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Productivity of Marigold and Mentha in response to wastewater irrigation, land configuration and nitrogen levels

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ABSTRACT

A field experiment was carried out on marigold and mentha to assess the impact of wastewater irrigation under different land configuration and nitrogen levels on the crop productivity during two consecutive season of 2014-15 at IARI, New Delhi. Wastewater irrigation resulted into significant increase in marigold flower yield (3.94%) and herb (10.8%) and oil yield (9.7%) of mentha as compared to ground water irrigation. Raised bed planting was proved more beneficial in case of marigold in producing significantly higher flower yield whereas the herb and oil yield differences in case of mentha were not significant when compared with flat bed planting. The higher dose of nitrogen (120 kg N / ha) application in marigold resulted 118.8 and 25.5% increase in flower yield over control and 60 kg N / ha, respectively. In case of mentha, the interaction effects between water quality and nitrogen rates indicated that application of 100 % recommended dose of nitrogen (75kg / ha) along with ground water irrigation produced herb and oil yield statistically at par with that obtained by applying 50% recommended dose of nitrogen under waste water irrigation thereby showing 50% (37.5 kg / ha) saving of applied nitrogen.

Key words: Flower yield, Herb yield, Irrigation, Nitrogen, Wastewater, Oil yield.

Increasing population coupled with rapid industrial growth and urbanization has not only raised the demand for fresh water consumption but also caused manifold increase in generation of wastewater. Both limited number and capacity of sewage treatment plants for recycling of polluted water compared to its generation has created a great challenge of safe disposal of wastewater which could otherwise pose a risk of health hazards if used untreated (Kaur *et. al.* 2012). Therefore, safe disposal of wastewater especially in the urban and peri-urban areas has forced the researchers to think about appropriate reuse of wastewater in agricultural sector for irrigation in suitable crops to avoid food chain contamination while sparing the fresh water resources for other purposes is needed priority. In contrary, wastewater also contains good amount of nutrients which can benefit by enhancing the productivity of the crops while saving the nutrient applied through fertilizers. Therefore, the use of wastewater for irrigation purpose, selecting suitable non-edible crops like marigold (*Tagetes* spp.) and mentha (*Mentha arvensis* L.), those are not consumed directly as food offers a good scope. Marigold *(Tagetes patula)* is an important and commonly grown commercial flower crop in India. Among loose flowers, it has the potential to fetch high market price due to higher demands. On the other hand, mentha which contains 0.50 to 0.75% oil in herb having 80-85% menthol, there is a great demand of essential oil as it has wider application for several purposes like in the food, perfumery,

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flavoring and pharmaceutical industry worldwide. It has the potential to fetch high market price due to higher demands, convenient storage and easier marketing especially in the urban and peri-urban areas. Besides sustaining the income of the farmer, such crops have greater scope for using wastewater for irrigation and reducing the pollutants load of the soil. There is also need to explore appropriate production technologies like land configuration to reduce direct contact of wastewater to plants for pathological concerns and optimization of nutrient requirement for higher productivity.

Materials and Methods

An experiment was conducted to assess the impact of wastewater irrigation and nitrogen under different land configuration in marigold and mentha at IARI, New Delhi during 2014 and 2015. The experiment consists of two sources of irrigation water (Ground water and municipal untreated wastewater) and three levels of nitrogen (control, 50% of recommended nitrogen and 100% of recommended nitrogen kg/ha) under raised and flat bed condition with three replications in split plot design. The soil of the experimental field was sandy loam in texture with available nitrogen, phosphorous and potassium content of 268, 25.6 and 290.2 kg/ha in 0-15 cm soil layer. The soil pH and EC was 7.7 and 0.62 respectively. The municipal wastewater and tube well water was used for irrigation as per treatment. The crop was raised through transplanting of 30 days old seedling of marigold variety 'Pusa Arpita'. Two rows of marigold were planted on each raised bed spaced at 90 cm whereas under flat bed planting row to row spacing was 45 cm. Plant to plant spacing was 45 cm in both raised and flat bed planting. A uniform dose of 75 kg/ha each of P_2O_5 and K_2O was applied before transplanting whereas nitrogen was applied as per treatments in two equal split half at first week and remaining half at 45 days after transplanting. Mentha crop was raised through transplanting of 45 days old seedling raised through suckers of variety 'Kosi'. Two rows of mentha were planted on each raised bed spaced at 90 cm whereas under flat bed planting row to row spacing was 45 cm. Plant to plant spacing was 15 cm in both raised and flat bed planting. A uniform dose of 40 kg/ha of P_2O_5 was applied before transplanting whereas nitrogen was applied through urea as per treatments in two equal splits, half at first week and remaining half at 40 days after transplanting. Only one cutting of the crop was taken in the first week of July and the herb yield was recorded. Oil content in the herb was determined through hydro-distillation process using Clevenger's apparatus.

Results and Discussions

Marigold growth and yield

Wastewater irrigation produced significantly higher flower yield of 13.2 t/ha (3.94%) than that obtained from ground water. The higher flower yield with waste water irrigation was due to the comparatively better crop growth and flower attributes in terms of plant height, total branches, flower diameter and weight over groundwater irrigation. Jagathjothi and Amanullah (2015) have also observed that irrigation with 100% domestic wastewater recorded comparable dry matter production and flower yield to that of normal water in case of marigold. Shahram and Mirshekari (2013) were found that irrigation by refined wastewater in mixture growing medium resulted in the best characteristics of marigold like plant height, flower number and flower diameter. Raised bed planting also produced significantly higher flower yield (13.3 t/ha) as compared to flat bed planting. Unlike flat bed planting, irrigation under bed planting was confined to furrows only, led to better aeration and more exposure to sunlight which might have caused better growth. The growth of marigold in terms of plant height and branching also got influenced significantly with the application of nitrogen. Application of 120 kg N/ha produced taller plants than that of lower dose of nitrogen. Similarly, 120 kg N/ha resulted in 62 and 30% higher number of branches over control and 60 kg N/ha respectively. Yield attributes like flower diameter and weight were also increased significantly and registered 16 and 14% increase respectively with the application of 120 kg N/ha as compared to 60 kg N/ha. Due to significant improvement in growth and yield

Table 1. Effect of waste water irrigation, land configuration and nitrogen levels on growth and yield of marigold.

Treatment	Plant height (cm)		Total branches	Flower diameter (cm)	Flower weight (g)	Flower yield (t/ha)
	First picking	Last picking				
Water quality						
Waste water	76.1	94.9	21.2	5.1	3.08	13.2
Ground water	74.8	92.0	20.3	4.9	2.91	12.7
CD (P=0.05)	NS	NS	NS	NS	NS	0.40
Land configuration						
Raised bed	76.8	93.7	21.4	5.0	3.11	13.3
Flat bed	74.0	93.2	20.2	4.9	2.88	12.6
CD (P=0.05)	2.70	NS	0.96	NS	NS	0.40
Nitrogen levels						
0 kg N/ha (Control)	67.9	80.9	16.0	4.30	2.58	7.9
60 kg N/ha	74.9	92.2	20.2	4.90	2.99	13.7
120 kg N/ha	83.6	107.3	26.2	5.70	3.41	17.2
CD (P=0.05)	2.75	5.34	1.78	0.28	0.27	0.90

Table 2. Response of mentha to waste water irrigation involving land configuration under different levels of nitrogen.

Treatment	Plant height (cm)	Stools/m2	Leaf area index (LAI)	Herb yield (t/ha)	Oil content (%)	Oil yield (l/ha)
Waste water	48.4	124.2	2.69	19.50	0.67	131.0
Ground water	45.8	119.8	2.15	17.63	0.68	119.4
CD (P=0.05)	2.4	NS	0.16	0.86	NS	6.5
Raised bed	47.6	123.0	2.39	18.74	0.68	127.6
Flat bed	46.6	121.0	2.26	18.38	0.67	123.6
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Control (0kgN/ha)	38.9	91.9	1.73	14.4	0.65	93.3
50% Rec. N (37.5kg/ha)	48.2	130.0	2.45	19.03	0.70	133.5
100 % rec. N (75kg/ha)	54.1	144.0	3.08	22.25	0.68	150.1
CD (P=0.05)	4.1	9.4	0.21	1.18	NS	7.4

attributes, higher dose of nitrogen (120 kg N/ha) resulted 118.8 and 25.5% increase in flower yield over control and 60 kg N/ha, respectively. The improvement in growth and flower yield with increased level of nitrogen may be attributed to its bigger plant vigor, high tonnage of flower yield synchronized with indeterminate type of growth habit (as indicated through plant height at first and last picking) and higher total biomass production potential. Maharnor *et al.* (2011) have also reported that plant height, number of branches, spread of plant and flower yield of marigold increased with increasing levels of nitrogen up to 150 kg/ha.

Mentha growth, herb and oil yield

Irrigation with wastewater significantly increased the plant height (5.7%), leaf area index (LAI) and herb (10.8%) and oil yield (9.7%) of mentha than that irrigated with ground water (Table 2). Fayaz and Darvishi (2011) reported that the essential oil percentage and essential oil yield were increased under the use of secondary drainage water/domestic wastewater. However, the response in terms of stools/m^2 and oil contents was statistically non significant. Raised and flat bed planting proved equally effective as the differences in terms of all the recorded aspects were statistically non significant. Application of

Table 3. Interaction effect of water quality and nitrogen rates on herb and oil yield of mentha.

Water quality	Herb yield (t/ha)		
	Nitrogen levels (kg/ha)		
	0	37.5	75
Wastewater	15.02	20.83	22.63
Ground water	13.79	17.23	21.86
CD (P=0.05): 16.74			
	Oil yield (l/ha)		
Wastewater	97.0	147.2	151.2
Ground water	89.5	119.8	148.9
CD (P=0.05): 10.5			

75 kg N/ha of (100% recommended dose of nitrogen) resulted in increased plant height, LAI, stools/m^2 and herb yield significantly as compared to control and lower dose of nitrogen. Anwar *et al.,* (2010) have reported that herb yield of mentha increased with increased level of NPK up to 150, 60 and 60 kg NPK/ha. Further the interaction effects (Table 3) between water quality and nitrogen rates indicated that application of 100 % recommended dose of nitrogen (75kg /ha) along with ground water irrigation produced herb and oil yield statistically at par with that obtained by applying 50% recommended dose of nitrogen under waste water irrigation thereby showing 50% (37.5 kg/ha) saving of applied nitrogen. This was attributed to higher nitrogen content in the wastewater than ground water which might have compensated the nitrogen requirements of the crop. Water quality, land configuration and different doses of nitrogen application did not show any significant effect on oil content which may be due to the inherited character of the species. In contrary, oil yield increased with wastewater irrigation and higher dose of nitrogen application which was due to higher herb yield under respective treatments.

Conclusion

Irrigation with wastewater was found beneficial in enhancing the productivity of both marigold and mentha crops. Besides higher productivity, wastewater irrigation also supplement the nitrogen requirements of these crops and has shown the potential to save 60 and 37.5 kg nitrogen/ha in marigold and mentha respectively at the location of the study. However, there may be variations in such findings depending upon the source of wastewater, climatic conditions and irrigation requirements of the crops.

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