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Effect of integrated nutrient management on economic yield of cut flower of China aster (*Callistephus chinensis* L. Nees)

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Abstract
The present investigation entitled "Effect of integrated nutrient management on economic yield of cut flower of China Aster (*Callistephus chinensis* L. Nees)" was carried out at Main Experiment Station, Department of Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, (U.P.) during the year 2015-16 to 2016-17. The experimental material i.e. China aster cv. Prince. The experiment was laid out in randomized block design with sixteen treatments comprising of PSB, Azotobacter and FYM alone or in combination with each other and variable doses of N, P and K in three replications.
The experimental results have clearly showed that the application of recommended nitrogen, phosphorus and potassium can be saved with the application of vermicompost and dual inoculation of *Azospirillum* and PSB besides obtaining higher flower yield of china aster. Therefore, it may be concluded that the use of T_{15}- Azo + PSB + VC + 50% RDF helped in realizing, higher quality of flower yield (216.49 q/ha in 2015-16 and 220.91 q/ha in 2016-17) and above all, in the C:B ratio (1.41 in 2015-16 and 1.45 in 2016-17) above all, in the production of china aster (*Callistephus chinensis* L. Nees) cv. Prince in eastern Uttar Pradesh.

Keywords: Integrated nutrient, management, economic yield, China aster

Introduction
China aster [*Callistephus chinensis* (L.) Nees.], belongs to family Asteraceae and is a native of China and Europe. The genus *Callistephus* derived its name from two greek words '*Kalistos*' and '*Stephos*' meaning 'most beautiful' and 'a crown', respectively. Cassini described the China aster as *Callistephus hortensis*. It was first named by Linnaeus as *Aster chinensis*, and Nees changed this name to *Callistephus chinensis*. China aster is a very popular annual flower crop and is mainly cultivated for production of cut flowers, loose flowers, as pot plant and for bedding plant purposes in landscape. It is gaining fast popularity in India because of its easy cultural practices, diversity of colours and varied uses. Evolution of aster flowers brought a new range of colours starting from white, rose, red, lavender, magenta and blue to their innumerable variations.
The plants of China aster are erect and attain a maximum height of 60-80 cm depending upon the genotypes. China aster is a half hardy annual, plants are erect, branches having hispid hair, leaves are arranged alternately on branches, broadly ovate or triangular ovate, deeply and irregularly toothed and the flowers are solitary. The aster blooms consist of two kinds of florets: ray florets and disc florets. The disc florets are short while the ray florets are usually long. The most suitable character for the classification of China aster is by the shape of ray florets. A comprehensive and updated account on the cultivation and breeding of China aster is provided in an ICAR bulletin.
Flower quality is primarily a varietal trait and is influenced by climatic conditions prevailing during growing period. Optimum temperature and requisite photoperiod go a long way in obtaining better blooms of good size and high quality.

Materials and Methods
The present investigation entitled "Effect of integrated nutrient management on economic yield and cut flower of China Aster (*Callistephus chinensis* L. Nees) cv Prince was carried out at Main Experiment Station, Department of Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, (U.P.) during the year 2015-16 to 2016-17.

The experiment was laid out in randomized block design with sixteen treatments comprising of PSB, azotobacter, vermicompost, poultry manure and FYM alone or in combination with each other and variable doses of N, P, K in three replications.
The observations with respect to height of yield of cut flower and C: B ratio were recorded during both cropping years i.e. 2015-16 and 2016-17.

Results and Discussion

Number of cut flower per plant

The higher number of cut flower per plant (8.02) was counted in T_{15} (Azo + PSB + VC + 50% RDF) as compared to other treatment including T_4 (FYM + 50% RDF) (4.15) treatment T_{13} (Azo + PSB + 50% RD 'N' and P + 100% RD 'K') and T_{16} (Azo + PSB + PM + 50% RDF) found at par.Similar pattern noted in 2016-17 with maximum number of cut flower per plant (8.27) observed in T_{15} (Azo + PSB + VC + 50% RDF) as compared to other treatment at least being in T_4 (FYM + 50% RDF) (4.27) (Table 1). Smita *et al*. (2006) and Manjusha *et al*. (2006).

Number of cut flower per hectare

The maximum number of cut flower per hectare (8.99 q/ha) was obtained T_{15} (Azo + PSB + VC + 50% RDF) which found significantly higher that other treatment including T_4 (FYM + 50% RDF) (4.64 q/ha) treatment T_{14} (Azo + PSB + FYM + 50% RDF), T_{16} (Azo + PSB + PM + 50% RDF) found at par. Similar pattern was followed in second year. Slightly more number of cut flower per hectare was recorded in this year with the maximum (9.18 q/ha) being in T_{15} (Azo + PSB + VC + 50% RDF) and the minimum (4.73 q/ha) recorded in T_4 (FYM + 50% RDF) (Table 1). Smita *et al*. (2006) and Manjusha *et al*. (2006).

Flower yield per hectare

The maximum flower yield (216.49 q/ha) flower yield was achieved with the application of T_{15} (Azo + PSB + VC + 50% RDF) followed by T_{16} (Azo + PSB + PM + 50% RDF) and T_{14} (Azo + PSB + FYM + 50% RDF). The minimum flower yield per quintal was observed T_3 (PSB + 75% RD 'P' + 100% RD 'N' and K) (103.77). It is interesting to mention that combined application of organic manure (216.49) was found significantly superior over application of inorganic manure (169.02) (Table 1).
Data also indicated that more number of organic combination (Azo + PSB+ FYM + 50% RDF) and other. Similar patter was followed in 2016-17 with the observation that slightly more flower yield was recorded. However the maximum yield (220.91q/ha) was obtained in T_{15} (Azo + PSB + VC + 50% RDF) and least being in T_3 (PSB + 75% RD 'P' + 100% RD 'N' and K) (105.89 q/ha). Arora and Saini (1976); Yasin and Pappiah (1990); Singh and Arora (1980); Syamal *et al.* (1990); Serawat *et al.* (2003) and Sharma *et al*. (2006).

Economics

The maximum average cost of cultivation of Rs. 93685.00 for the cropping years 2015-16 and 2016-17 was computed under the treatment of Azo + PSB + PM + 50% RDF (T_{16}), while the lowest cost of cultivation of Rs. 88085.00 was obtained with the FYM + 50% RDF and VC + 50% RDF (T_4 and T_5). The highest average gross return of Rs. 216490.00 during both cropping years i.e. 2015-16 and 2016-17 was achieved due to application of Azo + PSB + VC + 50% RDF (T_{15}) while the lowest average gross income of Rs. 120250.00 was obtained with the application of FYM + 50% RDF (T_4). The highest net income of Rs. 126855.00 for the two cropping years i.e. 2015-16 and 2016-17, was recorded with the treatment combination of Azo + PSB + VC + 50% RDF (T_{15}) whereas the lowest average net income of Rs. 3,67,279.00 was recorded under treatment of Azo + PSB + 50% RD 'N' and P + 100% RD 'K' (T_3). The highest average cost: benefit ratio 1:2.06 during both cropping years *i.e* 2015-16 followed by T_{14} (1:1.62). The lowest cost: benefit ratio (1:0.97) were recorded with T_2 (Azospirillum + 75% RDN + 100% RD 'P' and K) (Table 1). Renukaradya *et al.* (2011) and Idan *et al.* (2014).

Table 1: Effect of INM on yield and yield attributes and C:B ratio.

Treatment	Number of cut flower per plants		Number of cut flower per plants		Flower yield '(q/ha)		C:B Ratio	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1:100% RDF (180:120:60 kg, N: P_2O_5: K_2O ha^{-1})	36.75	37.90	7.07	7.27	169.02	172.47	0.84	0.88
T_2: Azospirillum + 75% RDN + 100% RD 'P' and K	36.12	37.23	5.28	5.47	128.25	130.87	0.34	0.42
T_3: PSB + 75% RD 'P' + 100% RD 'N' and K	28.33	29.20	5.91	6.10	103.77	105.89	0.14	0.17
T_4: FYM + 50% RDF	33.85	34.90	4.15	4.27	120.25	122.71	0.36	0.38
T_5: VC + 50% RDF	37.15	38.30	5.12	5.27	133.51	136.23	0.50	0.53
T_6: PM + 50% RDF	37.89	39.07	5.94	6.13	131.73	134.42	0.42	0.45
T_7: Azospirillum + FYM+ 50% RDF	39.09	40.30	5.18	5.33	148.98	152.02	0.68	0.72
T_8: Azospirillum + PM + 50% RDF	39.41	40.63	6.20	6.40	163.53	166.87	0.75	0.79
T_9: Azospirillum + VC + 50% RDF	28.54	29.43	6.89	7.10	113.13	115.44	0.27	0.29
T_{10}: PSB + FYM + 50% RDF	41.84	43.13	5.97	6.17	168.91	172.36	0.90	0.94
T_{11} PSB + VC + 50% RDF	42.81	44.13	6.47	6.67	187.23	191.05	1.10	1.14
T_{12} PSB + PM+ 50% RDF	43.10	44.43	6.89	7.10	187.53	191.36	1.01	1.04
T_{13} Azo + PSB + 50% RD 'N' and P + 100% RD 'K'	42.07	43.37	7.27	7.50	165.12	168.49	0.83	0.86
T_{14} Azo + PSB + FYM + 50% RDF	40.97	42.23	6.99	7.20	189.88	193.75	1.12	1.16
T_{15} Azo + PSB + VC + 50% RDF	41.97	43.27	8.02	8.27	216.49	220.91	1.41	1.45
T_{16} Azo + PSB + PM + 50% RDF	43.06	44.40	7.13	7.33	202.84	206.98	1.16	1.20
SEm±	0.35	0.36	0.09	0.10	3.095	3.112		
CD at 5%	0.99	1.03	0.28	0.29	8.938	8.988		

Table 2: Effect of INM on plant height (cm).

Treatment	Plant height		Number of leaf		Number of branches		Spread of plants (cm)		Stem diameter (cm)		Flower yield (q/ha)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1:100% RDF (180:120:60 kg, N: P_2O_5: K_2O ha^{-1})	34.31	35.37	96.82	100.33	19.63	20.23	23.85	24.33	1.78	1.83	169.02	172.47
T_2: Azospirillum + 75% RDN + 100% RD ‘P’ and K	26.55	27.37	80.55	83.47	14.84	15.30	26.53	27.07	1.75	1.80	128.25	130.87
T_3: PSB + 75% RD ‘P’ + 100% RD ‘N’ and K	30.43	31.37	81.29	84.23	15.78	16.27	28.42	29.00	1.65	1.70	103.77	105.89
T_4: FYM + 50% RDF	17.75	18.30	72.63	75.27	16.78	17.30	23.52	24.00	1.55	1.60	120.25	122.71
T_5: VC + 50% RDF	26.64	27.47	77.65	80.47	15.78	16.27	25.48	26.00	1.45	1.50	133.51	136.23
T_6: PM + 50% RDF	25.41	26.20	78.55	81.40	17.72	18.27	27.44	28.00	1.35	1.40	131.73	134.42
T_7: Azospirillum + FYM+ 50% RDF	28.39	29.27	85.21	88.30	18.66	19.23	29.40	30.00	1.25	1.30	148.98	152.02
T_8: Azospirillum + PM + 50% RDF	29.36	30.27	86.91	90.07	18.92	19.50	29.73	30.33	1.68	1.73	163.53	166.87
T_9: Azospirillum + VC + 50% RDF	29.49	30.40	87.20	90.37	18.30	18.87	28.75	29.33	1.75	1.80	113.13	115.44
T_{10}: PSB + FYM + 50% RDF	29.59	30.50	87.20	90.37	16.85	17.37	25.48	26.00	1.55	1.60	168.91	172.36
T_{11} PSB + VC + 50% RDF	30.43	31.37	89.78	93.03	17.75	18.30	26.46	27.00	1.65	1.70	187.23	191.05
T_{12} PSB + PM+ 50% RDF	32.40	33.40	91.93	95.27	18.37	18.93	28.42	29.00	1.75	1.80	187.53	191.36
T_{13} Azo + PSB + 50% RD ‘N’ and P + 100% RD ‘K’	25.77	26.57	88.20	91.40	16.88	17.40	26.46	27.00	2.04	2.10	165.12	168.49
T_{14} Azo + PSB + FYM + 50% RDF	35.21	36.30	92.54	95.90	17.85	18.40	27.44	28.00	1.71	1.77	189.88	193.75
T_{15} Azo + PSB + VC + 50% RDF	36.25	37.37	96.50	100.00	19.76	20.37	28.42	29.00	2.00	2.07	216.49	220.91
T_{16} Azo + PSB + PM + 50% RDF	39.09	40.30	94.92	98.37	18.20	18.77	29.40	30.00	1.75	1.80	202.84	206.98
SEm±	3.30	1.14	2.65	2.92	0.58	0.59	0.89	0.82	0.06	0.06	3.095	3.112
CD at 5%	2.56	1.28	7.66	8.43	1.66	1.70	2.57	2.36	0.18	0.16	8.938	8.988

Summery and Conclusion

- Maximum number of flower per plant were counted in Azo + PSB + VC + 50% RDF during 2015-16 and 2016-17.
- Observations made for number of flower per plant recorded the maximum values with the treatment combination of Azo + PSB + VC + 50% RDF during both the years of investigation.
- The highest average weight of flower per plant was obtained with the treatment Azo + PSB + VC + 50% RDF in both the years.
- The treatment combination of Azo + PSB + VC + 50% RDF produced the maximum number of flower per hectare during 2015-16 and 2016-17 also.
- Plants nourished with Azo + PSB + VC + 50% RDF yielded the maximum flowers during 2015-16 and also in successive years of experimentation.
- Due to the maximum harvest of loose and cut in T_{15} treatment condition comprised of Azo + PSB + VC + 50% RDF, the highest cost: benefit ratio of 1:2.74 was recorded.

From the above study, it could be concluded that the application of Azo + PSB + VC + 50% RDF responded as best treatment for almost all the parameters included under study. Keeping in view, overall performance of organic manures like Phosphate solubility Bacteria, Azotobacter, Farm Yard manure and inorganic fertilizers *viz*. Nitrogen, Phosphorus and Potassium. The application of Azo + PSB + VC + 50% RDF can be recommended for China aster cultivation in eastern Uttar Pradesh for better economic return.

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