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Effect of Different Level of NPK and Boron on Soil Health Growth and Yield of Cabbage (*Brassica olerasia* L.) var. Pusa Hybrid-1

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ABSTRACT: The study on effect of different level of NPK and Boron on soil health, growth and yield of Cabbage (*Brassica olerasia* L.) Pusa hybrid-1 was carried out at the research farm of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj during the season of Rabi 2020-21. The soil of the experimental area was sandy loam in texture. The experiment was laid out in randomized block design with three levels of N P and K (0%, 50% and 100%) and three levels of Boron (0%, 50% and 100%). The experimental results revealed that significantly maximum growth parameters like plant height (24.1 cm), head weight (830 g) and head yield (40.05t ha^{-1}) were noticed under T_9 (@100 % NPK + 100 % B) as compared to rest of the treatments and lowest under T_1 (Control). The result shows that pH (7.27), EC (0.28 dSm^{-1}), Bulk density (Mg m^{-3}), Particle density (Mg m^{-3}), Water holding capacity (39.29 %), Pore space (55.32 %), Organic carbon (%), available Nitrogen (275.45 kg ha^{-1}), phosphorus (32.41 kg ha^{-1}), potassium (228.54 kg ha^{-1}) and Boron (1.58 kg ha^{-1}) on the soil showed significant effect with T_9-[@100 % NPK + @ 100% B]. Maximum gross return (Rs. 166000.0), net return (Rs. 118137.38) and B:C ratio (1:3.46) were also recorded with the treatment.

Keywords: Soil Properties, Boron, N P K and Cabbage.

INTRODUCTION

Cabbage (*Brassica oleracea* var *capitata*) is a small, leafy biennial producing a compact globular mass of smooth or crinkled leaves wrapped over each other known as head. The outer leaves are generally larger than the inner. The stem is short and stout. Plants flower generally after winter. Leaves are low in calories (27 per cent), fat (0.1 per cent) and carbohydrates (4.6 per cent). It is good sources of protein (1.3 per cent) which contains all essential amino acids, particularly sulphur containing amino acids. Cabbage is an excellent source of minerals such as calcium (39 mg), iron (0.8 mg), magnesium (10 mg), sodium (14.1 mg), potassium (114 mg) and phosphorus (44 mg). It has substantial amounts of β carotene provitamin A), ascorbic acid, riboflavin, niacin and thiamine. Ascorbic acid content varies from 30-65 mg per 100 g fresh weight. Flavour in cabbage leaves is due to the glycoside sinigrin. Cabbage contains goitrogens which cause enlargement of thyroid glands USDA (2012).

Worldwide 71,803,269 tonnes of Cabbage are produced per year. China is the largest Cabbage producer in the world with 33,881,515 tonnes production volume per year. India comes second with 8,755,000 tonnes yearly production. China and India produce together 59% of World's total. In India West Bengal (2288.50 tonnes) is highest Cabbage producing state followed by Orissa (1058.78 tonnes) and Madhya Pradesh (686.91 tonnes) per year. Uttar Pradesh produces (302.97 tonnes) every year (APEDA Agri Exchange 2021).

MATERIALS AND METHODS

An experiment was carried out at SHUATS' Soil Science Research Farm, Allahabad (Prayagraj), which is located at 25°4′30″N latitude, 81°51′10″E longitude and 98 metres above sea level (MSL) and is situated 6 km away on the right bank of Yamuna River, representing the Agro-Ecological Sub Region [North Alluvium plain zone (0-1% slope)] and Agro-Climatic Zone (Upper Gangetic Plain Region). Allahabad has sub-tropical climate with extremes of summer and winter. Temperatures in the winter, particularly in December and January, can plummet to as low as 3-5°C, while in the summer (May-June), temperatures can reach 45-48°C. During the summer, scorching winds are a common occurrence, but frost may occur on occasion during the winter. The yearly rainfall is between 850 and 1100 mm, with most of it falling

during the monsoon season (July to September), with a few showers thrown in throughout the winter months.

Soil: Soil samples were taken at random depths of 0-15 cm from the experimental plot after the crop was harvested using a soil auger and khurpi. With the use of a mallet, these soil samples were ground and blended. To prepare the sample for mechanical, physical, and chemical analysis, the volume of the soil sample was reduced by conning and quartering and then passed through a 2 mm sieve.

A. Experimental Design and Treatments

The experiment was laid out in 1 × 1 randomized block design with three different levels of NPK@ 0, 50 and 100% ha^{-1} and three different levels of B @ 0, 50 and 100% ha^{-1}. Treatment were T_1-[control], T_2-[@ N_0 P_0 K_0 kg ha^{-1} + B @2 kg ha^{-1}] , T_3-[@ N_0 P_0 K_0 kg ha^{-1} + B @ 4 kg ha^{-1}], T_4-[@ N_{100} $P_{62.5}$ K_{75} kg ha^{-1} + B @ 0 kg ha^{-1}], T_5-[@ N_{100} $P_{62.5}$ K_{75} kg ha^{-1} + B @ 2 kg ha^{-1}], T_6 [-@N_{100} $P_{62.5}$ K_{75} kg ha^{-1} + B @ 4 kg ha^{-1}], T_7-[@N_{200} P_{125} K_{150} kg ha^{-1} + B @ 0 kg ha^{-1}], T_8-[@N_{100} $P_{62.5}$ K_{75} kg ha^{-1} + B @ 2 kg ha^{-1}], T_9-@N_{100} $P_{62.5}$ K_{75} kg ha^{-1} + B @ 4 kg ha^{-1}]. Nitrogen was applied in two split doses. The source of NPK and B were urea, DAP, MOP and B respectively Fisher, (1960).

RESULT AND DISCUSSION

As depicted in Table 1 and Fig. 1 maximum bulk density (Mg m^{-3}) and particle density (Mg m^{-3}) of soil at were found in treatment T_9 which was 1.46 Mg $m^{-3}$and 2.8Mg m^{-3} while the minimum values of the result were found in treatment T_1 (control) which was 1.22 Mg m^{-3} 2.31 Mg m^{-3} respectively. Depicted that the mean value of bulk density and particle density of soil (Mg m^{-3}) was found non significant different. It was also observed the bulk density of soil was gradually increased with an increase in dose of N P K and B. As depicted in the Table 2 and Fig. 2 the maximum pore space (%) and water holding capacity of soil at were found in treatment T_9 which was 55.32 % and 39.29 % while the minimum values of the result were found in treatment T_1 (control) which was 65.74 % and 30.31 %respectively. Similar result has been recorded by Yadav *et al.*, (2012).

Table 1: Effects of NPK and B on Physical Properties of Soil in Cabbage.

Treatment	Bd (Mg m^{-3})	Pd (Mg m^{-3})	Pore space (%)	WHC (%)
T_1	1.22	2.31	55.32	30.31
T_2	1.24	2.36	56.75	31.12
T_3	1.25	2.39	57.2	31.88
T_4	1.29	2.42	58.46	33.17
T_5	1.31	2.47	60.02	34.22
T_6	1.36	2.51	61.84	34.79
T_7	1.38	2.62	63.57	35.12
T_8	1.41	2.65	64.86	37.2
T_9	1.46	2.8	65.74	39.29
F test	NS	NS	NS	NS
SEd (±)	0.93	1.77	42.77	24.18
C.D.	1.99	3.77	91.05	51.48

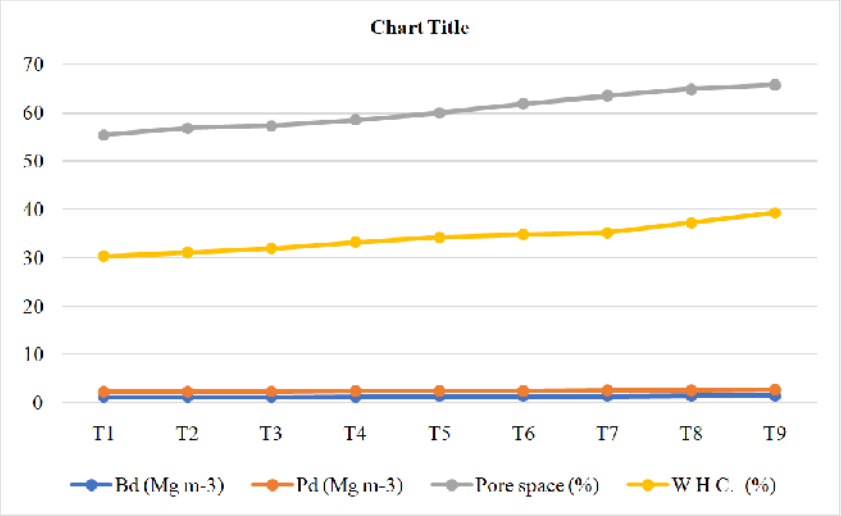

Fig. 1. Effects of NPK and B on Physical Properties of Soil in Cabbage.

Table 2: Effects of NPK and B on Chemical Properties of Soil in Cabbage.

Treatment	pH	EC (dS m^{-1})	Organic carbon	N (Kg ha^{-1})	P_2O_5 (Kg ha^{-1})	K_2O (Kg ha^{-1})	B (Kg ha-1)
T_1	6.74	0.17	0.58	175.16	21.58	190.23	0.3
T_2	6.8	0.19	0.59	184.78	22.25	203.52	0.38
T_3	6.89	0.23	0.63	194.74	23.94	209.47	1.12
T_4	6.95	0.21	0.69	202.47	25.57	210.92	0.57
T_5	7.07	0.22	0.71	212.94	27.16	212.63	0.83
T_6	7.11	0.23	0.73	217.45	28.52	214.47	1.35
T_7	7.16	0.25	0.75	252.45	29.14	220.14	0.89
T_8	7.22	0.27	0.78	268.19	30.47	223.65	0.97
T_9	7.27	0.28	0.79	275.45	32.41	228.54	1.58
F test	NS	NS	NS	NS	NS	NS	NS
SEd(±)	4.96	0.16	0.49	157.373	90.059	150.47	0.674
C.D.	10.57	0.34	1.049	334.77	40.57	320.327	1.445

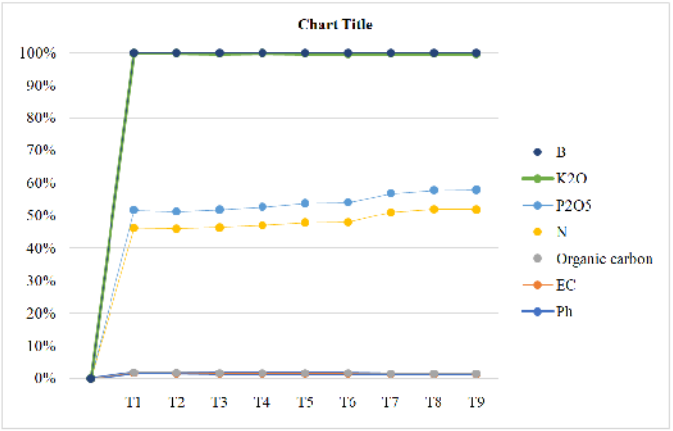

Fig. 2. Effects of NPK and B on Chemical Properties of Soil in Cabbage.

The maximum pH (1:2) w/v of soil at were found in treatment T_9 which was 7.27 while the minimum values of the result were found in treatment T_1 (control) which was 6.74 respectively. Application of nitrogen (N) fertilizer is one of the most important approaches on improving soil physical-chemical characters. Similar result has been recorded by Narsimha *et al.*, (2013). The maximum electrical conductivity (dSm^{-1}) of soil at were found in treatment T_9 which was 0.28 dSm^{-1} while the minimum values of the result were found in treatment T_1 (control) which was 0.16 dSm^{-1} respectively, that the mean value of soil EC (dSm^{-1}) of soil was found non-significant of different levels of N P K and B. It was also observed the soil EC of soil were gradually increased with an increase dose of N P K and B. Similar result has been recorded by Narsimha *et al.*, (2013). The maximum organic carbon (%) of soil at were found in treatment T_9 which was 0.79 % while the minimum values of the result were found in treatment T_1 (control) which was 0.58 % respectively. Depicted that the mean value of organic carbon (%) of soil was found significant of different levels of N P K and B. It was also observed the organic carbon (%) of soil were gradually increased with an increase dose of N P K and B. The interaction effect N P K and Boron on organic carbon (%) of soil was also found significantly. Similar result has been recorded by Singh *et al.*, (2015). The maximum available nitrogen (kg ha^{-1}) of soil at were found in treatment T_9 which was 275.45 kg ha^{-1} while the minimum values of the result were found in treatment T_1 (control) which was 175.16 kg ha^{-1} respectively. Same result also found by Sundaresh *et al.*, (2019). The maximum soil available phosphorus (kg ha^{-1}) of soil at were found in treatment T_9 which was 32.41 kg ha^{-1} while the minimum values of the result were found in treatment T_1 (control) which was 21.58 kg ha^{-1} respectively. The statistical analysis of soil available phosphorus (kg ha^{-1}) data indicates that there was a significant difference in soil available phosphorus (kg ha^{-1}) interaction between N P K and B. Same result also found by Bansal *et al.*, (2020). The maximum available potassium (kg ha^{-1}) of soil at were found in treatment T_9 which was 228.54 kg ha^{-1} while the minimum values of the result were found in treatment T_1 (control) which was 190.23 kg ha^{-1} respectively. Depicted that the mean value of available potassium (kg ha^{-1}) was found significant different. The trend of available N P K and B were also same as to that of uptake pattern due to the enhanced levels of nutrients at post-harvest soil. Same result also found by Srivastava *et al.*, (2018). As depicted in the Table 3 the maximum available boron (kg ha^{-1}) of soil at were found in treatment T_9 which was 1.58 kg ha^{-1} while the minimum values of the result were found in treatment T_1 (control) which was 0.3 kg ha^{-1} respectively. Depicted that the mean value of available Boron (kg ha^{-1}) was found significant different. Same result also found by Singh *et al.*, (2015).

Table 3: Effects of NPK and B on head^{-1} weight (g) Cabbage.

Treatment	Plant height (cm)			Head wt. g head^{-1}	Head Yield t ha^{-1}
	20 DAS	40 DAS	60 DAS		
T_1	8.2	12.2	15.80	41.8	2.09
T_2	9.4	13.6	16.30	75.0	3.75
T_3	9.6	13.8	16.50	81.2	4.06
T_4	11.7	16.8	21.70	448.2	22.41
T_5	12.3	16.9	22.10	440.6	22.03
T_6	12.8	17.4	22.46	495.6	24.78
T_7	13.4	18.3	23.20	647.4	32.37
T_8	13.9	18.4	23.80	717.27	35.87
T_9	14.2	18.9	24.10	830.0	41.05
F test	NS	NS	NS	NS	NS
S.Ed.(±)	8.38	11.57	14.74	341.899	17.04
C.D.	17.84	24.64	31.38	727.766	36.27

Response of plant height of cabbage recorded at 20 DAS, 40 DAS, 60 DAS as influenced by different levels NPK and B. The plant height of cabbage was found increased significantly with the increase in levels of NPK and B. The maximum plant height was recorded as 14.2 cm, 18.9 cm, and 24.1 cm in T_9 at 20 DAS, 30 DAS, and 60 DAS respectively and the minimum plant height was recorded as 8.2 cm, 12.2 cm, and 15.8 cm in T_1 (control) at 20 DAS, 40 DAS, and 60 DAS respectively. Increase in plant height is due to increase in N P K and B fertilizers may be due to adequate supply of nutrients which in turn helps in vigorous vegetative growth of plants and subsequently increase the plant through cell elongation, cell division, photosynthesis and turbidity of plant cell. Similar result has been recorded by Verma and Nawange (2015). The maximum mean values of head weight of Cabbage were found in treatment T_9 which was 830 gm/plant while the minimum mean values of the result were found in treatment T_1 (control) which was 41.8 gm/plant respectively. Increase in plant height is due to increase in N P K and B fertilizers may be due to adequate supply of nutrients. Similar result has been recorded by Singh *et al.,* (2015). The maximum mean head yield of Cabbage at were found in treatment T_9 which was 41.5 tha^{-1} while the minimum mean values of the result were found in treatment T_0 (control) which was 2.09 tha^{-1} respectively. The statistical analysis of head yield data indicates that there was a significant difference in head yield interaction between N P K and B. Similar result has been recorded by Singh *et al.,* (2015).

CONCLUSION

From trial it was concluded that the various level of NPK and B used from different sources fertilizers (*i.e.* Urea (N 46%), + DAP (18 N % + P_2O_5 46%,) + MOP 60% K_2O) in the experiment gave the best result in the treatment T_9-[NPK @ 100% + B @ 100% ha^{-1}] followed by treatment T_7, in T_9 the soil health parameters retained the suitable soil properties, yield attributes and yield of Cabbage and gave highest net profit of Rs. 118137.38 ha^{-1} with highest cost benefit ratio is 1:3.46. Therefore, it can be recommended for the farmers to obtain best combination Treatment (T_9) for higher farm income and sustainable agriculture.

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Conflict of Interest. As a Corresponding Author, I Deependra Pratap Singh, confirm that no-one else have any conflicts of interest associated with this publication.

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