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Effect of mulching, drip irrigation and fertigation on flowering, physiological and biochemical parameters of nerium (*Nerium oleander* L.)

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Abstract
A study was conducted to study the effect of mulching, drip irrigation and fertigation on flowering, physiological and biochemical parameters of nerium (*Nerium oleander* L.) at Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam in the year 2017. The experiment was laid out in a split split plot design consisting of three factors, *viz*., factor - I (Black polythene mulch - M_1, coir waste - M_2 and without mulch - M_3), factor - II three levels of drip irrigation (I_1- 75 % WRc through drip irrigation, I_2 - 100 % WRc through drip irrigation and I_3 - 125 % WRc through drip irrigation) and factor - III three levels of fertigation (75 % RDF through fertigation - F_1, 100 % RDF through fertigation - F_2, 125 % RDF through fertigation - F_3 with twenty seven treatment combinations. The results of the study indicated that the treatment $M_1I_2F_3$ (black polythene mulch + 100 % WRc through drip irrigation + 125 % RDF through fertigation) recorded highest number of inflorescence plant^{-1}and numbers of flowers inflorescence^{-1}, increased chlorophyll content, total phenol content and IAA oxidase activity.

Keywords: *Nerium oleander*, physiological and biochemical parameters, Madurai

Introduction
Soil, water and nutrients are the three most critical inputs in crop production and their efficient management is important not only for highest productivity but also for maintaining environmental quality. Loose flowers are largely cultivated in Madurai, Dindigul, Tanjore Ramanathapuram, Salem Tuticorin, Kanyakumari and Trichy districts of Tamil Nadu. Nerium (*Nerium oleander* L.) is one of important loose flower, belongs to the family Apocynaceae and native of Mediterranean basin. The crop is fast gaining popularity as a loose flower, not only because of the wide range of flower colours and fragrance but also because of it's ability to withstand adverse climatic conditions. However, given the present unpredictable climatic scenario, it becomes mandatory to standardize techniques like schedule of drip irrigation, fertigation and mulching for the crop.

Materials and Methods
The present investigation was undertaken at the Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam in the year 2017. The experimental field is situated at 77 E longitude, 10 latitude and at an altitude of 300 m above mean sea level (MSL). The treatments were randomly allocated in split split plot design and replicated three times. The experiment consisted of three factors, *viz*., factor - I (Black polythene mulch - M_1, coir waste - M_2 and without mulch - M_3), factor - II three levels of drip irrigation (I_1- 75 % WRc through drip irrigation, I_2 - 100 % WRc through drip irrigation and I_3 - 125 % WRc through drip irrigation) and factor - III (three levels of fertigation (75 % RDF through fertigation - F_1, 100 % RDF through fertigation - F_2, 125 % RDF through fertigation - F_3).The data was collected from four plants selected and the data were subjected to statistical analysis as suggested by Panse and Sukhatme, (1985) [8].

Result and Discussion

Effect of mulching drip irrigation and fertigation on number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1}

Flowering was significantly influenced by treatments applied to the crop (Table: 1 a, 1 b, 1 c and 2 a, 2 b and 2 c).Among the three main plot treatments, highest number of inflorescence plant^{-1}and numbers of flowers inflorescence^{-1}(11.35, 71.06 and 71.96 and 10.77, 15.71 and 14.20) was observed in black polythene mulch (M_1) at flowering, peak flowering and lean flowering stages respectively, followed by the treatment M_2 (coir waste) 10.56, 63.01 and 61.58 and 9.38, 13.75 and 11.90. Among the three sub plot treatments compared, highest number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1} (10.31, 65.55 and 68.17 and 9.61, 13.84 and 12.20) was observed at 100 % WRc through drip irrigation (I_2) at flowering, peak flowering and lean flowering stages followed by the treatment 125 % WRc through drip irrigation (I_3) 9.09, 59.08 and 60.19 and 8.70 and 11.85 and 10.73. Among the three sub sub plot treatments compared, the treatment F_3 (125 % RDF through fertigation) resulted in highest number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1} at flowering, peak flowering and lean flowering stages (10.27, 64.65 and 62.79 and 9.36, 14.47 and 11.91 respectively). The interaction effects between mulching and drip irrigation recorded significantly higher number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1}. The treatment M_1I_2 recorded the highest number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1}(12.62, 77.22 and 77.82 and 11.70, 18.36 and 15.01) at flowering, peak flowering and lean flowering stages followed by the treatment (M_2I_2) coir waste + 100 % WRc through drip irrigation 11.54, 71.39 and 76.90 and 10.91, 15.35 and14.58. Interaction between mulching and fertigation were significantly superior for number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1}. The treatment M_1F_3 (black polythene mulch + 125 % RDF through fertigation) recorded the highest number of inflorescence plant^{-1}and numbers of flowers inflorescence^{-1}(12.2, 76.00 and 70.65 and 11.53, 18.41 and 14.88) at flowering, peak flowering and lean flowering stages which is on par with the treatment M_2F_3 (coir waste + 100 % RDF through fertigation). Interaction between drip irrigation and fertigation was significantly superior for number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1}. I_2F_3 (100 % WRc through drip irrigation + 125 % RDF through fertigation) recorded the highest number of inflorescence plant^{-1} and numbers of flowers inflorescence^{-1} (11.30, 70.53 and 72.50 and 10.71, 15.47 and 13.02) at flowering, peak flowering and lean flowering stages respectively. The three way interaction of mulching, drip irrigation and fertigation significantly influenced the number of inflorescence plant^{-1}and numbers of flowers inflorescence^{-1}. The highest number of inflorescence plant^{-1}and numbers of flowers inflorescence^{-1} was observed in the treatment $M_1I_2F_3$ - black polythene mulch + 100 % WRc through drip irrigation + 125 % RDF through fertigation (13.56, 81.25 and 79.50 and 12.85, 19.25 and 15.77) at flowering, peak flowering and lean flowering stages and this was on par with treatment $M_2I_2F_3$ (coir waste + 100 % RDF through drip irrigation+ 125 % RDF through fertigation) 12.77, 79.35 and 78.65 and 12.73, 19.16 and 15.54. The number of inflorescence plant^{-1} was found to show a significant increase with higher levels of nitrogen and potassium. This might be attributed to the fact that the combination of nitogen and potassium was found to be more efficient in bio-mass production with better availability of photosynthates. Nitrogen being one of the major essential elements, regulates the cell or tissue functions of the plant and an essential part of the nucleic acid, mitochondria and cytoplasmic content of cells. Nitrogen has a strong control on vegetative and reproductive stages of the plants. The role of potassium in plants includes cation transport across membrane, water economy, energy metabolism and enezyme activity. Potassium increases carbon exchange and enhances carbohydrate movement (Laveti Gowthami, 2014) [11]. The findings were line with Chaitra, (2006) [4] in China aster and Ashutosh Sharma (2013) [1] in tuberose.

Effect of mulching, drip irrigation and fertigation on chlorophyll content (SPAD value), total phenol content and IAA oxidase activity

The bio chemical parameters*viz*., chlorophyll content, total phenol content and IAA oxidase activity varied significantly due to mulching, drip irrigation and fertigation and is presented in Table: 3 a, 3 b and 3 c. The results showed that there was an increase in chlorophyll content (SPAD value) in flowering, peak flowering and lean flowering stages under black polythene mulch (M_1) 57.94, 62.69 and 79.73 SPAD value followed by M_2(coir waste) which recorded 56.02, 59.07 and 75.42 SPAD value respectively. The results showed that there was an increase in chlorophyll content (SPAD value) under 100 % WRc through drip irrigation (I_2) (55.08, 59.89 and 78.36 SPAD value respectively). The interaction effects of mulching and drip irrigation were significant with respect to chlorophyll content (SPAD value). The treatment M_1I_2 (Black polythene mulch + 100 % WRc through drip irrigation) recorded the highest values (61.08, 64.98 and 83.83 SPAD value) at flowering, peak flowering and lean flowering stages which was followed with the treatment M_2I_2 (59.02, 63.33 and 83.16 SPAD value respectively). The interaction effects of mulching and fertigation were significant with respect to chlorophyll content (SPAD value) at flowering, peak flowering and lean flowering stages. The treatment M_1F_3 (black polythene mulch + 125 % RDF through fertigation) recorded the highest chlorophyll content (62.02, 64.16 and 82.03 SPAD value) which was followed with the treatment M_2F_3 (58.42, 62.63 and 80.04 SPAD value respectively).The interaction effects of drip irrigation and fertigation were significant with respect to chlorophyll content (SPAD value) at flowering, peak flowering and lean flowering stages. The treatment I_2F_3 (100 % WRc through drip irrigation + 125 % RDF through fertigation) recorded the highest chlorophyll content (57.53, 62.06 and 80.56 SPAD value respectively). The interaction effects of mulching, drip irrigation and fertigation were significant with respect to chlorophyll content (SPAD value) at flowering, peak flowering and lean flowering stages. The treatment $M_1I_2F_3$ (black polythene mulch + 100 % WRc through drip irrigation + 125 % RDF through fertigation) recorded the highest value (63.54, 66.84 and 86.12 SPAD value respectively) at flowering, peak flowering and lean flowering stages. The leaf chlorophyll content (SPAD value) is an important physiological factor as it directly influences the photosynthesis and it occurs in chloroplast as green pigments in all photosynthetic plant tissues. It is also considered as an index of metabolic efficiency of the plant to utilize the absorbed light radiation for dry matter production. Chlorophyll is the pigment responsible for harvesting solar energy and converting into chemical energy as reported by Manoj Kumar Ahirwar *et al*.,

(2012) [6] and Iftikhar Ahmad *et al*., (2011) [5] in african marigold. Significant difference was noticed in total phenol content under the different mulching tried (Table: 4 a, 4 b and 4 c). Highest total phenol content (6.10, 4.94 and 7.11 mg/ 100 g) was observed in black polythene mulch (M_1), at 100 % WRc through drip irrigation (I_2) 5.54, 4.96 and 6.64 mg/ 100 g at flowering, peak flowering and lean flowering stages respectively. With increase in fertigation levels, the total phenol content also increased and the highest total phenol content (5.46, 5.58 and 6.55 mg/100 g) was observed in F_3 (125 % RDF through fertigation) at flowering, peak flowering and lean flowering stages respectively.

The interaction effect of mulching and drip irrigation significantly influenced the total phenol content. Treatment M_1I_2 (Black polythene mulch + 100 % WRc through drip irrigation) recorded the highest value for total phenol content (6.38, 5.51 and 7.39 mg/100 g) at flowering, peak flowering and lean flowering stages followed by the treatment (M_2I_2) coir waste + 100 % WRc through drip irrigation5.76, 4.85 and7.21mg/ 100 g. The interaction of mulching and drip irrigation significantly influenced the total phenol content. Treatment M_1F_3 black polythene mulch + 125 % RDF through fertigation recorded the highest value for total phenol content (6.32, 5.64 and 7.32 mg/100 g) at flowering, peak flowering and lean flowering stages. The interaction of mulching and drip irrigation significantly influenced the total phenol content. The treatment (I_2F_3)100 % WRc through drip irrigation + 125 % RDF through fertigation recorded the highest value for total phenol content (5.95, 6.04 and 6.90 mg/ 100 g) at flowering, peak flowering and lean flowering stages. The three way interaction of mulching, drip irrigation and fertigation was significant with respect to total phenol content. The highest total phenol content (6.65, 6.45 and 7.65 mg/ 100 g) was observed in the treatment ($M_1I_2F_3$) black polythene mulch + 100 % WRc through drip irrigation + 125 % RDF through fertigation) at flowering, peak flowering and lean flowering stages.

IAA oxidase activity under mulching was significantly highest than other treatments (Table: 5 a, 5 b and 5 c). The treatment M_1(black polythene mulch) recorded the highest IAA oxidase activity of 20.29, 18.25 and 17.83 µg g^{-1} hr^{-1} and it was followed by M_2 with the value of (18.00, 17.23 and 17.00 µg g^{-1} hr^{-1}) at flowering, peak flowering and lean flowering stages. IAA oxidase activity under drip irrigation was significantly highest than other treatments. The treatment I_2 (100 % WRc through drip irrigation) recorded the highest IAA oxidase activity of 19.21, 17.47 and 16.93 µg g^{-1} hr^{-1} and it was followed by I_3 (17.41, 16.60 and 16.42 µg g^{-1} hr^{-1}) at flowering, peak flowering and lean flowering stages. IAA oxidase activity under fertigation was significantly highest than other treatments. The treatment F_3 (125 % RDF through fertigation) recorded the highest IAA oxidase activity of 18.88,17.35 and 16.81 µg g^{-1} hr^{-1} at flowering, peak flowering and lean flowering stages and it was followed by F_2 (17.02, 16.37 and 16.19 µg g^{-1} hr^{-1}) at flowering, peak flowering and lean flowering stages. The interaction between the mulching and drip irrigation showed significant influence on IAA oxidase activity. The treatment M_1I_2 (Black polythene mulch + 100 % WRc through drip irrigation) recorded the highest IAA oxidase activity of 22.28, 19.22 and 18.25 µg g^{-1} hr^{-1}at flowering, peak flowering and lean flowering stages, which was followed by M_2I_2 (20.25, 18.23 and 17.97 µg g^{-1} hr^{-1}). The interaction between the mulching and fertigation showed highly significant influence on IAA oxidase activity. The combined effects of mulching and fertigation levels on significantly superior than other treatmentsM_1F_3 (black polythene mulch + 125 % RDF through fertigation) exhibited highest IAA oxidase activity with the value of 21.73, 18.89 and 18.24 µg g^{-1} hr^{-1} at flowering, peak flowering and lean flowering stages respectively, which was followed by M_2F_3 which recorded (20.17, 18.38 and 17.81 µg g^{-1} hr^{-1}). The interaction between drip irrigation and fertigation on IAA oxidase activity showed significant difference. The treatment I_2F_3 (100 % WRc through drip irrigation + 125 % RDF through fertigation) exhibited highest IAA oxidase activity of 20.61, 18.17 and 17.40 µg g^{-1} hr^{-1} at flowering, peak flowering and lean flowering stages, which was followed by I_3F_3 (19.05, 17.67 and 17.03 µg g^{-1} hr^{-1}). The combined application of mulching, drip irrigation and fertigation indicated the significant influence on IAA oxidase activity. $M_1I_2F_3$ (black polythene mulch + 100 % WRc through drip irrigation + 125 % RDF through fertigation) exhibited highest IAA oxidase activity of 23.68, 19.78 and 18.62 µg g^{-1} hr^{-1} at flowering, peak flowering and lean flowering stages. Fertigation treatment with WSF showed its profound effect on suppressing the oxidation of auxin as observed in the present study. In plants with lesser levels of available nutrients, IAA synthesis would have been insufficient as the result of enhanced IAA oxidative metabolism (Balasubramaniam, 2008) [2]. Application of 100 per cent WRc through drip irrigation + 50 per cent FYM + 50 per cent VC also increases IAA oxidase activity by Muthu Kumar (2013) [7] in noni. It might be due to both a direct action of potassium humate, GA like substances and the property of increase in the uptake of nutrients. This is in accordance with the findings of Cacco and Agnola (1984) [3], Virgine (2003) and Swapna (2010) [9].

Table 1a: Influence of mulching, drip irrigation and fertigation on number of inflorescence plant^{-1} in nerium at flowering stage

Treatments	**M_1**				**M_2**				**M_3**				**I x F**			
	I_1	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**
F_1	9.85	12.05	10.25	10.70	8.25	11.25	9.77	9.80	3.20	5.96	4.44	4.53	7.10	9.75	8.15	8.33
F_2	10.05	12.25	11.00	11.10	9.56	10.59	10.66	10.30	4.55	6.85	5.89	5.76	8.05	9.89	9.18	9.04
F_3	11.56	13.56	11.56	12.20	10.58	12.77	11.65	11.70	6.58	7.58	6.64	6.93	9.57	11.30	9.95	10.27
Mean	10.49	12.62	10.94	11.35	9.46	11.54	10.69	10.56	4.78	6.80	5.66	5.74	8.24	10.31	9.09	9.22
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.081	0.074	0.058	0.132	0.115	0.111	0.177									
CD (0.05) %	0.224	0.162	0.118	0.318	0.277	0.233	0.370									
CV %	2.57															

Table 1b: Influence of mulching, drip irrigation and fertigation on number of inflorescence plant-1 innerium at peak flowering stage

Treatments	M1				M2				M3				I x F			
	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean
F 1	64.75	73.33	64.00	67.36	51.50	73.00	57.41	60.64	43.41	46.33	44.02	44.59	53.22	64.22	55.14	57.53
F 2	65.39	77.08	67.02	69.83	54.50	61.83	58.50	58.28	43.83	46.83	44.50	45.05	54.57	61.91	56.67	57.72
F 3	70.75	81.25	76.00	76.00	59.34	79.35	71.69	70.13	43.91	51.00	48.58	47.83	58.00	70.53	65.42	64.65
Mean	66.96	77.22	69.01	71.06	55.11	71.39	62.53	63.01	43.72	48.05	45.70	45.82	55.26	65.55	59.08	59.96
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.512	0.392	0.503	0.755	0.878	0.813	1.353									
CD (0.05) %	1.424	0.855	1.022	1.854	2.005	1.678	2.779									
CV %	2.98															

Table 1c: Influence of mulching, drip irrigation and fertigation on number of inflorescence plant-1 in nerium at lean flowering stage

Treatments	M1				M2				M3				I x F			
	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean
F 1	68.75	77.22	74.50	73.49	42.30	76.54	58.00	58.95	40.32	40.54	46.32	42.39	50.46	64.77	59.61	58.28
F 2	65.00	76.75	73.50	71.75	55.00	75.50	57.25	62.58	44.25	49.50	52.75	48.83	54.75	67.25	61.17	61.06
F 3	63.00	79.50	69.44	70.65	54.75	78.65	56.25	63.22	50.50	59.36	53.64	54.50	56.08	72.50	59.78	62.79
Mean	65.58	77.82	72.48	71.96	50.68	76.90	57.17	61.58	45.02	49.80	50.90	48.58	53.76	68.17	60.19	60.71
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.444	0.406	0.407	0.727	0.727	0.705	1.151									
CD (0.05) %	1.234	0.886	0.826	1.747	1.679	1.465	2.379									
CV %	2.48															

Table 2a: Influence of mulching, drip irrigation and fertigation on number of flowers inflorescence -1 in nerium at flowering stage

Treatments	M1				M2				M3				I x F			
	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean
F 1	9.65	11.01	10.02	10.23	7.25	9.36	8.00	8.20	3.79	5.88	5.24	4.97	6.90	8.75	7.75	7.80
F 2	9.68	11.23	10.74	10.55	7.56	10.64	9.56	9.25	4.36	6.22	5.45	5.34	7.20	9.36	8.58	8.38
F 3	10.43	12.85	11.32	11.53	7.74	12.73	11.60	10.69	4.56	6.56	6.43	5.85	7.58	10.71	9.78	9.36
Mean	9.92	11.70	10.69	10.77	7.52	10.91	9.72	9.38	4.24	6.22	5.71	5.39	7.23	9.61	8.70	8.51
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.097	0.070	0.068	0.139	0.136	0.119	0.194									
CD (0.05) %	0.269	0.154	0.138	0.344	0.329	0.248	0.402									
CV %	3.11															

Table 2b: Influence of mulching, drip irrigation and fertigation on number of flowers inflorescence -1 in nerium at peak flowering stage

Treatments	M1				M2				M3				I x F			
	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean
F 1	12.66	17.75	11.37	13.93	9.25	12.56	11.16	10.99	6.91	7.75	7.50	7.39	9.61	12.69	10.01	10.77
F 2	12.66	18.08	13.65	14.80	12.39	14.34	12.36	13.03	7.08	7.64	7.50	7.41	10.71	13.35	11.17	11.74
F 3	17.58	19.25	18.41	18.41	15.69	19.16	16.83	17.23	7.50	8.00	7.83	7.78	13.59	15.47	14.36	14.47
Mean	14.30	18.36	14.48	15.71	12.44	15.35	13.45	13.75	7.16	7.80	7.61	7.52	11.30	13.84	11.85	12.33
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.087	0.052	0.085	0.115	0.149	0.131	0.221									
CD (0.05) %	0.243	0.115	0.172	0.291	0.341	0.270	0.453									
CV %	2.38															

Table 2c: Influence of mulching, drip irrigation and fertigation on number of flowers inflorescence -1 in nerium at lean flowering stage

Treatments	M1				M2				M3				I x F			
	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean
F 1	12.75	14.44	13.97	13.72	8.21	13.87	9.75	10.61	4.31	6.53	5.33	5.39	8.42	11.61	9.68	9.90
F 2	12.81	14.82	14.32	13.98	8.65	14.32	10.00	10.99	4.58	6.77	5.66	5.67	8.68	11.97	9.99	10.21
F 3	13.65	15.77	15.23	14.88	11.89	15.54	14.85	14.09	5.07	7.76	7.45	6.76	10.20	13.02	12.51	11.91
Mean	13.07	15.01	14.51	14.20	9.58	14.58	11.53	11.90	4.65	7.02	6.15	5.94	9.10	12.20	10.73	10.68
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.089	0.084	0.065	0.149	0.128	0.124	0.199									
CD (0.05) %	0.249	0.183	0.132	0.357	0.308	0.261	0.414									
CV %	2.59															

Table 3a: Influence of mulching, drip irrigation and fertigation on chlorophyll content (spad value) mg/ 100 g in nerium at flowering stage

Treatments	M1				M2				M3				I x F			
	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean	I1	I2	I3	Mean
F 1	51.25	59.45	52.11	54.27	51.32	56.35	52.36	53.34	42.01	43.65	43.25	42.97	48.19	53.15	49.24	50.19
F 2	54.32	60.25	57.98	57.52	53.78	57.98	57.14	56.30	44.45	45.47	44.65	44.86	50.85	54.56	53.25	52.89
F 3	59.98	63.54	62.54	62.02	55.21	62.74	57.32	58.42	45.78	46.33	47.32	46.48	53.65	57.53	55.72	55.63

Mean	55.18	61.08	57.54	57.94	53.44	59.02	55.61	56.02	44.08	45.15	45.07	44.77	50.90	55.08	52.74	52.90
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.467	0.299	0.383	0.630	0.716	0.619	1.031									
CD (0.05) %	1.296	0.651	0.778	1.579	1.680	1.278	2.117									
CV %	2.59															

Table 3b: Influence of mulching, drip irrigation and fertigation on chlorophyll content (spad value) mg/ 100 g in nerium at peak flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	59.24	63.82	61.32	61.46	53.36	61.28	55.75	56.80	45.11	50.32	48.65	48.03	52.57	58.47	55.24	55.43
F_2	60.02	64.27	63.04	62.44	54.11	62.35	56.88	57.78	46.78	50.82	49.45	49.02	53.64	59.15	56.46	56.42
F_3	61.33	66.84	64.32	64.16	58.65	66.36	62.87	62.63	47.35	52.97	51.75	50.69	55.78	62.06	59.65	59.16
Mean	60.20	64.98	62.89	62.69	55.37	63.33	58.50	59.07	46.41	51.37	49.95	49.24	53.99	59.89	57.11	57.00
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.365	0.436	0.333	0.717	0.596	0.642	1.023									
CD (0.05) %	1.015	0.951	0.676	1.675	1.378	1.348	2.132									
CV %	2.35															

Table 3c: Influence of mulching, drip irrigation and fertigation on chlorophyll content (spad value) mg/ 100 g in nerium at lean flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	71.02	81.52	79.17	77.24	66.18	81.32	68.14	71.88	64.56	66.36	65.01	65.31	67.25	76.40	70.77	71.47
F_2	72.26	83.85	83.67	79.93	68.92	82.17	71.89	74.33	65.32	68.36	67.32	67.00	68.83	78.12	74.29	73.75
F_3	74.36	86.12	85.62	82.03	69.25	85.98	84.89	80.04	67.25	69.58	68.69	68.51	70.28	80.56	79.73	76.86
Mean	72.55	83.83	82.82	79.73	68.12	83.16	74.97	75.42	65.71	68.10	67.01	66.94	68.79	78.36	74.93	74.03
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.156	0.207	0.379	0.259	0.513	0.531	0.722									
CD (0.05) %	0.671	0.575	0.765	0.864	1.146	1.134	1.504									
CV %	2.60															

Table 4a: Influence of mulching, drip irrigation and fertigation on total phenol content (mg/ 100 g) in nerium at flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	5.65	6.20	5.98	5.94	4.76	5.32	5.10	5.06	3.63	4.30	4.09	4.01	4.68	5.27	5.06	5.00
F_2	5.76	6.30	6.09	6.05	4.87	5.43	5.21	5.17	3.76	4.43	4.19	4.13	4.80	5.39	5.16	5.12
F_3	5.87	6.65	6.43	6.32	5.00	6.54	5.54	5.69	3.88	4.65	4.54	4.36	4.92	5.95	5.50	5.46
Mean	5.76	6.38	6.17	6.10	4.88	5.76	5.28	5.31	3.76	4.46	4.27	4.16	4.80	5.54	5.24	5.19
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.029	0.054	0.042	0.082	0.066	0.081	0.129									
CD (0.05) %	0.081	0.119	0.085	0.186	0.144	0.170	0.269									
CV %	2.68															

Table 4b: Influence of mulching, drip irrigation and fertigation on total phenol content (mg/ 100 g) in nerium at peak flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	4.12	4.85	4.22	4.40	2.95	4.12	2.35	3.14	2.25	3.25	2.35	2.62	3.10	4.07	2.97	3.38
F_2	4.12	5.24	4.96	4.77	3.54	4.45	3.25	3.75	3.00	4.65	3.25	3.63	3.55	4.78	3.82	4.05
F_3	5.26	6.45	5.22	5.64	4.36	5.99	5.66	5.34	5.28	5.69	6.32	5.76	4.96	6.04	5.73	5.58
Mean	4.50	5.51	4.80	4.94	3.62	4.85	3.75	4.07	3.51	4.53	3.97	4.00	3.87	4.96	4.17	4.34
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.034	0.029	0.034	0.054	0.059	0.056	0.094									
CD (0.05) %	0.095	0.065	0.069	0.131	0.135	0.117	0.193									
CV %	2.82															

Table 4c: Influence of mulching, drip irrigation and fertigation on total phenol content (mg/ 100 g) in nerium at lean flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	6.65	7.21	7.00	6.95	5.61	7.00	6.09	6.23	4.54	5.16	4.92	4.87	5.60	6.46	6.00	6.02
F_2	6.76	7.32	7.10	7.06	5.72	7.08	6.75	6.52	4.70	5.27	5.05	5.01	5.73	6.56	6.30	6.20
F_3	6.87	7.65	7.43	7.32	6.83	7.54	6.92	7.10	4.81	5.50	5.39	5.23	6.17	6.90	6.58	6.55
Mean	6.76	7.39	7.18	7.11	6.05	7.21	6.59	6.62	4.68	5.31	5.12	5.04	5.83	6.64	6.29	6.26
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.029	0.054	0.042	0.082	0.066	0.081	0.129									
CD (0.05) %	0.081	0.119	0.085	0.186	0.144	0.170	0.269									
CV %	2.68															

Table 5a: Influence of mulching, drip irrigation and fertigation on IAA oxidase activity (μg g^{-1} hr^{-1}) in nerium at flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	18.12	21.69	18.24	19.35	15.49	18.98	16.14	16.87	13.14	14.95	14.27	14.12	15.58	18.54	16.22	16.78
F_2	17.89	21.48	20.03	19.80	15.63	19.00	16.25	16.96	13.32	14.98	14.58	14.29	15.61	18.49	16.95	17.02
F_3	19.37	23.68	22.15	21.73	17.85	22.78	19.87	20.17	13.69	15.36	15.12	14.72	16.97	20.61	19.05	18.88
Mean	18.46	22.28	20.14	20.29	16.32	20.25	17.42	18.00	13.38	15.10	14.66	14.38	16.05	19.21	17.41	17.56
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.159	0.088	0.136	0.202	0.250	0.212	0.357									
CD (0.05) %	0.442	0.193	0.277	0.516	0.584	0.436	0.731									
CV %	2.71															

Table 5b: Influence of mulching, drip irrigation and fertigation on IAA oxidase activity (μg g^{-1} hr^{-1}) in nerium at peak flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	17.28	18.86	17.71	17.95	15.72	17.36	16.28	16.45	13.62	14.63	14.22	14.16	15.54	16.95	16.07	16.19
F_2	17.47	19.02	17.23	17.91	15.98	17.98	16.59	16.85	13.74	14.89	14.38	14.34	15.73	17.30	16.07	16.37
F_3	17.59	19.78	19.29	18.89	17.09	19.36	18.69	18.38	13.92	15.36	15.02	14.77	16.20	18.17	17.67	17.35
Mean	17.45	19.22	18.08	18.25	16.26	18.23	17.19	17.23	13.76	14.96	14.54	14.42	15.82	17.47	16.60	16.63
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.113	0.081	0.116	0.161	0.200	0.184	0.308									
CD (0.05) %	0.314	0.176	0.237	0.398	0.454	0.378	0.632									
CV %	2.42															

Table 5c: Influence of mulching, drip irrigation and fertigation on IAA oxidase activity (μg g^{-1} hr^{-1}) in nerium at lean flowering stage

Treatments	M_1				M_2				M_3				I x F			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	17.39	18.02	17.26	17.56	15.22	17.29	16.22	16.24	13.28	14.38	13.75	13.80	15.30	16.56	15.74	15.87
F_2	17.00	18.11	18.00	17.70	15.36	18.12	17.35	16.94	13.42	14.25	14.12	13.93	15.26	16.83	16.49	16.19
F_3	17.73	18.62	18.36	18.24	16.75	18.49	18.20	17.81	13.55	15.09	14.52	14.39	16.01	17.40	17.03	16.81
Mean	17.37	18.25	17.87	17.83	15.78	17.97	17.26	17.00	13.42	14.57	14.13	14.04	15.52	16.93	16.42	16.29
	M	I	F	M x I	M x F	I x F	M x I x F									
SE d	0.076	0.106	0.102	0.168	0.163	0.179	0.292									
CD (0.05) %	0.213	0.231	0.207	0.388	0.359	0.373	0.603									
CV %	2.29															

Conclusions

From the above results, it can be concluded that black polythene mulch along with 100 % WRc through drip irrigation and125 % RDF through fertigation was found to be the best for *Nerium oleander* which showed improvement in flowering, physiological and biochemical parameters like chlorophyll, total phenols and IAA oxidase activity. Hence, this treatment can be recommended to get increased yield of flowers in N. oleander.

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