. The data were subjected to statistical analysis by means of random block design using one way ANOVA, consisting of treatments at 5 levels.

RESULTS AND DISCUSSION

Growth parameters

A significant increase in plant height was observed in both control and K treated plots, at successive growth stages with increase in duration of days after transplanting (Table-1). Plant height was found to be maximum at 90 DAT in all treatments beyond which no increase was noticed (data not given) as plant reached near to stage of maturity. While at earlier vegetative growth stage of 30 and 50 DAT, potassium application did not cause any change in plant height, but at 70 and 90 DAT i.e. flowering stage of chamomile, higher doses of applied K (i.e. 50-100 kg K/ha) significantly improved plant height in comparison to control counterparts. At 90 DAT, plant height was significantly higher at 100 kg K/ha, in comparison to other applied doses of K. Moreover, plant height of treatments @ 50 and 75kg K/ha were statistically at par to each other but significantly greater than 25 kg K/ha. In case of number of branches per plant (Table-1), significant increase was recorded at 50 DAT than 30 DAT, under both control and applied K conditions. But among the treatments, non significant differences were observed among K treated and non treated control plots at different DAT. Our results demonstrated that growth response of chamomile, to prevailing soil conditions of Punjab was satisfactory. Increase in plant height, number of branches with progression of crop growth and considerable flower yield under control conditions

Table-1 : Effect of different rates of potassium application on plant height (PH in cm) and number of branches (NOB) per plant during growth period of German chamomile (pooled data of two years)

S. No.	Treatments	30 DAT		50 DAT		70 DAT		90DAT	
		PH	NOB	PH	NOB	PH	NOB	PH	NOB
T_1	Control	5.4	9.2	8.9	20.6	15.3	22.2	39.3	24.1
T_2	25 kg K/ha	5.7	9.2	9.2	19.7	16.5	24.4	43.1	24.4
T_3	50 kg K/ha	5.9	9.6	9.9	22.2	19.5	25.3	43.6	25.7
T_4	75 kg K/ha	5.8	10.7	11.6	21.5	18.3	22.6	42.8	22.6
T_5	100 kg K/ha	5.9	10.4	11.2	19.3	18.6	22.1	45.0	23.0
	CD at 5%	0.42	NS	1.39	NS	1.05	1.94	1.33	1.76

Table-2 : Effect of different rates of potassium application on total chlorophyll content (mg/g FW), protein content (mg/g DW) and potassium levels (% K in given leaf sample) of German chamomile (pooled data of two years)

S. No.	Treatments	Total chlorophyll content		Total protein content			% K content		
		50 DAT	90 DAT	50 DAT	90 DAT	At maturity	50 DAT	90 DAT	At maturity
T_1	Control	1.705	2.528	45.0	35.9	30.3	1.229	0.763	0.534
T_2	25 kg K/ha	1.712	2.675	57.2	40.7	37.7	1.367	1.237	0.958
T_3	50 kg K/ha	1.847	2.586	52.8	41.5	39.4	1.605	1.433	1.136
T_4	75 kg K/ha	2.158	2.462	55.0	40.1	38.3	1.824	1.517	1.245
T_5	100 kg K/ha	2.005	2.480	54.4	46.6	41.5	2.071	1.767	1.609
	CD at 5%	0.55	0.28	1.85	1.76	1.32	0.84	0.71	0.78

Table-3 : Effect of different rates of potassium application on stover yield (q/ha), fresh flower yield (q/ha), dry flower yield (q/ha) and oil content (kg/ha) of German chamomile (pooled data of two years).

S. No.	Treatments	Stover yield	Fresh flower yield	Dry flower yield	Oil content
T_1	Control	43.81	56.60	11.25	7.99
T_2	25 kg K/ha	61.00	73.54	13.22	11.00
T_3	50 kg K/ha	67.06	81.38	15.73	11.69
T_4	75 kg K/ha	73.94	85.05	16.23	11.70
T_5	100 kg K/ha	81.31	91.74	18.17	15.77
	CD at 5%	18.56	13.75	3.44	1.61

suggested that chamomile crop required limited amount of irrigation and basal nutrients for its growth.

Biochemical parameters

When pooled across the treatments, significant increase in total chlorophyll content (Table-2) was observed at 90 DAT (2.546 mg/g FW) in comparison to 50 DAT (1.885 mg/g FW). However, non-significant differences existed among K treated and control plots, at both 50 DAT and 90 DAT. This suggested that the basal dose of applied nutrients and soil available K to control plots was quite effective in maintaining the chlorophyll content similar to K treated plots. In contrast to chlorophyll, levels of protein and potassium decreased with successive growth of chamomile plants, being lowest at maturity and highest at 50 DAT (Table-2). At 50 DAT i.e. at reproductive development stage of chamomile, protein levels were significantly higher @ 25 kg K/ha as compared to other rates of applied K and control. However with progression of plant growth at 90 DAT and at maturity, higher contents of protein were observed @ 100 kg K/ha in comparison to other doses of applied K. Moreover, protein contents of chamomile subjected to 25, 50 and 75 kg K/ha were statistically at par to each other, at both the 90 DAT and at maturity stages, but differed significantly from non-treated control plots. Decline in protein levels of leaves at 90 DAT could be explained by involvement of amino acids in production of secondary metabolites of chamomile oil during crop growth. Moreover, non-significant differences for potassium content in leaves of K treated and non treated control conditions and their significant decline with crop growth indicated more translocation of soil applied K to developing florets rather than leaves which might be responsible not only for their better reproductive development but also for more partitioning of photosynthates for oil formation in flowers. Lowest content of K were recorded in control plots at all the stages of growth, which was statistically on par with K content observed in treated plots of 25 kg K/ha and 50 kg K/ha.

Yield contributing parameters

As demonstrated from Table-3, stover yield was significantly greater at higher rate of applied K i.e. @ 100 kg K/ha, which was statistically on par with 50 and 75 kg K/ha. Lowest yields were recorded in both control and 25 kg K/ha conditions. Similar trend has been observed for the parameters of fresh and dry flower yields (Table-3). While in control and 25 kg K/ha treated plots, flower yields were statistically at par but increased significantly at higher rates of applied K. Maximum fresh and dry flower yields were obtained at 100 kg K/ha which was statistically on par with yields obtained @50 and 75 kg K/ha. Oil content, which represented economically important parameter in chamomile, improved significantly with K application. Maximum content of blue oil was obtained at 100 kg K/ha, which decreased with decrease in rates of applied K. However, minimum content of blue oil was observed in control plots. In conclusion, potassium application @ 100 kg K/ha was found to be optimum for maximum flower and oil yield in German chamomile.

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