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Article

Effect of different fertilization practices on the growth and yield of cabbage

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Abstract: The field experiment was conducted at the farmer's field of Sutiakhali, a village near the BAU, Mymensingh to investigate effect of integrated nutrient management on yield of cabbage and soil fertility during the period from 5th November 2013 to February2014. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications and five treatments levels viz. T_1: Recommended Dose (RD, $N_{150}P_{53}K_{50}S_{30}Zn_{1.5}Bo_{.7}Mo_{0.5}$) T_2: Soil Test Base (STB, $N_{178}P_{65}K_{51}S_{27}Zn_{1.5}B_{0.7}Mo_{0.5}$) T_3: Integrated Plant Nutrition System (IPNS, $N_{158}P_{59}K_{42}S_{24}Zn_{1.5}B_{0.7}Mo_{0.5}$) + Cow dung (CD) @ 5.0 tha^{-1}, T_4: Farmer's Practice (FP, $N_{65}P_{42}K_{71}S_6$) T_5: Control (no fertilizer). The Integrated Plant Nutrition System showed significant positive effect on the yield and yield components of cabbage cv. Atlas-70. The results of the present study showed that cow-dung with inorganic fertilizers have significant variation on all the parameters except number of loose leaves. The highest values for plant height (25.88cm), number of folded leaves per head (42.50), length of the biggest leaf (34.77cm), length of the lateral root (31.92 cm), length of stem (6.83cm) were recorded in T_3 treatments, on the other hand the highest values in case of number of loose leaves at the treatment of T5 (control). The yield of cabbage crop has increased significantly with application of inorganic fertilizer in combination of cow dung over the control. The highest values for fresh weight of cabbage was 89.16 t ha^{-1}, dry matter content of head (5.93%), dry matter content of loose leaves (9.72%), were recorded at T_3 treatments by the application of inorganic fertilizer ($N_{158}P_{59}K_{42}S_{24}Zn_{1.5}B_{0.7}Mo_{0.5}$) in combination with cow dung @ 5.0 tha^{-1}. The above results indicated that the integrated nutrient management had a remarkable effect in promoting soil fertility and increasing yield and yield components of cabbage.

Keywords: effect; fertilization practices; growth; yield; cabbage

1. Introduction

Cabbage (*Brassica oleracea var. capitata*L.) is a popular green leafy vegetable of the family Brassicaceae. It is a herbaceous, biennial, dicotyledonous flowering plant distinguished by a short stem upon which is crown with a mass of leaves, usually green but in some varieties red or purplish, which while immature form a characteristic compact, globular cluster (cabbage head). The only part of the plant that is normally eaten is the leafy head; more precisely, the spherical cluster of immature leaves, excluding the partially unfolded outer leaves. Cabbage is used in a variety of dishes for its naturally spicy flavor. In addition to, cabbage supplies B vitamins, potassium and calcium to the diet. 250 mL of raw cabbage contains 21 kilocalories and cooked 58 kilocalories (Haque 2006).

Among the vegetables grown in Bangladesh, cabbage is the most popular one. It ranks second in respect of production and area. In recent year, production of cabbage is increasing in Bangladesh. On the other hand, Bhuiyan *et al.* 1991 reported that cabbage was cultivated in an area of 11,000 hectares with a total production

of 1, 13,000 tones. At present it is being cultivated in an area of 11.74 thousand hectares with a production of 115 thousand metric tons (BBS, 2001). But the yield of cabbage is very low in Bangladesh (9.79 t ha-^{1}, BBS 2001) compared to that of other developed countries (30-70 t ha^{-1}) of the world (FAO, 1999).

Cabbage is generally grown in Rabi season. Growth and yield of cabbage is remarkably influenced by organic and inorganic nutrients. It is an established fact that use of inorganic fertilizer for the crops is not so good for health because of residual effect but in the case of organic fertilizer such problem does not arise. On the other hand, it increases the productivity of soil as well as crop quality and yield (Tindall 2000). Nutrients may be applied both from organic and inorganic sources. Increased use of chemical fertilizer in crop field creates problems to the environment by polluting water, air and soil. The continuous use of chemical fertilizers also badly affects the soil texture and structure, decreases organic matter content of soil, and hampers soil microbial activity. The use of organic manures improve texture, structure, color, aeration, water holding capacity and microbial activity of the soil. Soils of Bangladesh contain less than 2% organic matter in most of the regions (BARC, 2005). In Bangladesh, the use of chemical fertilizers as a supplemental source of nutrients has been increasing steadily, however they are not usually applied in balanced proportions (Ferdous *et. al.*, 2011). Hence, a pragmatic step needs to be taken for balanced application of fertilizer with the limiting nutrient elements wherever necessary. The conjunctive use of organic and inorganic sources will improve soil health and helps in maximizing production as it involves utilization of local sources and hence, turned to be rational, realistic and economically viable way of supply of nutrients to crop. As nutrients are the major contributing factors their appropriate management practices is essential to achieve the optimum yield of cabbage. A large number of research works have been conducted in the past on the effect of different fertilizer management practices on growth and yield of cabbage.

2. Materials and Methods

The research work was conducted at the farmer's field of Sutiakhali, a village near the BAU, Mymensingh (AEZ 9). The experimental site is situated at 24°N latitude and 91^{0}E longitude having an altitude of 8.3m. The climate of the experimental site is subtropical in nature, which is characterized by three distinct seasons, the monsoon extending from May to October, the winter or dry season from November to February and pre-monsoon period hot season from March to April. The soil texture of the experimental site was silty loam, land was medium high and belongs to the Agro-Ecological Zone-9 (AEZ-9). The test crop was Cabbage (Atlas 70).Date of transplanting was 5th November, 2013 and date of harvesting was 20 January, 2014. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Five treatments including a control were assigned randomly to the unit plot of 4.5 m x 3.15 m in size. The total experimental area was 25.5 m ^{x} 11.45m and was divided into three blocks. Each block consisted of 5 unit plots. Thus the total number of unit plots was 15, plant spacing in unit plot was 60 cm ^{x} 45 cm and thus each unit plot accommodated 42 Nos.

Treatments of the experiment:

T_1	Recommended Dose (RD, $N_{150}\,P_{53}\,K_{50}\,S_{30}\,Zn_{1.5}\,Bo_{.7}\,Mo_{0.5)}$
T_2	Soil Test Base (STB, $N_{178}\,P_{65}\,K_{51}\,S_{27}\,Zn_{1.5}\,B_{0.7}\,Mo_{0.5)}$
T_3	Integrated Plant Nutrition System (IPNS, $N_{158}\,P_{59}\,K_{42}\,S_{24}\,Zn_{1.5}\,B_{0.7}\,Mo_{0.5}$) + Cow dung(CD)@5.0tha
T_4	Farmer's Practice (FP, $N_{65}P_{42}K_{71}S_6$)
T_5	Control (no fertilizer)

Physical and chemical characteristics of the experimental field soil:

Characteristics	Value
1. Particle size distribution	
a. % Sand (2-0.05 mm)	27.06
b. % Silt (0.05 -0.002mm)	63.4
c. % Clay (<0.002mm)	9.54
2. Textural class	silt
3. pH	6.53
4. Organic matter (%)	1.35
5. Total nitrogen (%)	0 .097
6. Available phosphorus (µg g^{-1})	6.00
7. Available potassium (meq 100 g^{-1})	0.097
8. Available sulphur (µg g^{-1})	9.3
9. Available zinc (µg g^{-1})	0.41
10. Available boron (µg g^{-1})	0.17

3. Results

The research work was done to investigate different fertilization practice on the growth and yield of cabbage. The analyses of variance (ANOVA) of the data on different yield contributing characters and yield have been shown in table 1. The results of the study have been presented in this section.

Plant height is one of the important growth contributing characters for cabbage plant. The plant height of cabbage at harvest was significantly influenced by different sources of nutrients (Table 1). The highest plant height (25.88 cm) was found in the treatment T_3 (IPNS, $N_{158}P_{59}K_{42}S_{24}Zn_{1.5}B_{0.7}Mo_{0.5}$ + cow dung @ 5.0 tha^{-1}). The second highest plant height (25 cm) was found in the treatment T_1 (RD, $N_{150}P_{53}K_{50}S_{30}Zn_{1.5}Bo_{.7}Mo_{0.5}$). The lowest plant height (23.16 cm) was found in the treatment T_5 (control). The number of loose leaves per plant at 75 days after transplanting varied from 36.40 to 42.50. The highest number of loose leaves (42.50) was produced in T_5 (control) followed by T_1 ($N_{150}P_{53}K_{50}S_{30}Zn_{1.5}Bo_{.7}Mo_{0.5}$) and T_2 (STB) which were statistically similar with treatment T_4 (FP, $N_{65}P_{42}K_{71}S_6$). The lowest number of loose leaves (36.40) per plant was found in treatment T_3 (IPNS, $N_{158}P_{59}K_{42}S_{24}Zn_{1.5}B_{0.7}Mo_{0.5}$ + cow dung @ 5.0 t ha^{-1}) which was statistically identical with treatment T_2, (STB). Number of folded leaves of cabbage varied significantly with the different sources of nutrients (Table 1). The highest number of folded leaves (30.97) was recorded in the treatment T_3 (IPNS, $N_{158}P_{59}K_{42}S_{24}Zn_{1.5}B_{0.7}Mo_{0.5}$ + cow dung @ 5.0 tha^{-1}) followed by the treatment, T_2, T_1, T_4. The lowest number of folded leaves (23.70) was recorded from the treatment T_5 (control). As outer leaves of cabbage mainly take part in photosynthesis, their number as well as fresh weight of head per plant is the most important physio-morphological character, which has a great contribution on cabbage yield. Fresh weight of cabbage per plant as influenced by different sources of nutrients was found significant. The highest fresh weight 89.16 tha^{-1} was recorded from the treatment T_3 (IPNS, $N_{158}\ P_{59}\ K_{42}\ S_{24}\ Zn_{1.5}\ B_{0.7}\ Mo_{0.5}$) + Cow dung @ 5.0 tha^{-1}) which was statistically identical with T_2 treatment. The lowest fresh weight 39.24 tha^{-1} was recorded in control T_5 (Fig. 4.1). The fresh weight of cabbage due to different treatments ranked in the order of $T_3 > T_2 > T_1 > T_4 > T_5$.

Table 1. Effect of different treatments on cabbage (cv. Atlas-70).

Treatments	PH	LL	FL	BL	DM	DMH	LLR	LS	FW
T_1	25.00ab	39.13b	29.43 a	32.33ab	9.26b	5.47c	28.41b	6.303b	73.44b
T_2	24.75b	37.87bc	29.57a	31.67ab	9.22b	5.79b	27.29b	6.213b	84.13ab
T_3	25.88a	36.40c	30.97a	34.77a	9.72a	5.93a	31.92a	6.827a	89.16a
T_4	24.10bc	37.37bc	29.17a	31.40ab	8.85c	5.52c	27.10bc	6.140b	57.72c
T_5	23.16c	42.50a	23.70b	29.13b	8.65d	5.23d	24.60c	5.703c	39.24d
SE (±)	0.29	0.70	1.13	1.01	0.05	0.03	0.77	0.075	4.2
Level of sig.	**	**	*	*	**	**	**	**	**
CV (%)	2.06	3.13	6.83	5.47	0.93	0.99	4.80	2.09	12.4

Here, PH= Plant Height (cm), LL= Number of loose leaves, FL= Number of Folded Leaves, BL= Length of Biggest Leaf (cm), DM= Dry Matter Content (%), DMH= Dry Matter Content of Head (%), LLR= Length of Lateral Root (cm), LS= Length of Stem (cm), FW= Fresh Weight (t ha^{-1})

** =Significant at 1% level of probability, * =Significant at 5% level of probability

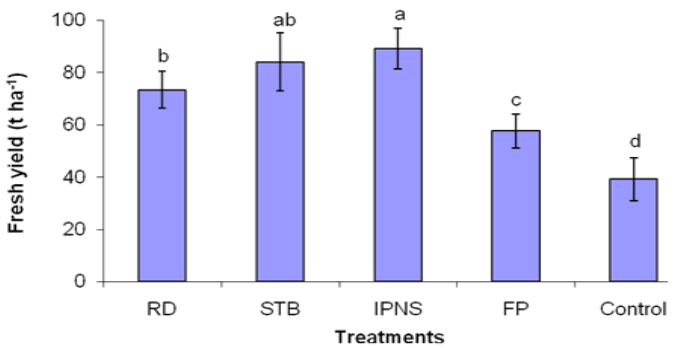

Figure 1. Fresh weight (t ha^{-1}) of cabbage as per different treatments.

4. Discussion

Cabbage (*Brassica oleracea* L.) is a leafy green or purple biennial plant, grown as an annual vegetable crop for its dense-leaved heads. Plants perform best when grown in well-drained soil in a location that receives full sun. Different varieties prefer different soil types, ranging from lighter sand to heavier clay, but all prefer fertile ground with a pH between 6.0 and 6.8. Growth of cabbage and leafy green roots is influenced (and in many cases is limited) by the soil profile. Hard pans, clay pans and generally compacted soil restrict root growth. This, in turn, reduces nutrient and water uptake, limits plant growth and reduces yields. Although cabbage and leafy greens are shallow rooted, under favorable conditions and in properly prepared soil, roots will grow to a depth of 18 to 24 inches. The highest values for plant height (25.88 cm), Number of folded leaves per head (42.50), Fresh weight of cabbage leaves at harvest (930.50 g), were recorded in integrated plant nutrition System. This might be due to the fact that organic manures (cowdung) and inorganic fertilizers supplied adequate available plant nutrients for proper vegetative growth of cabbage plants, which ultimately influenced the plant height. Azad (2000) observed similar results. The highest values for yield of cabbage at the treatment of T_3, Number of folded leaves per head (42.50), Fresh weight of cabbage (89.16 t ha^{-1}) at harvest. This might be due to the fact that organic manures (cow-dung) and inorganic fertilizers supplied adequate available plant nutrients for proper vegetative growth of cabbage plants, which ultimately influenced the yield of cabbage. Hasan and Solaiman (2012) carried out a field experiment to evaluate the performance of fertilizers (organic) on the growth of cabbage. Vimala *et al*. (2006) carried out an experiment in Serdang, Malaysia to study the growth,yield and nutrient content of cabbage, and found a quadratic yield response to organic fertilizer rates and observed similar findings with this research. As nutrients are the major contributing factors, the appropriate management practices are essential to achieve the optimum yield of cabbage Sekender (2007). However, the conjunctive use of organic and inorganic sources will improve soil health and helps in maximizing production.

5. Conclusions

Cabbage is a tasty cool weather crop, easy to grow and delicious to eat. The yield of the Cabbage (Atlas-70) increased significantly due to integrated use of chemical fertilizer and organic manure in the farmers' field under AEZ 9. Use of cow dung may reduce the use of chemical fertilizer from the conventional recommendation. Integrated Plant Nutrition System (IPNS, $N_{158}P_{59}K_{42}S_{24}Zn_{1.5}B_{0.7}Mo_{0.5}$) along with cow dung (CD) @5.0 tha^{-1} appeared as the best suited combination providing higher yield and economic return.

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Conflict of interest

None to declare.

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