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Studies on yield and yield components of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Amal under various sources of nitrogen

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ABSTRACT

An investigation was undertaken to study the yield and yield components of spray-type chrysanthemum cv. Amal under variaous sources of nitrogen. The treatments considered different levels (100%, 75%, 50% or 25%) of four sources of nitrogen *viz*., urea, calcium ammonium nitrate, mustard cake and neem cake, alone or in combination of two or more of these. Results revealed that maximum stem length (62 cm) of cut flower and flower yield, number of flower heads (6387) and weight (4071.48 g/sqm) were mostly achiveved by application of total recommended dose of nitrogen through a combination of 25% N as neem cake + 25% N as mustard cake + 25% N as CAN + 25% as urea, and the treatment increased flower yield by 57.96% over treatment with nitrogen solely through urea. Flower size, individual flower weight, shelf and vase life of flower as well as anthocyanin content in floral tissue were higher in combined application of all oil cakes and urea and maximum under treatment combination of 50% recommended dose of nitrogen supplied through mustard cake, 25% N through neem cake and 25% N through urea. Anthocyanin content of flower tissues increased gradually upto 20 days from opening of the flower and, thereafter, declined sharply.

Key words: Chrysanthemum, nitrogen source, oil cake, organic

INTRODUCTION

Chrysanthemum (*Chrysanthemum morifolium* Ramat.) also known as "Queen of the East" (Anderson, 1987) belongs to the family *Asteraceae* and is a popular flower crop having its admireres and enthusiasts all over the world. In the current scenario, lower productivity and inferior flower quality of spray-type chrysanthemum is due to inefficient and frequent use of inorganic fertilizers, especially the quick-release nitrogenous fertilizers. In order to minimize these ill effects, organic farming practices involving oil cakes, organic manures etc. must be adopted for sustainable production. Neither chemical fertilizer alone nor organic sources exclusively can achieve sustainable production at the present level. The interactive advantages of combining organic and inorganic sources of nitrogen in integrated nutrient management systems are superior to inorganic fertilizer application alone. In view of the above objectives, we undertook an investigation to study yield and yield components of spray chrysanthemum in response to various sources of organic and inorganic nitrogenous fertilizers.

MATERIAL AND METHODS

The field experiment was conducted at Horticultural Research Station, Mondouri (23^o N, 83^o E and 9.75 mamsl altitude), Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India, during two consecutive winter seasons of 2003-05. The soil texture was clay-loam, having pH 6.8, organic carbon 0.58, total N 156.8 Kg/ha, available P_2O_5 50.4 Kg/ha and available K_2O 208.5 Kg/ha. The experiment was conducted using cultivar 'Amal' in a factorial RBD design (FRBD) with 16 treatments, and replicated thrice. All plots of the experiment were supplied with the recommended dose of N:P:K @ 20:10:10 g/sqm in both years of experiment. The treatments consisted of different levels (100%, 75%, 50% or 25%) of four sources of nitrogen, *viz*., urea (UR), calcium ammonium nitrate (CAN), mustard cake (MC) and neem cake (NC) alone or in combination of two or more of these. Treatment combinations were as follows:

Nitrogen sources like neem cake and mustard cake were applied during land preparation two weeks before planting, and calcium ammonium nitrate was applied as basal

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T_1 100% N of RDN through UR (50% basal + 50% in two top-dress)
T_2 100% N of RDN through NC (50% basal + 50% top dressing)
T_3 100% N of RDN through MC (50% basal + 50% top dressing)
T_4 100% N of RDN through CAN (50% basal + 50% top dressing)
T_5 50% N through NC (basal) + 50% N through UR (25x% basal + 25% in two top-dress)
T_6 50% N through MC (basal) + 50% N through UR (25% basal + 25% in two top-dress)
T_7 50% N through MC (basal) + 50% N through CAN (basal)
T_8 50% N through NC (basal) + 50% N through CAN (basal)
T_9 50% N through NC (basal) + 50% N through MC (basal)
T_{10} 75% N through MC (basal) + 25% N through CAN (basal)
T_{11} 75% N through NC (basal) + 25% N through CAN (basal)
T_{12} 50% N through MC (basal) + 25% N through CAN (basal)+25% N through UR (two top-dress)
T_{13} 50% N through NC (basal) + 25% N through CAN (basal)+25% N through UR (two top-dress)
T_{14} 50% N through MC (basal) + 25% N through NC (basal)+25% N through UR (two top-dress)
T_{15} 50% N through NC (basal) + 25% N through MC (basal)+25% N through UR (two top-dress)
T_{16} 25% N through NC (basal) + 25% N through MC(basal) +25% N through CAN (basal) + 25% N through UR (two top-dress)
where N= Nitrogen, RDN= Recommended dose of nitrogen

during final land preparation. First top dressing of CAN and urea was made 15 days after transplanting (DAT) and second top dressing of urea at 30 DAT. Full dose of P_2O_5 and K_2O was applied through single super phosphate (SSP) and muriate of potash (MOP), respectively, as basal application.

Observations on growth and yield parameters were recorded and subjected to statistical analysis as per Panse and Sukhatme (1967). Anthocyanin was estimated from freshly-harvested petals starting at flower opening upto colour fading stage, harvested at five days intervals. Anthocyanin was estimated by using the method of Thimmaiah (2004).

RESULTS AND DISCUSSION

A perusal of results presented in Tables 1, 2, 3 and 4 and Fig. 1 and 2 on plant height, canopy spread plant^{-1}, days to optimum bloom, stem-length of flower, flower size, individual flower weight and flower yield (number and weight of flowers heads sqm^{-1}), shelf-life and vase-life of flowers and anthocyanin content of petal revealed significant differences between sole application of inorganic and organic fertilizer and their combinations. Maximum plant height and canopy spread plant^{-1} of 93.20 cm and 59.50 cm, respectively, in pooled data was observed in treatment T_{16} in which plants were supplied with total RDN through 25% each of neem cake, mustard cake, CAN and urea closely followed by the plants treated with a combination of 50% N as MC + 25% N as CAN + 25% N as urea (T_{12}) showing 89.75 cm and 56.63 cm, respectively. Plant height was lowest (65.88 cm) in plants that received with 100% N, supplied solely as neem cake (T_2). With regard to sources of nitrogen, plants treated with full dose of recommended nitrogen solely through urea (T_1) produced earliest flowering (125.13 days) compared to other treatments, whereas, plants raised on 50% N as

Table 1. Plant height (cm) and canopy spread (cm) of spray chrysanthemum cv. Amal under various sources of nitrogen

Treatment	Plant height (cm)			Canopy spread (cm) per plant		
	1st yr	2nd yr	Pool	1st yr	2nd yr	Pool
T_1	71.50	66.00	69.00	43.50	35.50	39.50
T_2	66.50	63.25	65.88	42.00	34.00	38.00
T_3	68.00	64.50	66.25	42.50	33.25	37.88
T_4	73.50	68.50	71.00	45.50	38.00	41.75
T_5	74.50	69.00	71.75	46.00	39.00	42.50
T_6	76.00	70.50	73.25	47.00	40.00	43.50
T_7	80.00	75.50	77.75	50.00	43.50	46.75
T_8	78.50	74.00	76.25	49.00	42.50	45.75
T_9	76.50	71.50	74.00	47.00	40.50	44.00
T_{10}	84.00	81.50	82.75	53.50	47.50	50.50
T_{11}	82.50	80.00	81.75	52.00	46.00	49.00
T_{12}	91.50	88.00	89.75	59.25	54.00	56.63
T_{13}	90.50	87.25	88.88	58.00	53.00	55.50
T_{14}	87.50	84.50	86.00	56.50	51.00	53.75
T_{15}	86.00	83.50	84.75	55.50	50.00	52.75
T_{16}	95.25	91.15	93.20	62.50	56.50	59.50
SEm ±	1.085	1.482	0.918	1.113	1.474	0.924
CD (*P*=0.05)	2.31	3.16	2.54	2.41	3.14	1.97

Table 2. Days required to full-bloom and stem-length (cm) in flower of spray chrysanthemum cv. Amal under various sources of nitrogen

Treatment	Daysto full-bloom			Stem-length (cm) of cut-flower		
	1st yr	2nd yr	Pool	1st yr	2nd yr	Pool
T_{1}	136.75	113.50	125.13	45.50	42.50	44.00
T_{2}	139.25	116.50	127.88	43.00	40.50	41.75
T_{3}	140.00	117.00	128.50	44.00	41.00	42.50
T_{4}	137.00	114.00	125.50	47.00	44.50	45.75
T_{5}	137.50	114.50	126.00	47.50	45.00	46.25
T_{6}	138.00	115.50	126.75	48.00	46.00	47.00
T_{7}	139.00	116.00	127.50	52.00	49.50	50.75
T_{8}	138.50	115.75	127.13	51.00	48.50	49.75
T_{9}	144.75	120.00	132.38	49.00	46.50	47.75
T_{10}	142.00	117.75	129.88	55.50	52.00	53.75
T_{11}	141.00	117.25	129.13	54.50	51.00	52.75
T_{12}	144.00	119.25	131.68	62.00	57.50	59.75
T_{13}	142.50	118.25	130.38	61.00	56.50	58.75
T_{14}	146.00	121.00	133.50	59.00	55.00	57.00
T_{15}	145.25	120.50	132.88	57.50	54.00	55.75
T_{16}	143.50	119.00	131.25	64.50	59.50	62.00
SEm ±	0.716	0.653	0.485	1.008	0.758	0.631
CD *(P=0.05)*	1.53	1.39	1.03	2.15	1.61	1.34

Table 3. Size (cm) and weight (g) of individual flowers of spray chrysanthemum cv. Amal under various sources of nitrogen

Treatment	Flower-size (cm)			Weight (g) of individual flower		
	1st yr	2nd yr	Pool	1st yr	2nd yr	Pool
T_{1}	4.00	4.15	4.08	1.35	1.51	1.43
T_{2}	4.60	4.70	4.65	1.47	1.67	1.57
T_{3}	4.75	4.90	4.83	1.53	1.75	1.64
T_{4}	4.10	4.20	4.15	1.36	1.53	1.45
T_{5}	4.20	4.30	4.25	1.37	1.55	1.46
T_{6}	4.40	4.50	4.45	1.40	1.59	1.50
T_{7}	4.55	4.65	4.60	1.45	1.65	1.55
T_{8}	4.45	4.55	4.50	1.41	1.61	1.51
T_{9}	5.45	5.60	5.53	1.87	2.14	2.01
T_{10}	5.00	5.15	5.08	1.62	1.85	1.74
T_{11}	4.85	5.00	4.93	1.57	1.79	1.68
T_{12}	5.35	5.55	5.45	1.79	2.05	1.92
T_{13}	5.10	5.25	5.18	1.66	1.88	1.77
T_{14}	5.75	5.80	5.78	2.10	2.40	2.25
T_{15}	5.50	5.65	5.58	1.95	2.20	2.08
T_{16}	5.25	5.40	5.33	1.73	2.00	1.87
SEm ±	1.111	0.961	0.073	0.078	0.066	0.063
CD *(P=0.05)*	2.37	2.05	0.16	0.17	0.14	0.13

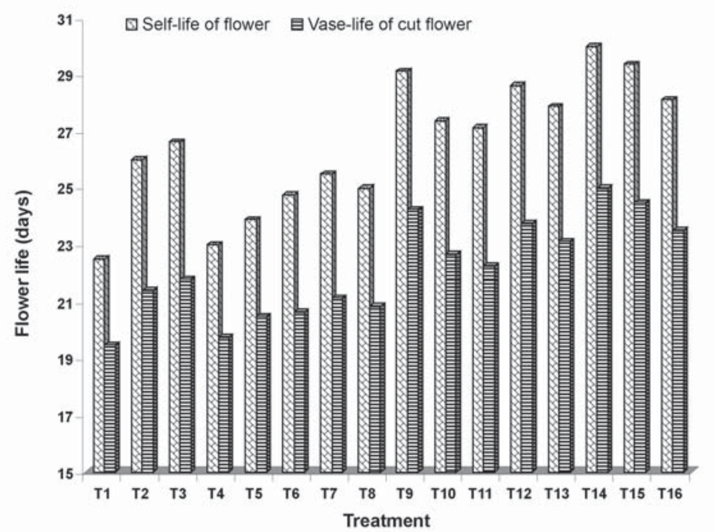

Fig 1. Self-life and vase-life of flower of spray chrysanthemum cv. Amal under various sources of nitrogen

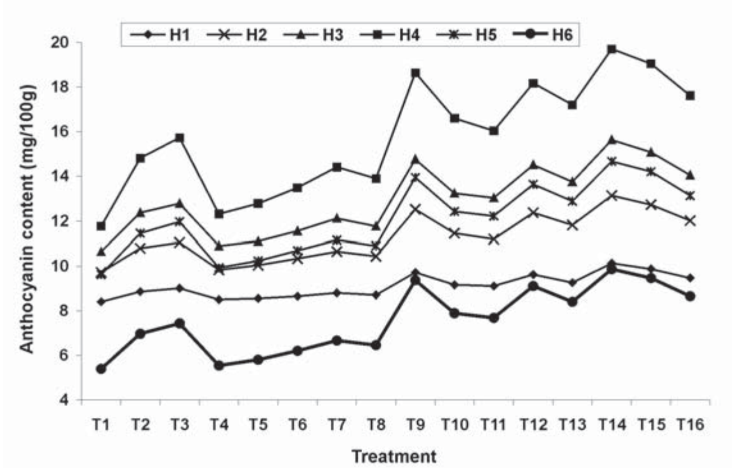

Fig 2. Changes in anthocyanin content (mg/100 g) in flower tissue of spray chrysanthemum cv. Amal under varioussources of nitrogen

MC + 25% N as NC + 25% N as urea (T_{14}) took maximum number of days (133.50 days) to flower. Plants treated with 25% N as NC + 25% N as MC + 25 % N as CAN + 25% N as urea (T_{16}) produced maximum stem length (62 cm) in flowers which was at par with treatment T_{12}. Plants raised on total RDN with neem cake (T_{2}) recorded minimum (41.75 cm) stem-length in flower. Largest size in flower (5.78 cm) was recorded in plants under treatment T_{14} (50 % N as MC + 25% N as NC + 25% N as urea), closely followed by plants under treatment T_{15} (50 % N as NC + 25% N as MC + 25 % N as urea), whereas, plants treated with total RDN as urea (T_{1}) produced smallest size of flower (4.08 cm). Heaviest flower (2.25 g) was produced in T_{14} treatment and flower weight was minimum (1.43 g) with T_{1} treatment.

Maximum number of flowers (6387) sqm^{-1} was recorded in plants treated with 25% N as NC + 25% N as MC + 25% N as CAN + 25% N as urea (T_{16}), whereas, plants supplied with total RDN solely through neem cake (T_{2}) produced lowest number (2001) of flowers which was closest to treatment T_{3} (100% N as MC) with 2230.95 flowers. Plants grown on treatment T_{16} recorded 218.89%

Table 4. Number of flowers per sqm and flower-yield (g) per sqm of spray chrysanthemum cv. Amal under varioussources of nitrogen

Treatment	Number of flowers per sqm			Flower yield (g) per sqm		
	1st yr	2nd yr	Pool	1st yr	2nd yr	Pool
T_1	2880.20	2320.60	2600.40	2730.40	2424.60	2577.50
T_2	2186.50	1815.50	2001.00	2566.60	2197.40	2382.00
T_3	2480.30	1981.50	2230.95	2645.45	2318.30	2481.88
T_4	3181.65	2515.40	2848.53	2780.30	2524.55	2652.43
T_5	3386.55	2774.40	3080.48	2865.45	2587.80	2736.63
T_6	3750.55	3190.50	3470.53	2993.35	2694.65	2844.00
T_7	4453.40	4008.55	4230.98	3306.35	3001.40	3153.88
T_8	4266.70	3804.40	4035.55	3206.65	2908.45	3057.55
T_9	3920.40	3386.30	3653.35	3057.55	2766.60	2912.08
T_{10}	4906.35	4524.45	4715.40	3520.30	3242.45	3381.38
T_{11}	4764.35	4248.40	4506.38	3427.60	3157.65	3292.63
T_{12}	5985.55	5635.45	5810.50	4060.30	3761.50	3910.90
T_{13}	5768.45	5350.60	5559.53	3974.55	3640.35	3807.45
T_{14}	5324.25	5075.50	5199.88	3797.65	3477.35	3637.50
T_{15}	5137.55	4870.55	5004.05	3669.40	3392.55	3530.98
T_{16}	6720.45	6053.55	6387.00	4238.30	3904.65	4071.48
SEm ±	145.055	146.091	102.937	95.68	123.387	78.070
CD *(P=0.05)*	308.97	311.17	219.26	203.80	262.81	166.29

and 145.62% greater number of flowers compared to T_2 and T_3 treatments, respectively. Among different treatments, maximum flower yield (4071.48 g sqm^{-1}) was recorded with T_{16} treatment. Plants under T_{16} treatment produced 70.93% and 57.96% more yield over T_2 and T_1 treatments respectively.

Both shelf-life and vase-life of flowers was found to be maximum (30 days and 25 days, respectively) in plants under T_{14} treatment and the minimum in plants under T_1 treatment (Fig.1). Plants raised on 100% N solely through neem cake (T_2) recorded lowest flower yield by weight (2382 g sqm^{-1}), followed by application of full dose of N in the form of mustard cake (T_3). Anthocyanin content in floral tissues was estimated from flower opening to flower colour fading stage (Fig. 2). Anthocyanin content increased gradually upto 20 days from opening of the flower and, thereafter, declined sharply till flower colour fading stage, irrespective of source of nitrogen or combination. Flowers under treatment T_{14} recorded maximum anthocyanin content, followed by treatment T_{15} and, the lowest in flower tepals of plants supplied with total RDN solely through urea (T_1).

In the present investigation, different sources of nitrogen, alone or in combination, were found to significantly influence all the vegetative and flowering attributes. Plants on 75% of recommended dose of nitrogen through equal parts neem cake, mustard cake and CAN and remaining 25% as top dressing of urea (T_{16}) were outstanding in respect of plant growth, flower yield and yield components. Application of total RDN solely through urea (T_1) registered early blooming and low quality of flowers as well as lowest anthocyanin content solely in flower tepals at all stages of sampling, followed by T_4 (100% N as CAN) treatment. Oil cakes contain some percentage of oil, which prevents rapid conversion of organic nitrogen into the available form. As nitrogen present in the oil-cake is slow-releasing, nitrogen supply to the plant continued throughout the growing period. Several studies have shown that oilcake, in general, increased organic carbon, total and inorganic nitrogen and available phosphorus, exchangeable potassium, calcium and magnesium content of the soil (Herron and Ehrhart, 1965; Olsen *et al*, 1970; Mays *et al*, 1973).

Higher proportion of mustard cake in combination with urea and CAN (T_{12}) registered better performance compared to neem cake combined with urea and CAN (T_{13}). Application of total RDN through neem cake (T_2) showed poor vegetative growth and yield of flowers, followed by application of total RDN through mustard cake (T_3) compared to other treatments. This might be due to a low level of leaf-N at all the stages of sampling. Das and Mukherjee (1990) noted adverse effects of neem cake on beneficial micro-organisms present in the soil. Mukherjee *et al* (1991) reported that different groups of soil microorganisms responded differently to addition of different types of oil-cake to soil. Mustard cake was superior to neem cake in terms of preponderance of soil organisms, while, neem cake caused adverse effects on beneficial organisms and maintained least amount of total nitrogen in the soil. The presence of lipids and bioregulators like meliacins, epinmbin, salin and azadirachtin associated with oil cake may be responsible for inhibition of bacterial growth.

Based on results of this study it can be concluded that maximum plant growth, flower, stem length and flower-yield were influenced by combined application of total RDN through 25% N as neem cake + 25% N as mustard cake + 25% N as CAN + 25% as urea and this treatment increased 57.96% of flower yield over application of total RDN solely through urea. Flower size, individual flower-weight, shelf- and vase-life of flowers as well as anthocyanin content in flower tepals were found to be higher in plants under sole or combined application of oil cakes (mustard cake and neem cake) than under urea and those characters were recorded to be maximum under treatment combination of 50% N of RDN supplied through mustard cake, 25% N through neem cake and 25% N through urea. Anthocyanin content of flower tepals increased gradually upto 20 days from opening of the flower and, thereafter, declined sharply till flower colour fading stage, irrespective of the nitrogen source.

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