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EFFECT OF BORON AND MOLYBDENUM ON GROWTH, YIELD AND QUALITY OF CAULIFLOWER IN MID ALTITUDE CONDITION OF ARUNACHAL PRADESH

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Summary

The present study was carried out during Sep-Dec 2007 and 2008 at ICAR Research Complex for NEH Region AP centre, Basar Arunachal Pradesh to find out the optimum doses of boron and molybdenum for proper growth of cauliflower var. Snow Crown. It was found that both boron and molybdenum has profound effect on vegetative growth either applied individually or in combination. However, the plant height and more number of leaves per plant was highest with 2 kg soil application of ammonium molybdate + 3 kg soil application of borax + 0.3% each of foliar application of borax and ammonium molybdate over control. The same treatment recorded more curd weight, width, length and curd yield.

सारांश

पत्तागोभी की स्नो क्राउन प्रजाति पर बोरान एवं मालिब्डेनम की मात्रा के प्रभाव का अध्ययन किया गया। बोरान एवं मालिब्डेनम दोनों का अलग–अलग तथा साथ में गोभी की बढ़वार पर काफी प्रभाव पाया गया। 2 कि. प्रति हेटेयर मोलिब्डेनम, 3 कि. प्रति हे. बोरान मिट्टी में मिलाकर एवं 0.3% मोडिब्डेनम छिड़काव करने पर सबसे अच्छा प्रभाव पाया गया।

Introduction

Cauliflower is one of the important cole crop grown all over India. It is a high output crop and is an important constituent of intensive agriculture. Although agriculture is the main stay of rural economy, the state is technologically far behind than other parts of the country. With its congenial climate, the state offers great scope for cultivation of cole crops. There is a need to increase the productivity of cauliflower per unit area by judicious and balanced use of nutrients together with better management practices (Sarma *et al.* 2005). It is well known that micronutrients play a vital role in crop production. Among which, boron and molybdenum plays and important role in cauliflower curd production and in deficiency many problems (brown heart, whiptail, etc) occurs which ultimately affects the crop growth and yield. Application of micronutrients corrects nutritional disorders as well as improves the yield and quality of the produce (Kotur and Kumar, 1993). Besides it's proved that foliar feeding of nutrients is many a time more effective than soil application (Malewar, 2003). There is very little information about the dose of application of boron and molybdenum in mid altitude condition of Arunachal Pradesh. Therefore, the present study was carried out, to find out the optimum doses and method of application for proper growth of cauliflower var. Snow Crown.

Materials and Methods

A field trial was laid out at ICAR RC NEH Region, AP Centre, Basar, Arunachal Pradesh for consecutive two seasons during Sep-Dec 2007-08. Boron and molybdenum was applied either as soil treatment before transplanting or foliar spray (45 and 60 DAP) separately or combination of both. Borax and Ammonium molybdate were used as source of boron and molybdenum respectively. The experiment was laid out in randomized block design and replicated thrice. The treatment were as follows T_1- 0.3% foliar spray of borax; T_2- 0.3% foliar spray of ammonium molybdate; T_3- 6 kg soil application of borax; T_4- 2 kg soil application of ammonium molybdate; T_5- 0.3% borax + 0.3% ammonium molybdate foliar spray; T_6- 0.3% foliar spray + 6 kg soil application of borax; T_7- 0.3% foliar spray of borax + 2 kg soil application of ammonium molybdate T_8- 0.3% ammonium molybdate foliar spray + 6 kg soil application of borax; T_9- 0.3% ammonium molybdate foliar spray + 2 kg soil application of ammonium molybdate spray; T_{10}- 6 kg soil application of borax + 2 kg soil application of ammonium molybdate; T_{11}- 0.3% foliar spray of borax + 0.3% foliar spray of ammonium molybdate + 6 kg soil application of borax + 2 kg soil application of ammonium molybdate and T_{12}- Control (NPK application only).

A fertilizer dose of 100:80:80 kg N:P:K was applied

to each treatment with the plot size of 5x3 m. Plant spacing of 45x30 cm was maintained. 25 days old seedlings were transplanted into main field. All the scientific package of practices was followed uniformly to all the treatments. Growth parameters like plant height (cm), number of leaves/plant and stalk length were recorded after harvest. Yield parameters were also studied. For each replication, five plants were randomly tagged for different treatments in the middle rows, an average value of tagged plants for particular parameter was recorded. Statistical analysis was carried out to know the variance for different parameters using AGRES package.

Results and Discussion

Both borax and molybdenum has profound effect on growth and yield attributes of cauliflower irrespective of their method of application (Table 1). Combined application of fertilizers with both foliar and soil application (T_{11}) resulted into more plant height (41.3 cm) which is on par with T_{10} and T_8. Foliar spray (T_1 and T_2) either of fertilizers were superior than control and at par with each other. It was observed from the experiment that soil application of borax and molybdenum was beneficial than foliar spray. The result was dissonance with the findings of Sarma *et al*. (2005). Maximum .number of leaves per plant (18.3) was recorded with T_{11} while minimum plant height was recorded with control. The stalk length was more with T_{10} followed by T_{11} while control recorded minimum stalk length. This may be due to the fact that both boron and molybdenum helps in growth of meristmatic tissues growth which ultimately increases the vegetative growth. Soil application of borax recorded more plant height than foliar spray. The results of the present study were in line with the findings of Mishra (1992) and Sharma (1995).

The application of B and Mo showed significant variations in average curd weight of cauliflower. The effect was evident in combined application of two micronutrients. Other curd characters such as diameter, length and curd yield per plot and yield per hectare were significantly influenced by application of micronutrients. The highest curd weight was accounted by T_{11} while the control (T_{12}) recorded very low curd weight (548.4 g). It was further noticed that soil application improved the yield much more than foliar spray. The increase in curd weight and diameter by B may be due to its beneficial effect in enhancing the translocation of carbohydrates from the site of synthesis to the storage tissue in curd as reported by Shortriya and Martin Phillips (2002) and Varghese and Duraisamy (2004). The treatments exerted positive and significant effect on the curd yield. The yield of the crop increased linearly with an increase in curd weight. Response to B was more phenomenal than Mo. Combined spray of both nutrients in both the mode of application was more beneficial and maintained soil health. T_{11} (38.4%) recorded highest increase in yield over control followed by T_{10} (30.23%). T_8 and T_6

Table 1. Effect of Boron and Molybdenum on growth and yield attributes of cauliflower

Treatment	Plant height (cm)	No of leaves /plant	Stalk length (cm)	Curd weight (g)	Curd diameter (cm)	Curd length (cm)	Curd yield/plot (kg)	Yield (q/ha)	Yield increase over control (%)
T_1	35.8^{d}	14.5^{e}	5.9^{bc}	606.4^{ef}	15.2^{g}	8.12^{cd}	25.4^{fg}	189.3^{ef}	7.84
T_2	35.2^{d}	13.3^{f}	5.3^{cd}	576.6^{fg}	14.7^{gh}	7.73^{de}	24.2^{g}	181.2^{f}	3.23
T_3	36.3^{cd}	14.7^{e}	6.0^{bc}	612.0^{def}	15.3^{fg}	8.57^{bcd}	26.1^{ef}	194.0^{e}	10.53
T_4	35.6^{d}	13.6^{f}	5.6^{cd}	585.8^{efg}	14.9^{gh}	7.94^{cde}	24.2^{g}	187.4^{ef}	6.7
T_5	37.4^{bc}	15.2^{e}	6.3^{ab}	657.3^{cd}	16.5^{de}	8.66^{bcd}	27.6^{de}	204.6^{cd}	16.54
T_6	39.5^{ab}	16.3^{cd}	6.4^{ab}	710.9^{b}	17.1^{cd}	8.82^{abc}	29.5^{c}	211.6^{c}	23.42
T_7	39.2^{ab}	16.1^{d}	6.3^{ab}	703.4^{bc}	16.8^{de}	8.73^{abc}	28.9^{cd}	210.7^{c}	21.18
T_8	40.8^{a}	17.1^{bc}	6.8^{a}	740.7^{ab}	17.9^{bc}	8.86^{abc}	30.4^{bc}	223.5^{b}	26.94
T_9	36.1^{cd}	14.8^{e}	6.2^{ab}	628.5^{de}	16.1^{ef}	8.62^{bcd}	27.3^{de}	202.1^{d}	15.13
T_{10}	40.9^{a}	17.9^{ab}	6.8^{a}	765.2^{a}	18.2^{b}	8.94^{ab}	31.2^{b}	228.6^{b}	30.23
T_{11}	41.3^{a}	18.3^{a}	6.6^{ab}	773.8^{a}	19.4^{a}	9.25^{a}	34.8^{a}	242.9^{a}	38.34
T_{12}	33.6^{e}	12.8^{g}	5.1^{d}	548.4^{g}	13.8^{i}	7.58^{e}	21.2^{h}	165.5^{g}	-
CD (P=0.05)	2.79	0.80	0.56	50.21	0.88	0.99	1.63	7.28	

-In each column, means with similar alphabets do not vary significantly at P= 0.05

Table 2. Effect of Boron and Molybdenum on chemical and mineral content of cauliflower

Treatment	Ascorbic acid (mg/100g)	Crude protein (g/100g)	Dry matter content (%)	P (%)	K (%)	Ca (%)	Mg (%)
T_1	17.3^{f}	1.64^{e}	9.1^{de}	0.18^{bc}	2.21^{ef}	0.19^{g}	0.25
T_2	16.1^{g}	1.59^{f}	8.7^{ef}	0.17^{d}	2.20^{f}	0.26^{de}	0.26
T_3	18.2^{e}	1.64^{e}	9.2^{de}	0.18^{bc}	2.21^{ef}	0.23^{ef}	0.24
T_4	16.5^{g}	1.61^{ef}	8.7^{ef}	0.18^{bc}	2.19^{g}	0.27^{de}	0.25
T_5	23.7^{b}	2.03^{bcd}	9.5^{cd}	0.19^{cd}	2.23^{def}	0.27^{de}	0.26
T_6	19.6^{d}	1.75^{de}	9.9^{bc}	0.20^{b}	2.28^{cd}	0.32^{bc}	0.27
T_7	23.9^{ab}	2.06^{abc}	9.7^{bcd}	0.20^{b}	2.27^{de}	0.36^{ab}	0.26
T_8	22.4^{c}	1.83^{cde}	9.9^{bc}	0.21^{b}	2.34^{bc}	0.36^{ab}	0.26
T_9	18.7^{e}	1.68^{e}	8.8^{ef}	0.19^{b}	2.25^{def}	0.28^{cd}	0.25
T_{10}	24.0^{ab}	2.12^{ab}	10.2^{ab}	0.26^{a}	2.36^{b}	0.34^{ab}	0.28
T_{11}	24.3^{a}	2.18^{a}	10.5^{a}	0.26^{a}	2.47^{a}	0.35^{ab}	0.28
T_{12}	14.8^{h}	1.43^{g}	8.4^{g}	0.15^{e}	2.25^{def}	0.38^{a}	0.24
CD (P = 0.05)	0.53	0.45	0.24	0.03	0.06	0.05	NS

In each column, means with similar alphabets do not vary significantly at P = 0.05

followed those treatments while least increase was recorded with foliar spray of ammonium molybdate (3.23%) followed by soil application (6.7%). The increase in curd yield as a result of B application was supportive of the earlier findings of Batal *et al.* (1997). Mo plays a vital role in photosynthesis which decides the yield of crops as observed by Mishra (1992) and Malewar (2003).

Effect of various treatments on chemical characteristics and mineral content of cauliflower is depicted in table 2. All the treatments has significantly positive effect on the ascorbic acid content of cauliflower curd. Highest Vit. C was noticed with T_{11} (24.3 mg) followed by T_{10} and T_7 while low content of Vit. C was recorded with control (14.8 mg). An improvement in the ascorbic acid content through the application of B has been reported by Sharma (1995) and Varghese and Duraisamy (2004). Highest crude protein and dry matter content was also more with T_{11} followed by T_{10}. This may be attributed to the significant role of Mo in carbohydrate metabolism and that of B which helps in the translocation of sugars to the curd. Soil application of micronutrients enhanced more dry matter than foliar spray and combined application gave better result than individual application. The findings of this study were in line with Kotur (1993) and Singh (2003) who also reported the significant effect of boron on quality of cauliflower. There was significant change in mineral content of cauliflower with fertilizer application. Phosphorus content was more with T_{11} followed by T_{10}. The treatments like T_6, T_7, T_8 and T_9 were at par with each other while lower content was recorded with control. Potassium content was also more with T_{11}. It was observed that T_1 and T_3 were at par with each other and T_5 was at par with control on P content of cauliflower. T_6, T_8, T_{10} and T_{11} were at par with each other on their Calcium content. It was interested to note that control recorded more calcium than other treatments. Kumar and Kotur (1989) and Malewar (2003) have also reported the reduction in Ca content with Boron application while no such reduction was observed with molybdate application.

Table 3. Correlation studies on different growth and yield affecting parameters of okra plant

Parameters	No of leaves/ plant	Stalk length	Curd weight	Curd diameter	Curd length	Curd yield/ plot	Yield (q/ha)
Plant ht	0.98**	0.99**	0.94**	0.91**	0.89**	0.95**	0.95**
No of leaves/plant		0.84**	0.91**	0.87**	0.85**	0.93**	0.94**
Stalk length			0.82**	0.87**	0.88**	0.83**	0.82**
Curd weight				0.96**	0.95**	0.98**	0.97**
Curd diameter					0.92**	0.96**	0.96**
Curd length						0.97**	0.98**
Curd yield/plot							0.99**

** Significant at 1% level

Table 4. Economics of cultivation of cauliflower with different treatments

Treatment	Cost of cultivation (Rs.)	Gross return (Rs. 5/kg of produce)	Net return (Rs.)	Cost: Benefit ratio
T_1	17567	94665	77098	4.39
T_2	17836	90630	72794	4.08
T_3	17966	97030	79064	4.40
T_4	18045	93690	75645	4.19
T_5	18422	102295	83873	4.55
T_6	19565	105835	86270	4.40
T_7	18745	105370	86425	4.56
T_8	20868	111425	91957	4.41
T_9	18864	101065	82201	4.35
T_{10}	20971	114305	93634	4.46
T_{11}	21427	121430	100003	4.67
T_{12}	16858	82790	65932	3.91

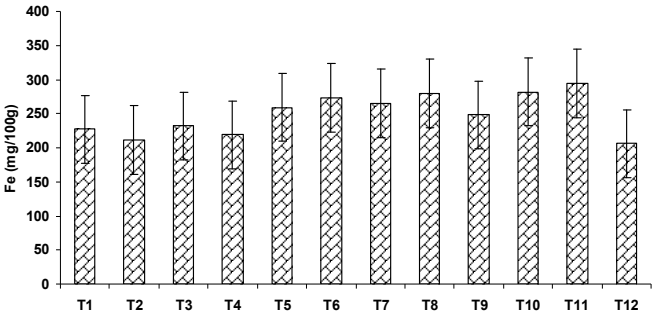

Fig 1. Effect of treatments on Iron content of cauliflower

The treatments effect on magnesium content of curd were statistically non significant. Iron content of cauliflower significantly varies with the treatments (Fig. 1). It was observed that T_{11} recorded more iron followed by T_{10} which is at par with T_8. T_2 and T_4 were at par with each other on their iron content. Singh and Dixit (1994) reported the increase in iron content with the application of boron which lend support to the present findings.

The relationships among different parameters are depicted in table 3. It was observed that plant height has highly significant positive effect on the other growth and yield parameters. Likewise all the other parameters significantly affect the yield of the crop. Leaf which was the photosynthetic organ of the plant has very high significant affect on the yield of cauliflower. Final yield has significantly positive relation with plant height, number of leaves, curd length and curd diameter. Similar relationship was recorded in bell pepper (Gaye *et al.*, 1993). Economics is another criterion which affects the output of the crop. It was noticed from the table 4 that the cost of cultivation increased significantly with the increase in application of external inputs. However the increase was nullified with the additional income generated through intensive cultivation. In addition it was observed that growing cost was more with soil application of fertilizers than foliar spray. It was concluded from the experiment that combined application of fertilizers with optimum dose was much more beneficial than single application of either of fertilizers. Soil applications of nutrients were better for crop growth and enrich the soil health.

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