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NUTRIENT MANAGEMENT IN CABBAGE FOR HIGHER PRODUCTION IN BUNDELKHAND REGION OF UTTAR PRADESH

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ABSTRACT

A field experiment was conducted at Research farm, Bundelkhand University, Jhansi (U.P.) to study the effect of inorganic (NPK) fertilizer and boron spray on cabbage (Brassica oleracea L. var. capitata) production and quality. Application of 180 kg N + 80 Kg P_2O_5 + 60 Kg K_2O ha^{-1} + 0.25% borax spray recorded significantly taller plants at all the stages of growth, greater number of leaves (open and folded) per cabbage head (28.6 and 60.9) ,head diameter (cross sectional and vertical) of cabbage (18.2 and 18.0) dry weight of cabbage per head (10.3%) fresh weight (2.6 kg). The crop responded significantly upto highest level of NPK (180 + kg N + 80 kg P_2O_5 + 60 kg K_2O ha-^{1}) + 0.25% borax spray and increased the head yield by 116.5 % over control. Boron spray (0.25%) proved superior to the control with respect to head yield of cabbage. The maximum protein content (1.7 %) and yield (162.4 q ha^{-1}) were recorded with 180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha-^{1} + 0.25% B spray.Maximum total soluble solid (6.8%) was also recorded under 180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha^{-1} + 0.25 foliar spray of borax. The lowest values of all the parameters were recorded under control.

Keywords: Nutrient, management, cabbage, quality, yield

INTRODUCTION

Cabbage (*Brassica oleracea* L. var. Capitata) is one of the most important cole crops of India. It is a good source of vitamin A, C and minerals like iodine, copper, potassium and sulphur etc. It is used in salad, cooked vegetable, curries pickles as well as dehydrated forms. Cabbage juice is used to be a remedy against poisonous mushrooms and is also used as a gargle against hoarseness. The leaves are used to cover wounds and ulcers and are also recommended against hangover (Chatterjee 1990).Nitrogen encourages the vegetative development of plants by imparting a healthy green colour to the leaves. It also controls to some extent the efficient utilization of phosphorus and potassium. Its deficiency retards growth and root development, turns the foliage yellowish or pale green, hastens maturity and causes lower crop yield. Phosphorus influences the vigour of plants and improves the quality of crops. It encourages the formation of new cells, promotes root growth and hastens leaf development, the emergence of buds and the formation of heads. Potassium enhances the ability of the plants to resist disease, insect attack and cold and other adverse conditions. It plays an essential part in the formation of starch and in the production and translocation of sugars.Modern agriculture over the years has resulted in greater depletion of boron (B) in soil, so its deficiencies have emerged as a serious obstacle in sustaining higher production f food as well as vegetable crops in all parts of the country. Boron is directly and indirectly involved with many plant metabolic functions. Boron acts as new cell developer in meristematic tissue, fruit and seed setting, is involved in the regulation of the carbohydrate metabolism and its transport within the plant, DNA synthesis in meristems, synthesis of amino acids and proteins and nitrogen fixing bacteria. Boron has marked effect on plant from the stand point of both nutrition as well as toxicity. The application of boron through different sources either through soil or foliar spray was found to be beneficial in stimulating plant growth and in increasing yield of crops. However; research on the performance of cabbage with nutrient management practices especially in Bundelkhand region of Uttar Pradesh is very meager. Keeping in view, an attempt was made to find out through field experiment the effect of integrated use of major (NPK) and micronutrient (B) on growth, yield and quality of cabbage.

MATERIALS AND METHODS

A field experiment was conducted at experimental farm, Institute of Agricultural Sciences, Bundelkhand University, Jhansi during rabi season of 2007-08. Bundelkhand region is located along the Vindhyan tract between 24° 26' N latitute, 78° 81' E longitude at 251m above mean sea level. The soil was clay loam in texture with alkaline in reaction (pH 7.5), organic carbon 3.7 g kg^{-1}, available N 160 kg ha^{-1}, available P 16 kg ha^{-1}, K 150 kg ha^{-1} and hot water

soluble boron 0.18 mg kg^{-1}. The experiment was conducted in a randomized block design replicated thrice. The treatments were: T_1, control, T_2, 0.25% boron spray, T_3, 150 kg N ha^{-1}, T_4, 150 kg N ha^{-1} + 0.25% boron spray, T_5, 150 kg N + 60 kg P_2O_5 ha^{-1}, T_6, 150 kg N + 60 kg P_2O_5 + 0.25% boron spray, T_7, 150 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}, T_8, 150 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} + 0.25% B spray, T_9, 180 kg N ha^{-1}, T_{10}, 180 kg N + 0.25% B spray, T_{11}, 180 kg N + 80 kg P_2O_5 ha^{-1}, T_{12}, 180 kg N + 80 kg P_2O_5 + 0.25% B spray.$T_{13,}$ 180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha-^{1} and $T_{14,}$ 180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha-^{1} + 0.25% B spray. The sources of N, P and K were urea, diammonium phosphate and muriate of potash, respectively. Half dose of N and full dose of P_2O_5 and K_2O were applied at the time of transplanting. Remaining dose of N was applied in two splits and boron was applied as foliar spray after 20 days of transplanting. Cabbage variety Golden Acre seedlings (25 days old) were transplanted on 15 November 2007. Rest of the management practices were in accordance with the recommended package of practices for the crop. The height of plant at one month interval was recorded. Number of leaves (open and folded), cross sectional area, vertical length, fresh weight of head and yield were recorded at maturity. Dry matter was determined by sun drying of head and then oven dried at 40° C till the constant weight. Finally the dry matter yield was calculated. Total soluble solids were determined with hand refractometer. Nitrogen content in head was determined by Kjeldahl method and protein content was obtained by multiplying N content with 6.25.

RESULTS AND DISCUSSION

Growth and Yield attributes

Plant height increased consistently with advanced age of the crop irrespective of various treatments. Application of 180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha^{-1} + 0.25% foliar spray of borax proved most effective in improving the plant height of cabbage at all the stages of growth followed by 180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha^{-1} + no borax. These treatments, being at par, proved significantly superior to most of the treatments in respect of plant height. The increase in plant height may be attributed to balanced supply of nutrients through chemical fertilizers resulting in higher plant canopy which in turn increased photosynthetic processes during development, Kumar and Choudhary (2002) and Kumar *et al.* (2013) reported similar results.The plants under control showed poorest height at all the stage of growth. Nitrogen was more effective in improving the plant height followed by P and K. Boron proved less effective in increasing the height of plants. Kumar and Singh (2009) and Kumar *et al.* (2013) reported similar results.

Table 1: Effect of various treatments on plant height (cm) of cabbage

Treatment	Days after planting			
	25	55	85	Harvest
T_1 Control	14.1	17.1	20.0	21.0
T_2 0.25% borax spray	14.4	17.5	20.4	21.5
T_3 150 kg N ha^{-1}	17.1	20.1	23.0	24.0
T_4 150 kg N + 0.25% B spray	17.4	20.4	23.3	24.4
T_5 150 kg N + 60 kg P_2O_5 ha^{-1}	18.2	21.4	24.4	25.7
T_6 150kg N + 60kg P_2O_5 + 0.25% B stray	19.0	21.7	24.7	25.9
T_7 150 kg N + 60kg P_2O_5 + 40kg K_2O ha^{-1}	20.0	22.0	25.1	26.3
T_8 150kg N+60kg P_2O_5 +40kg K_2O ha^{-1} +0.25% B spray	20.4	22.4	25.4	26.7
T_9 180 kg N ha^{-1}	21.0	24.0	27.0	27.7
T_{10} 180 kg N ha^{-1} + 0.25% B spray	21.2	24.4	27.4	27.9
T_{11} 180 kg N + 80 kg P_2O_5 ha^{-1}	22.0	25.1	28.4	28.0
T_{12} 180kg N + 80kg P_2O_5 + 0.25% B spray	22.3	25.4	28.9	29.3
T_{13} 180 kg N + 80kg P_2O_5 + 60 kg K_2O ha^{-1}	23.0	26.0	29.9	30.0
T_{14} 180 kg N + 80kg P_2O_5 + 60 kg P_2O_5 + 0.25% B spray	23.2	26.4	30.0	30.3
CD (P=0.05)	1.02	1.21	1.41	1.49

The number of leaves per plant is one of the most important parameter in cabbage as it is the leaves, which are consumed in one or the other form. The number of leaves, both open and folded, were produced maximum with180 kg N + 80 Kg P_2O_5 + 60 kg K_2O ha^{-1} + 0.25% foliar application of borax. The lowest numbers of leaves were produced in control. Thus, it is clear from the results that the maximum numbers of leaves were produced with combined use of nutrients (Panday *et al.*, 2007). The degree of

boron response on number of leaves was quite low as reported by Kumar *et al.* (2013) in cauliflower. Boron is associated with the rate of water absorbance and translocation of sugar in plant. Hence, the increase in number of leaves per head (Kumar *et al.* 2013). The size of heads, as noted by cross sectional and vertical length, increased significantly by most of the treatments over control. The most effective treatment in producing heads of greater size was180 kg N + 80 kg P_2O_5 + 60 kg K_2O ha + 0.25% B spray. The plants under control exhibited smallest and lightest heads. Beneficial effect of N, P and K was reported by Singh et al. (2010) and Singh et al. (2011) in cauliflower and cabbage, respectively but when N was applied with P and K, there was a significant improvement in size of cabbage heads (Singh et al. 2011). Foliar application of boron also improved the size of heads as compared to control but the magnitude of improvement was of low order. The crop grown with higher doses of N (180 kg ha^{-1}) and P_2O_5 (80 kg ha^{-1}) with and without K_2O and borax produced significantly higher fresh weight and proved significantly superior to control. However, the magnitude of response to boron was lower than those of N, P and K.The highest percentage of dry matter (10.3) was recorded with 180 kg N + 80 kg P_2O_5 + 60 kg K_2O + 0.25% B spray followed by 180 kg N + 80 kg P_2O_5 + 60 kg K2O and no B spray. Boron spray alone did not improve dry matter accumumilation significantly over control but rest of the treatments proved significantly superior to control. The probable reason for improving growth and yield parameters with the use of NPK + 0.25% boron spray could be due to increased availability of nutrients to plants, resulting better growth (Kumar *et al.* 2013).

Yield

The yield of cabbage heads improved significantly by most of the treatments over control.The head yield of cabbage ranged from 75.0 to 16204 q ha^{-1}. Among the treatments, 180 kg N + 80 kg P_2O_5 + 60 kg K_2O + 0.25% B spray proved most effective in improving the head yield of cabbage (Table 2). The increase in head yield due to this treatment was 116.5% over control. Higher productivity of vegetable crops as a result of integrated use of major nutrients and boron could be explained on the grounds that addition of NPK in balanced and adequate amounts increased nutrient uptake which leads higher yield of cabbage heads (Parmar, 2014). Integration of NPK and B could therefore be considered as a better option in increasing fertilizer use efficieny and providing a more balanced supply of nutrients.The lower yield of cabbage heads was recorded under control.

Table 2: Effect of various treatments on growth, quality and yield of cabbage

Treatment	Open leaves/plant	Folded leaves/plant	Cross sectional diameter (cm)	Vertical length (cm)	Fresh wt. (kg)	Dry wt. %	Protein (%)	TSS (%)	Yield (q/ha^{-1})
T_1	16.0	48.0	12.9	12.2	1.2	6.7	1.2	4.8	75.0
T_2	16.3	48.2	13.3	13.0	1.3	7.1	1.2	5.3	81.2
T_3	19.0	52.7	15.0	14.6	1.4	7.7	1.3	5.4	90.6
T_4	19.6	53.0	15.3	14.8	1.6	7.9	1.3	5.5	100.0
T_5	21.0	53.3	15.5	15.2	1.7	8.0	1.3	5.6	109.3
T_6	22.0	54.0	15.6	15.3	1.9	8.3	1.5	5.8	118.7
T_7	23.6	54.5	16.0	15.4	2.0	8.7	1.5	5.9	125.0
T_8	24.0	55.3	16.2	16.0	2.1	9.0	1.5	6.1	129.1
T_9	24.6	56.7	16.3	16.2	2.1	7.7	1.6	6.3	134.3
T_{10}	25.0	58.0	16.6	16.5	2.2	7.9	1.6	6.4	137.5
T_{11}	26.0	59.0	16.7	16.6	2.3	9.5	1.6	6.6	143.7
T_{12}	26.3	59.0	17.3	17.2	2.3	9.6	1.6	6.6	146.8
T_{13}	17.0	60.0	17.7	17.5	2.4	10.0	1.7	6.8	153.1
T_{14}	28.6	60.9	18.2	18.0	2.6	10.3	1.7	6.8	162.4
CD (P=0.05)	2.08	1.08	1.26	1.76	0.27	0.78	0.35	0.62	17.96

Quality

Data (Table 2) indicated that application of NPK levels improved the protein percentage in cabbage head significantly over control. The maximum protein percentage in cabbage heads was noticed with 180 kg N + 80 kg P_2O_5 + 60 kg K_2O + 0.25% B spray and lowest in control. Foliar application of B also improved the protein percentage over control.The maximum percentage of TSS (6.83%) was recorded with 180 kg N + 80 kg P_2O_5 + 60 kg K_2O + 0.25% B sprays. However, the lowest value (4.80%) was recorded under control. Improvement in quality parameters such as protein and TSS due to integrated use of major (NPK) and B could be attributed to synthesis of amino acids, which might have collectively lead to improvement in

quality parameters. Similar observations have also been reported by Varghese and Duraisama (2005).

It is concluded from the results that application of higher level of NPK alongwith 0.25% boron spray proved to be playing a synergistic role in sustaining the productivity of cabbage. This is reflected in terms of enhancement of biometric characters, yield and quality of cabbage heads. Hence, application of magor nutrients along with boron would likely to improve the yield and quality of cabbage.

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