The Bioscan 11(2): 1167-1169, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFICACY OF INTEGRATED NUTRIENT MANAGEMENT ON SEED YIELD AND QUALITY PARAMETERS OF CALENDULA OFFICINALIS

BAPPITODU[1], D K RANA[1], PARUL PUNETHA[1]* AND PRABHAT KUMAR[2]
[1]Department of Horticulture, Chauras Campus H.N. B Garhwal University, Srinagar Garhwal - 246 174
[2]Department of Floriculture and Landscaping IARI, New Delhi - 110 012
e-mail: parulpunetha@gmail.com

KEYWORDS
Biofertilizers
Inorganic fertilizers
Calendula and HA

Received on :
10.10.2015

Accepted on :
02.05.2016

***Corresponding author**

ABSTRACT
To ascertain the productivity and seed yield of calendula, a field experiment was conducted with different quantums of inorganic nutrients(Nitrogen, Phosphorus and Potassium)and biofertilizers (*Azotobacter*, PSB, KMB, HA) during winter season of 2012-2013 under valley conditions of Garhwal Himalayas.The results revealed that seed yield and quality parameters were progressively increased by the application of 75%NPK + *Azotobacter* + PSB + KMB + 3%HA, while the minimum values of these parameters were recorded in the treatment that was not supplemented with any nutrients.

INTRODUCTION

Among the ornamentals, annuals provide an array of different hues which become the centre of attraction for all. Their colour range varies from red yellow, blue, orange and so many. Among the various annuals this yellowish orange coloured annual, *Calendula officinalis*also known as pot marigold is an important one.Besides an important attractive annual it is also popular as a medicinal herb having great demand in pharmaceutical operations. Increased flower production and improved flower quality are the important objectives in commercial flower production. There is meagre information on the nutritional requirementof Calendula. Application of Nitrogen (200 kg/hac), Phosphorus (100 kg/hac) and Potassium (200 kg/hac) interacted positively resulting in maximum flower yield (Gantait and Chattopadhyay, 2005). At present these nutrients are supplied through chemical fertilizers but the indiscriminate and continuous use of chemical fertilizers has led to an imbalance of nutrients in soil which has adversely affected the soil structure, environment, flora and fauna (Bohra and Kumar, 2014). But the concept of INM not only improves the quality of the produce but also help in improving the soil fertility including the biosphere by reducing the cost of production in agriculture. Integrated nutrient management practice involves judicious combination of organic manures, bio-fertilizers and chemical fertilizers and also they are eco-friendly, easily available and cost-effective as reported by Verma *et al.* (2011). Keeping in view the soil structure and to increase the quantity and quality of flowers this investigation has been undertaken to standardize the optimum dose of integratednutrients in Calendula.

MATERIALS AND METHODS

A field experiment was conducted in Calendula at H. R. C (Horticultural Research Centre), H. N. B. Garhwal (A Central University) Srinagar Garhwal, Uttarakhand, during winter season of 2012 – 2013. Soil of the experimental site is sandy loam in texture with pH 6.4. The sampling site consists of 95.3 kg/ha Nitrogen (N), 3.05 kg/ha Phosphorus (P) and 135 kg/ha Potassium (K). The experiment was laid out in Randomized Block Design (RBD) with 8 treatments which were replicated thrice. The experimental details consisted of: T1 = Control, T2 = Recommended dose of Fertilizer (N:P:K = 12:6:6 g/m^2), T3 = 75% NPK + *Azotobacter* + Phosphate Solubilizing Bacteria (PSB) + Potash Mobilizing Bacteria (KMB), T4 = 50% NPK + *Azotobacter* + PSB + KMB, T5 = 75% NPK + *Azotobacter* + PSB + KMB + 2% HA, T6 = 75% NPK + *Azotobacter* + PSB + KMB + 3% HA, T7 = 50% NPK + *Azotobacter* + PSB + KMB + 2% HA, T8 = 50% NPK + *Azotobacter* + PSB + KMB + 3% HA. The recommended packages of practices were followed for cultivation of crop and to control the pest and diseases.

The seed quality parameters like germination per cent was counted as per ISTA rules (Anonymous, 1996), root length was measured from collar region to the tip of the root, shoot length from collar region to the apex of shoot, dry weight of 10 normal seedlings, seedling vigour index by following the method suggested by Abdul- Baki and Anderson, 1973.

RESULTS AND DISCUSSION

Significant differences were obtained amongst treatments for all attributes of growth parameters and seed yield and seed

Table 1: Influence of integrated nutrient management on growth and seed yield attributing parameters of *Calendula officinalis*

Treatments	Plant height (cm)	No of primary branches	Flower yield/ plant (g)	No of seeds /flower	Seed yield / plant(g)	Seed yield (kg/ha)	Test weight (g)
T1	53.73	18.50	81.86	38.14	30.86	2683.28	9.80
T2	54.58	18.84	84.57	39.47	38.40	3456.05	10.33
T3	57.29	19.30	90.98	40.74	37.92	3412.50	11.33
T4	56.77	19.22	88.00	40.15	36.68	3301.40	10.37
T5	61.01	21.33	105.42	42.77	61.80	5561.70	13.83
T6	68.76	24.54	116.77	45.66	86.85	7816.28	16.23
T7	60.30	20.54	101.61	42.65	56.82	5113.88	13.77
T8	62.21	23.14	113.18	43.56	63.22	5469.09	14.47
SE m±	1.70	1.21	3.86	1.02	5.77	525.39	1.36
CD at 5%	5.16	3.67	11.70	3.10	17.49	1593.46	4.12

Table 2: Influence of integrated nutrient management on seed quality attributing parameters of *Calendula officinalis*.

Treatments	Seed viability (%)	Germination Percent (%)	Speed of germination	Seedling length(cm)	Seedling dry weight(mg)	Moisture (%)	Seed EC (dSm^{-1})
T1	90.33	88.00	16.13	5.12	16.15	8.16	1.32
T2	91.33	89.67	16.18	5.15	16.17	8.14	1.32
T3	92.67	90.00	16.43	5.25	17.65	8.12	1.31
T4	92.00	88.00	16.36	5.23	17.45	8.13	1.31
T5	93.33	90.00	16.81	5.33	17.81	8.10	1.31
T6	94.67	91.67	16.85	5.37	17.86	8.02	1.30
T7	92.00	90.00	16.76	5.26	17.77	8.11	1.31
T8	93.67	91.00	16.83	5.27	17.83	8.07	1.31
SE m±	0.70	0.73	0.11	0.10	0.78	0.10	0.38
CD at 5%	2.13	2.21	0.34	0.31	0.23	0.32	0.11

quality parameters of Calendula (*Calendula officinalis*) (Table 1 and 2).

Application of 75 per cent recommended NPK , Azotobacter, PSB, KMB and 3 per cent HA resulted in maximum plant height (68.76 cm), number of primary branches (24.54), and flower yield/plant (116.77). The increase in the vegetative growth parameters in the treatment (T6) is might be due to the beneficial effect of the nutrients supplied to the plant while the decrease in the vegetative growth parameters under control (T1) might be due to unavailability of sufficient nutrients at critical stages of plant for its luxuriant growth. Similar findings of increased vegetative growth due to integrated nutrient management were reported by Polara *et al*. (2014) in marigold, Mohanty *et al*.(2013), Warade *et al*. (2007)in Dahlia and by Narsimha Raju and Haripriya (2001) in Crossandra.

Qualitative and quantitative seed production is directly influenced by proper plant growth, flowering and nutrient supply to the plants. Analyzed data presented in Table 1 revealed that maximum number of seeds per flower (45.66) was recorded in the treatment T6 and this treatment was statistically at par with the treatment T8, T5 and T7, whereas, the treatment T1 recorded minimum (38.14) number of seeds per flower. It was observed that a profound influence of integrated nutrients was there on increasing the vegetative growth parameters which in turn increased the number of seeds per flower and seed yield parameters. This might be due to the enhanced cell division in apical meristem which resulted in higher vegetative growth and accumulation of more photosynthates and thus seed yield contributing traits. This is in line with the findings ofWarade *et al*. (1995) in onion, Singh and Verma (1999) in rice, Sharma *et al*. (2014) in okra

In the present investigation among the various treatment combinations, the plot applied with 75%NPK+ *Azotobacter*+ PSB+ KMB+ 3%HA (T6), gave significantly maximum seedyield per plant (86.85 g) and seed yield per hectare (7816.28 kg/ha). The difference in the seed yield per hectare due to the influence of different sources of nutrients could be related to their flower yield per plant which showed significantly varying differences as that of seed yield per plant and seed yield per hectare. However higher seed yield with T6 treatment was mainly due to maximum number of primary branches and flower yield per plant obtained with T6.Minimum seed yield per plant (30.86 g) and seed yield per hectare (2683.28 kg/ha) was registered in T1 (control).These results are in agreement with the findings of Chandrikapure *et al*. (1999) in marigold who reported that seed production is directly influenced by proper plant growth and nutrient supply to the plants. Positive increasement in seed yield and their related characters by the integrated approach of nutrients may be due to the increasement in availability of micro and macro nutrients to the plants and increasement in hormonal activation within the plant. This is in line with the findings of Nayek *et al*.(2014) in sesame, Sunita *et al*. (2007) in marigold and Nethra *et al*. (1999) in China Aster.

Test weight of seeds is one of the yield contributing component which differed significantly due to different sources of nutrients (Table 1).Maximum test weight (16.23 g) of seeds was recorded in the treatment T6 and it wasstatistically at par with the treatment T8, T5 and T7 (14.47, 13.83 and 13.77 g), whereas, significantly lower test weights (9.80 g) of seeds was recorded in T1 (control). The increase in the test weight could be attributed to the proper development of seeds by the influence

of the nutrients supplied to the plants. Similar increase in the test weight of seeds by INM was reported by Sunitha and Hunje (2010) in African Marigold.

Seed quality parameters such as seed viability (%), Germination per cent (%), Speed of germination, Seedling length (cm), dry weight, moisture per cent (%) and seed Ec was significantly influenced by the combination of various nutrients as compared to control. Seed viability (94.67%), germination percent (91.67%), speed of germination (16.85), seedling length (5.37 cm), dry weight of seedling (17.86 mg), moisture percent (8.16%) was obtained maximum with the application of 75%NPK + *Azotobacter* + PSB + KMB + 3%HA in treatment T6. The higher seed quality attributes was due to the application of biofertilizers and foliar spraying of HA. The HA may have promoted better development of seed as evident with higher test weight which inturn have supplied adequate food reserves during germination and seedling development. Similar improvement in seed quality parameters with spray of growth retardants was reported by Doddagoudar *et al*.(2004) in China aster, Shivakumar, (2000) in marigold and Kulkarni *et al*. (1996) in China aster.

Minimum seed EC (1.30dSm^{-1}) was recorded in the treatment T6 (75%NPK + *Azotobacter* + PSB + KMB + 3%HA), and it was found to be statistically at par with the all treatments. However, significantly higher seed EC (1.32 dSm^{-1}) was observed in the treatment T1 (control) and T2 with the application of RDF. The seed EC range from1.30 dSm^{-1} to 1.32 dSm^{-1} within all the treatments. FurtherSunitha and Hunje (2010) found that better development of seeds due to the application of integrated nutrients on marigold leads to higher test weight and germination percent of seeds.

Keeping in view the above facts, it is recommended that the application of 75%NPK + *Azotobacter* + PSB + KMB + 3%HA is beneficial to obtain higher seed yield and good seed quality in *Calendula officinalis*.

REFERENCES

Abdul-Baki, A. A. and Anderson, J. D. 1973. Vigour determination in soybean seeds by multiple criteria. *Crop Sci*.**13:** 630-632.

Anonymous 1996. International rules for seed testing. *Seed Sci. and Tech*. **24 (supplement):** 1-355.

Bohra, M. and Kumar, A. 2014. Studies on effect of organic manures and bioinoculants on vegetative and floral attributes of Chrysanthemum cv. Little Darling. *The Bioscan*. **9(3):** 1007-1010.

Chandrikapure, K. K., Sadawrte, K. T., Panchbhai, D. M. and Sholke, B. D. 1999. Effect of bioinoculants and graded doses of nitrogen on growth and flower yield of marigold (*Tagetes erecta* L.). *Orissa J. Hort*. **27(2):** 31-34.

Doddagoudar, S. R., Vyakaranahal, B. S., Shekhargouda, M. 2004. Effect of mother plant nutrition and chemical spray on seed germination and seedling vigour of chinaaster cv. Kamini. *Karnataka J. Agri. Sci*. **17(4):** 701-704.

Gantait, S. S. and Chattopadhyay, T. K. 2005. Agrotechniques to maximize productivity of Hydroalcoholic extract from medicinal garden herb Calendula. *Green Page*. **4(2):** 113-118.

Kulkarni, B. S., Nalawadi, U. G. and Giraddi, R. S. 1996. Effect of vermicompost and vermiculture on growth and yield of china aster (Callistephus chinensis Nees) cv. Ostrich plume mixed cultivation using vermicompost as organic amendment. *Crop Res*.**17(2):** 209-215.

Mohanty, A., Mohanty, C. R. and Mohapatra, P. K. 2013. Studies on the response of integrated nutrient management on growth and yield of Marigold (*Tagetes erecta* L.). *Res.J. Agri. Sci*. **4:** 383-385.

Narasimha Raju, S. and Haripriya, K. 2001. Integrated nutrient management in Crossandra (Crossandra infundibuliformis L.) Cv. Dindigul local. *South Indian Hort*. **49:** 181-184.

Nayek, S. S., Brahmachari, K. and Chowdhury, M. R. 2014. Integrated approach in nutrient management of sesame with special reference to its yield, quality and nutrient uptake. *The Bioscan*. **9(1):** 101-105.

Nethra, N. N., Jayaprasad, K. V. and Radha, D. K. 1999. China Aster [Callistephus chinensis (L.) Nees] cultivation using vermicompost as organic amendment. *Crop Res*. **17(2):** 209-215.

Polara, N. D., Gajipara, N. N. and Barad, A. V. 2014. Effect of nitrogen and phosphorus on nutrient content and uptake in different varieties of African marigold (*Tagetes erecta* L.). *The Bioscan*. **9(1):** 115-119.

Sharma, I. J., Samnotra, R. K. and Kumar, V. 2014. Response of bio- and inorganic fertilizers on growth and seed yield of Okra (*Abelmoschus esculentus* (L.) Moench) under sub tropical irrigated area of Jammu. *Environment and Ecology*. **32(4):** 1237-1242.

Shivakumar, C. M. 2000. Effect of mother plant nutrition, plant density and seed maturity on seed yield and quality in marigold (Tagetes erecta L.) M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad (India).

Singh, N. B. and Verma, K. K. 1999. Integrated Nutrient Management in Rice-Wheat Crop Sequences. *Oryza*. **36(2)**: 171-172.

Sunita, H. M., Hunje, R., Vyakaranahal, B. S. and Bablad, H. B. 2007. Effect of plant spacing and integrated nutrient management on yield and quality of seed and vegetative growth parameters in African marigold (Tagetes erecta L.). *J. Orn. Hort*. **10(4):** 245-249.

Sunitha, H. M. and Hunje, R. 2010. Effect of plant population and integrated nutrient management on growth, seed yield and quality of African marigold (*Tageteserecta* L.). *Karnataka J. Agric. Sci*. **23(5):** 783-786.

Verma, S. K., Angadi, S. G. Patil, V. S. Mokashi, A. N. Mathad, J. C. and Mummigatti, U. V. 2011. Growth, yield and quality of Chrysanthemum (Chrysanthemum morifolium Ramat.) cv. Raja as influenced by integrated nutrient management. *Karnataka J. Agric. Sci*. **24(5):** 681-683.

Warade, A. P., Golliwar, V. J., Chopde, N., Lanje, P. W. and Thakre, S. A. 2007. Effect of organic manures and biofertilizers on growth, flowering and yield of Dahlia. *J. Soils Crops*. **17(2):** 354-357.

Warade, S. D., Desale, S. B. and Shinde, K. G.1995. Effect of organic, inorganic and bio fertilizer on yield of onion bulbs Cv. B - 780. *J. Maharashtra Agric. Univ*. **20(3):** 268-269.