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Effect of mulch, N and K application on soil chemical properties under chrysanthemum (*Chrysanthemum coronarium* L) cultivation

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Abstract
The present investigation was carried out to study the Effect of mulch, N and K application on soil chemical properties during production of annual chrysanthemum (*Chrysanthemum coronarium* L.) using three types of mulches (*i.e.* Crop residue mulch, Silver plastic mulch and Black plastic mulch) and four levels of nitrogen and potassium *i.e.* 0 g N + 0 g K/m^2, 20 g N + 10 g K/m^2, 30 g N + 20 g K/m^2 and 40 g N + 30 g K/m^2 along with a uniform dose of phosphorus @ 20 g/m^2 & FYM @ 5 kg/m^2 except control. Black plastic mulch gave maximum values *w.r.t.* available N,P and K in soil, soil pH, electrical conductivity of seeds and in case of N and K application the maximum value of these parameters were recorded in case of the application of 40 g N+ 30 g K/m^2. The interaction, $M_4 \times N_3K_3$ *i.e.* black plastic mulch and application of 40 g N/m^2 + 30 g K/m^2 recorded maximum values in terms of various soil quality parameters of commercial importance.

Keywords: Soil chemical properties, annual chrysanthemum, mulch, N and K application

Introduction
Annual chrysanthemum (*Chrysanthemum coronarium* L.) belongs to family Asteraceae and has been originated in South Europe. It has been established as one of the most important flower crops grown in India especially for loose flower production and landscapes. It is gaining popularity among the growers owing to the facts that it is a short duration crop with a wider adaptability and easy to cultivate besides less photosensitive, thus capable of producing quality blooms round the year. Annual chrysanthemum is commercially grown in Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Uttar Pradesh, Punjab and Haryana. Annual chrysanthemum is also known as 'crown daisy' or 'garland chrysanthemum'. In India, the crop has been naturalized and locally called 'Bijli' in Nagpur (Meshram *et al*., 2008) [8], 'Babbona' in Haryana (Mishra *et al*., 2002) [9] 'Guldhak' in Punjab, 'Market' in Delhi and 'Gendi' in Uttar Pradesh (Arora *et al*., 1990) [1]. Flower crops are generally weak competitors and suffer from heavy infestation of many annual weeds. So, use of mulching is a way to prevent weeds. Black plastic mulch, silver mulch and other plastic mulches are most commonly used in agriculture as they reduce the deterioration of soil by way of preventing the runoff and soil erosion, minimize the weed infestation, reduce water evaporation and nutrient losses too. Thus, mulching facilitates more retention of soil moisture and helps in reduction of temperature fluctuation, improvises physical, chemical and biological properties of soil and ultimately enhances the growth, flowering and seed yield of a crop (Bhardwaj, 2011) [2]. Among the various factors influencing growth and flowering of annual chrysanthemum, balanced nutrition is also very important. The growth and development of plants generally depends on their judicious feeding right from very beginning till the harvest. Annual chrysanthemum is a heavy feeder of major nutrients and hence warrants for larger requirement of N, P and K. The emphasis at an early stage for better vegetative growth should be especially on nitrogen. Lunt and Kofranek (1958) [6] were of the opinion that plant growth during initial seven weeks needs a maintenance of higher levels of nitrogen and plants do not need additional phosphorus throughout the growing period and it should be applied as a basal dose only. However, Joiner and Smith (1962) [5] emphasized the need of phosphorus during initiation of flower buds and subsequent development of flowering buds. Whereas, potassium is required by the plants right from initial plant growth till flowering. Thus, need was felt to standardize the optimum doses of nutrients (N & K) as well as use of mulching in annual chrysanthemum and its effect on chemical properties of soil.

Materials and Methods

The present investigation was carried out at Khaltoo experimental farm of Department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. during the year 2014 to 2016. The farm is located at an altitude of 1250 meters above mean sea level having a latitude of 35.5° N and longitude of 77.8° E. Climate of the area is generally sub-temperate and semi-humid characterized by mild summers and cold winters. Generally, December and January months are the coldest while May and June are the hottest months. Meteorological data (rainfall, maximum and minimum temperature, relative humidity) as recorded at the meteorological observatory of the Department of Environmental Sciences, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during cropping period (October, 2014-June, 2015) are presented in Table 1. During the cropping season, mean temperature varied from 9.85 to 23.50 °C while relative humidity ranged from 45 to 63 per cent with minimum rainfall (0.00 mm) in the month of November, 2014 and maximum rainfall (213.00 mm) in March, 2015.

Table 1: Mean monthly meteorological data of Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) for the year 2014-15

Month	Rainfall	Temperature (°C)			Relative Humidity (%)
		Maximum	Minimum	Mean	
October, 2014	15.70	25.70	10.30	18.00	60.00
November, 2014	0.00	23.60	5.70	14.65	49.00
December, 2014	75.60	19.70	2.40	11.05	58.00
January, 2015	49.40	17.10	2.60	9.85	63.00
February, 2015	67.00	19.60	5.70	12.65	59.00
March, 2015	213.60	21.40	7.80	14.60	58.00
April, 2015	71.80	25.40	11.90	18.65	58.00
May, 2015	16.10	31.30	15.70	23.50	45.00

Before laying out the experiment, random soil samples were collected from the different spots of the experimental field and the composite sample was prepared which was analyzed for various physico-chemical properties of the soil. The methods employed and results obtained for important physico-chemical characteristics (initial) of experimental area are presented in Table 2

Table 2: Physico-chemical properties of soil before planting of crop

Particulars	Value obtained	Method employed	Soil status
Chemical analysis			
1. Soil pH	7.71	Digital pH meter	Neutral
2. Soil EC (dSm^{-1})	0.58	Digital conductivity meter	Normal
3. Available N (kg/ha)	289.55	Alkaline potassium permanganate method (Subbiah and Asija, 1956) [13]	Medium
4. Available P (kg/ha)	49.28	Olsen method (Olsen *et al*.,1954)	High
5. Available K (kg/ha)	255.36	Normal neutral ammonium acetate method (Merwin and Peech,1951) [7]	Medium

The healthy, disease free, bold and uniform seeds of annual chrysanthemum (*Chrysanthemum coronarium* L.) were obtained from the Department of Floriculture and Landscape Architecture, Dr. Y.S. Parmar University of Horticulture and Forestry Nauni, Solan (H.P.). These obtained seeds were sown in nursery beds. Each seed was covered with sieved well rotten Farm Yard Manure and watered properly. The experiment was laid out in randomized block design comprising of sixteen treatment combinations of mulches (M_1: no mulch; M_2: crop residue mulch; M_3: silver plastic mulch; M_4: black plastic mulch) and four levels of nitrogen and potassium (N_0K_0: Control *i.e.* no fertilizers; N_1K_1: 20g N + 10g K/m^2; N_2K_2: 30g N + 20g K/m^2; N_3K_3: 40g N + 30g K/m^2). A constant dose of phosphorus @ 20 g/m^2 and FYM @ 5 kg/m^2 (except control) was applied uniformly. The half dose of nitrogen and full doses of phosphorous and potassium were applied at the time of field preparation. The remaining half dose of nitrogen was applied after 30 days of transplanting. Calculations of different fertilizers doses are presented in Table 3.

Table 3: Calculation of fertilizers doses

Nitrogen doses (Source Urea; 46 % N; Quantity of urea in g)			Potassium doses (Source MOP; 60 % K; Quantity of MOP in g)	
	1st dose	2nd dose		
N_0 (0 g)	0 g/m^2	0 g/m^2	K_0 (0 g)	0 g/m^2
N_1 (20 g)	21.74 g/m^2	21.74 g/m^2	K_1 (10 g)	16.67 g/m^2
N_2 (30 g)	32.61 g/m^2	32.61 g/m^2	K_2 (20 g)	33.33 g/m^2
N_3 (40 g)	43.48 g/m^2	43.48 g/m^2	K_3 (30 g)	50.00 g/m^2

Healthy, disease free and stocked seedlings of uniform size and vigour at 5-6 leaf stage were selected and transplanted on the beds of 1 m × 1 m size accommodating 9 plants with a spacing of 30 × 30 cm. The plants were gently watered or irrigated daily during summer months and twice a week during winter months in the entire cropping period. Frequency of irrigation was altered depending on the prevailing weather conditions. Weeds were removed manually as and when they appeared. Hoeing was started right after few days from establishment of seedlings and practiced when hard crust formed over the soil surface. After 30 days of transplanting, the plants were pinched so as to encourage lateral growth.

The available N, P and K were calculated as per method suggested by Subbiah and Asija (1956) [13], Olsen *et al.* (1954), Merwin and Peech (1951) [7] respectively and the pH

and electrical conductivity of soil were measured and calculated as per method described by Jackson (1973) [4].
The statistical analysis was done as per design of the experiment as suggested by Gomez and Gomez (1984) [3].

Results and Discussion

Maximum available nitrogen (337.16 kg/ha) was recorded with the black plastic mulch (M_4) and found to be statistically at par with M_3 (333.66 kg/ha), whereas, minimum available nitrogen *i.e.* 325.41 kg/ha (Table 4) was recorded in the control (M_1). The application of 40 g N + 30g K /m^2 (N_3K_3) has resulted in maximum available nitrogen (397.91 kg/ha) and found to be significantly higher over all other treatments. However, minimum available nitrogen (278.00 kg/ha) was observed with no application of nitrogen and potassium (N_0K_0) *i.e.* in the control and found to be statistically at par with N_1K_1 (283.83 kg/ha). The interaction effects of mulching, N and K applications (M × NK) on available N have been found to be non-significant. However, maximum available nitrogen (400.25 kg/ha) was recorded in the treatment combination, M_4 × N_3K_3 *i.e.* combined effect of mulching with black plastic sheet and application of 40 g N/m^2 + 30 g K/m^2. The available nitrogen was found to be minimum (276.31kg/ha) with interactive effects of M_1 × N_0K_0 *i.e.* no application of nitrogen, potassium and mulch was practiced. The availability of nitrogen increased with the increasing levels of nitrogen and potassium. Increased availability of the nitrogen at higher doses was due to their higher application in the soil especially when plants were mulched with black polythene sheet. Maximum available nitrogen (457.55 kg/ha) was reported by Sharma (2013) [11] with the application of 300 kg N/ha and minimum (304.98 kg/ha) in control (0 kg N/ha).

Table 4: Effect of mulch, N and K application and their interaction on available N (kg/ha) of annual chrysanthemum

N & K application / Mulches	N_0K_0 (Control)	N_1K_1 (20gN+10gK/m^2)	N_2K_2 (30gN+20gK/m^2)	N_3K_3 (40gN+30gK/m^2)	Mean
M_1(No mulch)	276.31	279.33	351.33	395.54	325.41
M_2(Crop residue mulch)	277.21	283.33	361.13	398.02	329.83
M_3(Silver plastic mulch)	279.10	285.12	372.12	398.66	333.66
M_4(Black plastic mulch)	280.23	287.66	381.00	400.25	337.16
Mean	278.00	283.83	366.33	397.91	
$CD_{0.05}$	M:6.5; NK:6.5; M × NK:NS				

Different mulches, N and K doses have exhibited significant effects on available phosphorus (Table 5). Among different types of mulches used, maximum available phosphorus (48.66 kg/ha) was recorded with the use of black plastic mulch (M_4). Whereas, minimum available phosphorus (45.33 kg/ha) was reported with no mulch (M_1) and found to be statistically at par with M_2 (46.91 kg/ha). Maximum available phosphorus (53.08 kg/ha) was recorded with the application of 40 g N + 30g K /m^2 (N_3K_3) and found to be significantly higher over all other doses. However, minimum available phosphorus (42.11 kg/ha) was observed with no application of nitrogen and potassium (N_0K_0) *i.e.*in the control. The interactive effect of mulches, N and K applications (M × NK) on available phosphorus have been found to be non-significant. However numerically, maximum available phosphorus (55.06 kg/ha) was recorded in the interaction M_4 × N_3K_3 *i.e.* combined effect of mulching with black plastic mulch and application of 40 g N/m^2 + 30 g K/m^2. The available phosphorus was recorded to be minimum (40.33kg/ha) with the interactive effects of M_1 × N_0K_0 *i.e.* control. The availability of phosphorus increased with the increasing levels of nitrogen and potassium applications in the soil. Maximum available phosphorus (63.55 kg/ha) was reported by Sharma (2013) [11] with the application of 300 kg N/ha and minimum (35.81 kg/ha) in control (0 kg N/ha) in tuberose. The availability of phosphorus also increased with higher dose of potassium *i.e.*30 g/m2. On the contrary, Singh (1995) [12] reported maximum available phosphorus (48.73 kg/ha) in french bean cv. 'Contender' with 0 kg K/ha and minimum (44.67 kg/ha) with 90 kg K/ha.

Table 5: Effect of mulch, N and K application and their interaction on available P (kg/ha) of annual chrysanthemum

N & K application / Mulches	N_0K_0 (Control)	N_1K_1 (20gN+10gK/m^2)	N_2K_2 (30gN+20gK/m^2)	N_3K_3 (40gN+30gK/m^2)	Mean
M_1(No mulch)	40.33	42.66	47.33	51.00	45.33
M_2(Crop residue mulch)	42.00	44.33	49.11	52.33	46.91
M_3(Silver plastic mulch)	42.66	45.21	49.33	54.08	47.75
M_4(Black plastic mulch)	43.02	47.12	49.32	55.06	48.66
Mean	42.11	44.65	48.83	53.08	
$CD_{0.05}$	M:1.82; NK:1.82; M × NK:NS				

Mulches, N and K doses influenced availability of potassium in the soil significantly (Table 6). Among different types of mulches, maximum available potassium (267.41 kg/ha) was recorded with the use of black plastic sheet (M_4) and found to be significantly higher with all other mulching treatments. Whereas, minimum available potassium (250.75 kg/ha) was recorded with no mulch (M_1). The maximum available potassium (289.83 kg/ha) was reported with the application of 40 g N + 30 g K /m^2 (N_3K_3) and found to be significantly higher over all other doses. However, minimum available potassium (222.25 kg/ha) was observed with no application of nitrogen and potassium (N_0K_0) *i.e.* in the control. The interaction effect of mulching, N and K applications (M × NK) on available potassium have been found to be non-significant (Table 8). The availability of potassium was recorded to be maximum (300.33 kg/ha) in the interaction M_4 × N_3K_3 *i.e.* combined effect of mulching with black plastic sheet and application of 40 g N/m^2 + 30 g K/m^2. Whereas, the available potassium was minimum (212.04 kg/ha) with interactive effects of M_1 × N_0K_0 *i.e.* no application of

nitrogen, potassium and mulch. The availability of potassium in the soil increased with the application of higher doses of nitrogen and potassium in combination with the augmentation of black plastic mulching in comparison to application of lower doses of nutrients (N & K) alone as well as mulching treatments. Singh (1995) [12] has also reported maximum available potassium (265.05 kg/ha) in french bean cv. 'Contender' with the application of 90 kg K/ha and minimum (248.35 kg/ha) with 0 kg K/ha. The results also got support from the work of Sharma (2013) [11] who observed maximum available potassium (185.20 kg/ha) with the application of nitrogen @ 200 kg/ha and minimum (124.44 kg/ha) with control (0 kg N/ha) in tuberose.

Table 6: Effect of mulch, N and K application and their interaction on available K (kg/ha) of annual chrysanthemum

N & K application / Mulches	N_0K_0 (Control)	N_1K_1 (20gN+10gK/m^2)	N_2K_2 (30gN+20gK/m^2)	N_3K_3 (40gN+30gK/m^2)	Mean
M_1(No mulch)	212.04	242.26	266.01	283.45	250.75
M_2(Crop residue mulch)	222.03	252.19	271.41	286.13	257.75
M_3(Silver plastic mulch)	226.24	259.11	278.14	290.02	263.25
M_4(Black plastic mulch)	229.04	261.07	279.33	300.33	267.41
Mean	222.25	253.50	273.58	289.83	
$CD_{0.05}$	**M:**10.08**; NK:**10.08**; M x NK:**NS				

The effect of different mulches, N and K application and their interaction effect on soil pH was found non-significant (Table 7). However, numerically maximum pH (7.60) was recorded with the black plastic mulch (M_4) and minimum pH (7.50) in silver plastic mulch (M_3).The maximum pH of soil (7.59) was observed with the application of 40 g N + 30g K /m^2 (N_3K_3) and it was found to be minimum (7.49) in the control. The interaction effects of mulches, N and K applications (M × NK) had also exhibited non-significant effects on soil pH. However, maximum soil pH (7.73) was reported in the interaction, $M_4 \times N_3K_3$ *i.e.* combined effect of mulching with black plastic mulch and 40 g N/m^2 + 30 g K/m^2. Whereas, the pH of soil was found to be minimum (7.36) in the treatment combination, $M_3 \times N_0K_0$ *i.e.* use of silver plastic mulch and no application of nitrogen and potassium was practiced.

Table 7: Effect of mulch, N and K application and their interaction on soil pH of annual chrysanthemum

N & K application / Mulches	N_0K_0 (Control)	N_1K_1 (20gN+10gK/m^2)	N_2K_2 (30gN+20gK/m^2)	N_3K_3 (40gN+30gK/m^2)	Mean
M_1(No mulch)	7.45	7.49	7.57	7.62	7.53
M_2(Crop residue mulch)	7.62	7.61	7.42	7.53	7.54
M_3(Silver plastic mulch)	7.36	7.68	7.46	7.51	7.50
M_4(Black plastic mulch)	7.51	7.57	7.55	7.73	7.60
Mean	7.49	7.58	7.50	7.59	
$CD_{0.05}$	M:NS; NK:NS; M × NK: NS				

Different mulches, N and K doses as well as their interaction have shown non-significant effects on soil electrical conductivity (Table 8). However, numerically maximum soil electrical conductivity (0.446 dSm^{-1}) was recorded with black plastic mulch (M_4) and minimum (0.376 cm) with no mulch (M_1). The maximum soil electrical conductivity (0.439 dSm^{-1}) was recorded with the application of 20 g N + 10g K /m^2 (N_1K_1) However, minimum soil electrical conductivity (0.419 dSm^{-1}) was observed with the 30 g N + 20 g K /m^2 (N_2K_2). The interaction $M_3 \times N_3K_3$ recorded maximum soil electrical conductivity (0.471dSm^{-1}) and it was found to be minimum (0.295 dSm^{-1}) with interactive effects of $M_1 \times N_2K_2$ *i.e.* no mulch and 30 g N + 20g K/m^2.

Table 8: Effect of plastic mulch, N and K application and their interaction on soil electrical conductivity (dsm^{-1}) of annual chrysanthemum

N & K application / Mulches	N_0K_0 (Control)	N_1K_1 (20gN+10gK/m^2)	N_2K_2 (30gN+20gK/m^2)	N_3K_3 (40gN+30gK/m^2)	Mean
M_1(No mulch)	0.396	0.490	0.295	0.321	0.376
M_2(Crop residue mulch)	0.404	0.489	0.440	0.433	0.442
M_3(Silver plastic mulch)	0.396	0.341	0.359	0.471	0.392
M_4(Black plastic mulch)	0.499	0.434	0.398	0.453	0.446
Mean	0.424	0.439	0.373	0.419	
$CD_{0.05}$	M:NS; NK:NS; M × NK:NS				

Conclusion

Use of organic amendments with chemical fertilization is of vital importance and of great need in modern era. It is concluded that for improving soil physio-chemical proterties, the annual chrysanthemum should be fertilized with 40gN/m^2 + 30 g K/m^2 and mulched with black plastic sheet.

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