Effect of integrated nutrient management in China aster cv. Arka Poornima under mid hills of Himalayas

ABSTRACT

The present investigation conducted to investigate the effect of integrated nutrient management on vegetative parameters of China aster cv. Arka Poornima under the mid hills of Himachal Pradesh. The experiment was laid out in simple randomized design (RBD) with eighteen treatments. The experiment was conducted at the Kakhaliresearch farm of Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib, Himachal Pradesh during *kharif* season of 2023. For integrated nutrient management eighteen treatments were constituted with three levels of recommend dose of inorganic fertilizers (50, 75 and 100 %) and three biofertilizers *viz.,Azotobacter,* PSB and KSB along with control. The observations for the vegetative parameters *i.e.,* plant height (cm) at maturity, numbers of leaves, number of primary branches, number of secondary branches, leaf area per plant, leaf area index and plant spread were recorded and analyzed. The plant height (91.40 cm), No. of leaves (356.13), No. of primary branches (12.40) and secondary branches (33.70) were found maximum in treatment T_{12} (RDF@75% + Azotobacter + PSB + KSB), while the lowest values were observed in T_0 (control). The highest leaf area (27.49 cm^2) was found in T_8 (RDF@75% + Azotobacter), while the leaf area index (12.02) and plant spread (16.57 cm) were found in treatment T_{11} (RDF@75% + Azotobacter + PSB). The lowest values for leaf area (17.77 cm^2), leaf area index (5.48) and plant spread (11.82 cm) were found in treatments T_{14} (RDF@100% + Azotobacter), T_{16} (RDF@100% + KSB) and T_{10} (RDF@75% + KSB), respectively. Therefore, it can be concluded that, application of T_{12} (RDF@75% + Azotobacter + PSB + KSB) is best for the getting higher production in China aster followed by T_{11} (RDF@75% + Azotobacter + PSB). This study will reduce the use of inorganic fertilizer without polluting the soil and environment.

Keywords: China aster, Integrated nutrient management, Azotobactor, Phosphorous solubilizing bacteria, Potassium solubilizing bacteria

1. INTRODUCTION

The China aster (*Callistephus chinensis* L) belongs to the Asteraceae family and is indigenous to China. It is a prominent annual flower crop cultivated worldwide for a variety of uses, including cut flowers, loose flowers, pot plants, and landscape bedding. The flower has grown in popularity in the floral business because to its small size, diverse colour palette, extended vase life, and transportability [1]. In India, it is mostly grown in Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, and West Bengal. China aster cultivated in Indian fields could be impacted from toxic nutrient levels. The right fertilizer combinations are essential for growing robust plants with more shoots and leaves, improving flower quality, and lengthening the flowering season [2,3]. There hasn't been much research done on the effects of organic and inorganic fertilizers on China aster growth and production, though. Combining biofertilizers (*Azotobacter*, *phosphorous* solubilizing bacteria and potassium solubilizing bacteria) with balanced inorganic fertilizers and organic manures is crucial for achieving higher yields. Increased interest in organic farming can result from the use of organic materials such as green manures, which can enhance soil structure, nutrient exchange, and general soil health [4]. According to Shylaja et al. [5], FYM (farmyard manure) helps regulate soil pH and increases accessible NPK levels. Biofertilizers increase the quantity and quality of flowers while using less inorganic fertilizer. They improve soil qualities and provide a home for advantageous microbes, which promotes long-term soil fertility [6]. PSB raises the availability of phosphorus, increasing yield. Therefore, the prime objective of the present investigation is to investigate the effect of integrated nutrient management in China aster cv. Arka Poornima using inorganic fertilizers and biofertilizers under mid hills of Himachal Pradesh.

2. MATERIAL AND METHODS

The present study was carried out in Kakhaliresearch farm of Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib, Sirmour, Himachal Pradesh (India) during the *Kharif* season of 2023. The study geographical area lies on latitudes 30.7537° N and longitudes 77.2965° E of mid hills of Himachal Pradesh (India) in an altitude of 1067 m from above mean sea level. The research trail includes 18 treatments, combing different levels of recommended dose of fertilizers with biofertilizers laid out in randomized block design. The effect of different treatments of integrated nutrient management i.e., T_0 (Control), T_1 (RDF@50%), T_2 (RDF@50% + Azotobacter), T_3 (RDF@50% +PSB), T_4 (RDF@50% +KSB), T_5 (RDF@50% + Azotobacter+PSB), T_6 (RDF@50% + Azotobacter+PSB+KSB), T_7 (RDF@75%), T_8 (RDF@75% + Azotobacter), T_9 (RDF@75% +PSB), T_{10} (RDF@75% +KSB), T_{11} (RDF@75% + Azotobacter+PSB), T_{12} (RDF@75% + Azotobacter + PSB + KSB), T_{13} (RDF@100%), T_{14} (RDF@100% + Azotobacter), T_{15} (RDF@100% +PSB), T_{16} (RDF@100% +KSB), T_{17} (RDF@100% + Azotobacter+PSB) and T_{18} (RDF@100% + Azotobacter + PSB + KSB) on 'Arka Poornima' of China Aster (Table 1). The seeds of China aster cv. Arka Poornima were sown in the nursery, and one month old seedlings of China aster were treated with the liquid consortium of *Azotobacter*, PSB (Phosphorous solubilizing bacteria) and KSB (Potassium solubilizing bacteria) separately for few minutes. After that the treated seedlings were planted in the experimental field in a spacing of 30 cm plant to plant and 30 cm row to row. The observations for the traits i.e. plant height (cm) at maturity, numbers of leaves, number of primary branches, number of secondary branches, leaf area per plant, leaf area index and plant spread were measured and recorded as per standard procedure. The plant parameters were recorded, by selecting the five random plants from each replication of a treatment and significant variations were recorded from the plant. The plant were undergone from the various inter culture operations and plant protection procedure required for the better plant production during the course of investigation. Further, the analysis of variance (ANOVA) was done through OPSTAT software [7].

3. RESULTS AND DISCUSSION

The observation recording for plant height (cm) was significantly affected by the treatments of various integrated nutrient management. The highest plant height (91.40 cm) of China Aster cv. Arka Poornima was found in T_{12} (RDF@75% + Azotobacter + PSB + KSB), which was closely followed by T_{11} (RDF@75% + Azotobacter + PSB) and T_{16} (RDF@100% + KSB) recording 90.07 cm and 87.00 cm, respectively. Whereas, the lowest plant height (74.13 cm) was observed in T_0 (Control) (Table 1).The increased plant height can be associated with PSB's critical contribution in the solubilization of insoluble P by the formation of organic acid. The appropriate supply of P appears to have encouraged root development, which leads to rapid vegetative growth of plants. [8] noticed a similar finding in tuberose.The data recorded for number of leaves per plant was significantly affected by the different treatments of integrated nutrient management. The maximum number of leaves per plant (356.13) of was found in T_{12} (RDF@75% + Azotobacter + PSB + KSB), which was followed by T11

(RDF@75% + Azotobacter + PSB) and T_{16} (RDF @100% + KSB) recording 354.27 and 345.53 respectively (Table 1). Whereas, the minimum number of leaves per plant (276.07) was found in T_0 (Control). The increment in plant growth is can be due to reason that Biofertilizers produce a number of growth-promoting hormones (auxins, cytokinins, and gibberellins, etc.) while also improving the accessibility of nitrogen, phosphate, and potash to plants, leading to improved plant development. Several authors have observed similar results of increased plant height at harvest because of the combination application of biofertilizers with lower doses of NPK i.e. [9,10] in China Aster, [11] in annual chrysanthemum and [12] in chrysanthemum.

The observation regarding the number of primary branches per plant was showed significant variation for different treatments of integrated nutrient management. The highest number of primary branches per plant (12.40) of was recorded in T_{12} (RDF@75% + Azotobacter + PSB + KSB), which was followed by T_{11} (RDF@75% + Azotobacter + PSB) recorded as 11.77 number of primary branches per plant. While, the lowest number of primary branches per plant (9.13) was observed in T_0 (Control). The highest number of secondary branches per plant (33.70) of was found in T_{12} (RDF@75% + Azotobacter + PSB + KSB), which was followed by T_{11} (RDF@75% + Azotobacter + PSB) and T_{16} (RDF @100% + KSB) recording 31.70 and 29.07, respectively. Whereas, the lowest number of secondary branches per plant (22.13) was observed in T_0 (Control) (Table 1). The increase in branches could be attributed to the formation of nitrogenous compounds such as proteins, amino acids, nucleic acids and other enzymes and coenzymes that were responsible for cell division and enlargement, as well as the role of phosphorous in structural components such as phospholipid and the translocation of food components. Additionally, *Azotobacte*r's presence in the nitrogen fixation process and the release of growth-promoting chemicals such as gibberellins and IAA may contribute to an increase in the number of primary branches per plant. There have been reports of a similar result, with an increase in the number of primary branches following the immunization of African marigold with *Azotobacter* and PSB (Phosphorous solubilizing bacteria) by several authors [13,14] in annual chrysanthemum.

The perusal of data showed that, the maximum leaf area per plant (27.49 cm^2) was observed in T_8 (RDF@75% + Azotobacter), which was followed by T_9 (RDF@75% + PSB) recording 27.13 cm^2. Whereas, the minimum leaf area per plant (17.77 cm^2) was observed in treatment T_{14} (RDF@100% + Azotobacter) (Table 1). These growth-promoting compounds may have resulted from increased cell division and elongation, which improved leaf explanation by increasing leaf length and width, thereby increasing leaf area. These results closely align also the conclusions of [15] and [11] in chrysanthemum and [16] in petunia [17] in China aster.

The highest leaf area index (12.02) of was found in T_{11} (RDF@75% + Azotobacter + PSB), which was followed by T_{15} (RDF@100% + PSB) and T_{10} (RDF@75% + KSB) recording 10.40 and 10.15, respectively (Table1). Whereas, the lowest leaf area index (5.48) was found in T_{16} (RDF@100% + KSB). Leaf area index is dependent to total leaf area and numbers of leaves, therefore treatment having the larger area and number of leaves will also have the higher leaf area index. These results closely align also the conclusions of [15] and [11] in chrysanthemum and [16] in petunia [17] in China aster.

The highest plant spread (16.57 cm) of was found in treatment T_{11} (RDF@75% + Azotobacter + PSB), which was followed by T_{14} (RDF@100% + Azotobacter) recording 16.35 cm. whereas, the lowest plant spread (11.82 cm) was observed in T_{10} (RDF@75% + KSB) (Table 1). The increased plant spread could be related to the creation of colonies of the biofertilizers (Azotobacter and PSB) inoculates, as well as their growth-promoting actions, such as the generation of plant growth-promoting substances. A further potential reason for greater plant spread after biofertilizers inoculation is increased cell metabolism, which is induced by increased enzyme activity, chlorophyll content, and photosynthetic activities. The similar observations were also discovered by [18] in Annual chrysanthemum, [19] in petunia, [20] in marigold and [21] in bird of paradise. The use of NPK together with the inoculation of bio-fertilizer proved beneficial, presumably because it fixed atmospheric nitrogen in the soil and made phosphorus freely available to plants. The role and stimulating effects of non-symbiotic nitrogen-fixing bacteria (Azotobacter) in connection with N-fertilization have been thoroughly researched these nutrients are essential for increasing soil microbial activity. Similar results were reported [5, 22]

Table 1. Effect of inorganic and biofertilizers on vegetative plant parameters of China aster

4. CONCLUSION

From the findings or the current experiment, It can be inferred that,T_{12} (RDF@75% + Azotobacter + PSB + KSB) was the best treatment for the plant height (cm), No. of leaves, No. of primary and secondary branches.Whereas, T_8 (RDF@75% + Azotobacter) is superior for leaf area (cm^2) and T_{11} (RDF@75% + Azotobacter + PSB) were best for the leaf area index and plant spread (cm).Therefore, it can be concluded that from the findings of the experiment, that plant treatment with T_{12} (RDF@75% + Azotobacter + PSB + KSB) andT_{11} (RDF@75% + Azotobacter + PSB) are best for the getting higher production in China aster under mid hills of Himalayas. Without causing pollution to the environment or soil, this study will decrease the need of inorganic fertilizers and directly increases the farmer's income.

Treatments	Plant Height at maturity (cm)	No. of Leaves Plant per plant	No. of Primary Branches Plant per plant	No. of Secondary Branches Plant per plant	Leaf Area Plant^{-1} (cm^2)	Leaf Area Index	Plant Spread (cm)
T_0	74.13	276.07	9.13	22.13	23.38	8.53	13.31
T_1	84.17	307.73	9.27	23.2	24.75	8.82	12.33
T_2	86.47	312.53	9.57	24.43	25.53	8.93	12.83
T_3	76	297.27	9.97	26.4	23.34	9.32	13.09
T_4	78.8	304.67	11.27	23.5	21.4	8.4	13
T_5	79.73	315.67	10.73	25	20.55	7.74	12.18
T_6	83.73	284.9	10.53	23.13	21.65	8.03	13.92
T_7	85	314.6	11.23	27	25.69	9.73	12.67
T_8	83.27	313.6	10.67	23.23	27.49	9.7	13.45
T_9	85.8	305.87	11.33	28.2	27.13	10.05	13.19
T_{10}	76.93	322.8	10.7	26.5	24.55	10.15	11.82
T_{11}	90.07	354.27	11.77	31.7	21.51	12.02	16.57
T_{12}	91.4	356.13	12.4	33.7	19.81	7.11	12.28
T_{13}	86	306.53	10.63	27.2	19.48	9.11	12.8
T_{14}	86.6	296.6	11.37	25	17.77	7.67	16.35
T_{15}	86.27	294.6	10.43	24.77	20.63	10.4	15.77
T_{16}	87	345.53	11.47	29.07	22.47	5.48	13.75
T_{17}	81.47	315.13	10.37	25.1	24.51	9.86	14.11
T_{18}	85.73	286.67	11.4	25.33	24.13	9.71	12.94
C.D. at 5 %	9.5	5.23	1.61	3.73	1.72	0.76	1.79

DATA AVAILABILITY STATEMENT

Data will be available in request

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