Response of Cabbage Yield under Variable Spacing and Boron Levels

Swetal Rana, Barholia, A.K., Lekhi, R., Singh, V.B., Pippal, R. and Rana, P.

CoA, RVSKVV, Gwalior (M.P.)

Abstract—*In order to evaluate the effect of spacing and boron levels on yield and quality of cabbage in gird region of Madhya Pradesh. Field experiment was conducted at Nursury area, CoA, Gwalior. The study was carried out during the rabi of 2013-14 and 2014-15. Two spacing 60 x 60 (S_1) and 60 x 45 (S_2) and three levels of Boron i.e. B_1- 0%, B_2-0.25%, B_3- 0.5% in FRBD with three replications. Foliar spray of Boron was done at 30 and 50 days after planting (DAP) and all other cultivation practices were adopted as per recommendations. Higher yield 577 q/ha. achieved using 60 x 45 cm planting distance against 440 q/ha. in 60 x 60 cm planting distance and foliar spray of 0.5 % boric acid. Among the boron levels 0.5% boric acid increased all the character of the plant.*

Keyword*: Cabbage, boron, spacing, foliar spraying, yield*

1. INTRODUCTION:

Cabbage (*Brassica oleracea var. capitata L.*) belongs to the family crucifereae is one of the important vegetables among the cole crops and grown in almost all parts of the world. It originated in Cyprus and around the Mediterranean region. Cabbage was reported to be grown in the subcontinent during the Mughal period, but the vegetable became popular during British rule. The edible portion of cabbage is known as 'head' that is made up of numerous thick and overlapping smooth leaves. Among the leafy vegetables cabbage has a prominent place and grown as an annual crop prized for its compact green head.

A 100 g edible portion of cabbage contains 1.8 g protein, 0.1 g fat, 4.6 g carbohydrate, 0.6 g mineral, 29 mg calcium, 0.8 mg iron and 14.1 mg sodium. Moreover, it is a rich source of vitamins A and C (Prabhakar and Srinivas, 1990). It may be served in slaw, salads or cooked dishes. Cabbage is one of the five best vegetables in the world (Rashid, 1999). It is an important winter leafy vegetables grown in India.

India is the second largest producer of cabbage in the world next to China. It is commercially cultivated in U.P., Orissa, Bihar, Assam, West Bengal, Maharashtra and Karnataka states in the country. The area (in '000 Ha), production (in '000 MT) and productivity (in MT/ha) of cabbage in Madhya Pradesh are 19.7, 578.4, 29.4, in India 400.13, 9039.21, 22.6 and in the World are 2416.88, 70644.19, 29.2, respectively (NHB, 2015).

Micronutrient plays a vital role in growth and development of plants besides being improving the quality of the produce. Though it required in small amount but equally indispensable for the normal growth of the plant and in deficient condition it leads to the occurrence of some physiological disorders and ultimately affected the yield and quality of the produce. Micronutrient improves the chemical composition of head and general condition of the plant. It increases seed germination, macronutrient uptake, production and quality of produce through enhanced photosynthetic activity and increased metabolite content of leaves. They also reduce the incidence of diseases, pests and disorders and improve the post-harvest quality of the crop produce. (Hemphill *et al.* 1982).

Boron regulates the metabolism of carbohydrates in plants. It plays an important role in enhancing the translocation of carbohydrates from site of synthesis to reproductive tissue in the head. It is essential for the process by which meristem cells differentiate to form specific tissues. In case of boron deficiency, plant cells may continue to divide, but structural components are not differentiated.

2. MATERIAL AND METHODS:

Cabbage (*Brassica oleracea* var. Capitata L.). cv. Pusa Drum Head" was used to explore its yield potential by different boron levels and spacing. The present investigation was conducted in nursery area, Dept. of Horticulture, College of Agriculture, Gwalior during *rabi* of 2013-14 and 2014-15. The treatments comprises of three levels of boron i.e. B_1- 0%, B_2- 0.25%, B_3- 0.5% and two spacing 60 x 60 (S_1) and 60 x 45 (S_2) in FRBD with three replications. Foliar spray of Boron was done at 30 and 50 days after planting (DAP) and all other cultivation practices were adopted as per recommendations. The plot size was 3.2 m x 3.2 m. Three raised nursery beds of 2 x 1 x 0.15 m size were prepared by mixing well rotten farm yard manure in soil @ 15 kg per square meter. Seeds of cabbage cv. Pusa Drum Head were sown on 22nd October 2013 in the first trial and on 25th October 2014 in second year trial @ 10 g seed per bed after treating with 0.3% thiram to check the infection of damping off and seed borne diseases. Five weeks old healthy and uniform sized seedlings were transplanted in the experimental plots on 25th November 2013

in first year trial and on 27th November 2014 in second year trial. Seed beds were watered in the morning before uprooting the seedlings in the afternoon of the same day to avoid damage to the roots. During transplanting a spacing of 60 cm × 60 cm and 60 cm x 40 cm and thus unit plot accommodated 25 and 40 seedlings respectively where the treatment was allocated at random. Two days before transplanting each plot was fertilized with a basal dose of NPKS. The recommended dose of nitrogen (120 kg/ha), phosphorus (80 kg/ha), potassium (60 kg/ha) and sulphur (20 kg/ha) were applied through urea, SSP, MOP and Gypsum, respectively. Half of the total quantity of nitrogen was applied as a basal dose. One-fourth of the total nitrogen was applied after 20 days of transplanting and remaining one-fourth at the time of head formation. Boron and was applied as foliar spray (at 30 and 50 DAP). Boric acid was used as source of boron.

3. RESULTS:

The mean data pertaining to different yield parameters and yield of different treatments were subjected to statistical calculations. Both spacing and boron levels influenced these parameter significantly. Interaction of spacing × boron, spacing × molybdenum and boron × molybdenum also affect the yield per plot. The same trend was found in both the years. The results indicated that there was significant affect of spacing and boron levels on various yield attributing traits and yield. The mean data of pooled basis (both years) are only sawn here. The effect of spacing on diameter of head was found significant. Spacing S_1 has recorded maximum diameter of head *i.e.* 17.06 cm. While minimum diameter of head *i.e.* 13.21 cm was noted in case of S_2. Among the boron levels, diameter of head showed significant differences, B_3 recorded maximum diameter of head 16.11 cm followed by B_2 15.17 cm. Minimum diameter of head was recorded in case of B_1 *i.e.* 14.11 cm. The difference between B_3, B_2 and B_2 and B_1 showed significant. Weight of untrimmed head was found maximum in S_1 i.e. 2.45 kg followed by 2.13 in S_2. Boron levels also showed significant differences in weight of untrimmed and trimmed head, B_3 recorded weight of untrimmed 2.43 followed by 2.30 in B_2. Minimum weight of untrimmed and trimmed head was recorded in case of B_1 *i.e.* 2.15.

Weight of trimmed head was found maximum in S_1 i.e. 1.8 kg followed by 1.48 kg in S_2. Boron levels also showed significant differences in weight of untrimmed and trimmed head, B_3 recorded weight of trimmed head 2 1.78 kg followed by 1.65 kg in B_2. Minimum weight of untrimmed and trimmed head was recorded in case of B_1 i.e. 1.50 kg. Yield was obtained higher 577.02 q/ha in lower spacing of 60 x 45 cm (S_2) followed by 440.98 q/ha in case of S_1. The trend in boron levels was similar to other parameter B_3 recorded maximum yield of 547.19 q/ha followed by B_2 512.70 q/ha Minimum yield was recorded in case of B_1 *i.e.* 467.15 q/ha

4. DISCUSSION:

An attempt has been made to establish the relationship amongst the yield attributes and yield of produce as affected by the different treatments under study. Data recorded for various yield parameters and yield reveals several points of interest which can be discussed in conjunction with the findings of other workers. It is realized that the assessment of experimental treatments by such supplementary data has been reasonably justified.

Effect of Spacing:

The various yield traits i.e. diameter of head (cm), weight of untrimmed head (g/kg), weight of trimmed head (g/kg), yield per plot (kg) and yield (q/ha.) were studied. The data presented in the chapter results denoted that both the plant spacing significant influenced the various yield traits. Values were found to be maximum at wider spacing i.e. S_1 (60 x 60 cm) for diameter of head (cm), weight of untrimmed head (kg), weight of trimmed head (kg) in both years followed by S_2 (60 x 40 cm). There was a linear increase in spacing S_1 (60 x 60 cm) it was found better than spacing S_2. The plants grown under wider spacing received more nutrients, light and moisture around compared to plants of closer spacing, which was probably the cause of better performance in yield attributes and yield of individual cabbage head. The total marketable head yield of cabbage per plot and per hectare grown in closer {S_2 (60 x45 cm)} spacing resulted in significantly higher yields in both the years than those of wider spacing {S_1 (60 x 60 cm)}. In wider spacing the plant population decreased and failed to compensate the loss of increase of due to lesser plant population, though large number of best quality head was obtained. Consequently the yield of head q/ha was more in closer spacing as compared to wider.

Effect of boron:

The various yield traits i.e. diameter of head (cm), weight of untrimmed head (g/kg), weight of trimmed head (g/kg), yield per plot (kg) and yield (q/ha.) were studied. The data presented in the chapter results denoted that different boron levels significant influenced the various yield traits. Values were found to be maximum under B_3 i.e. (B @ 0.5 %) for diameter of head (cm), weight of untrimmed head (kg), weight of trimmed head (kg) in both years followed by B_2 (B @ 0.25 %) and minimum values for these parameters were found under B_1 (B @ 0%). The increase in the head weight by Boron application may be due to its role in enhancing the translocation of carbohydrates from the site of its synthesis to the storage tissue in the head as Boron is known to play beneficial role in the translocation of carbohydrates which helps in better seed or fruit set. The total marketable head yield of cabbage per plot and per hectare sprayed by B_3 i.e. (B @ 0.5 %) resulted in significantly higher yields in both the

years followed by B_2 (B @ 0.25 %) and minimum values for these parameters were found under B_1 (B @ 0%).

5. CONCLUSION:

Based on the findings of the experiment, it may be concluded that for efficient production of cabbage and maintenance of soil productivity, it is judicial to use different micronutrients with NPKS fertilizer with recommended dose. Application of micronutrients is one of the important management practices to improve soil productivity. Crop yield and profit are both important to a farmer. Soil health is also very important for sustainable production. Higher yield may also be achieved using lower plant population. Thus considering crop productivity, economic return and soil fertility together combined application of micronutrient and reduced plant spacing may be helpful for sustainable crop production without application of any inorganic fertilizer. So it may be recommended at farmer's level for profitable crop production without affecting the soil health

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Table 1: Effect of spacing, boron and its interaction on yield parameters of cabbage.

	Diameter of head (cm)			**Weight of untrimmed head (kg)**			**Weight of trimmed head (kg)**			**Yield per plot (kg)**			**Yield per ha. (q)**		
Spacing	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
S1	17.75	16.36	17.06	2.50	2.41	2.45	1.84	1.76	1.80	46.22	44.09	45.16	451.40	430.55	440.98
S2	13.87	12.54	13.21	2.18	2.09	2.13	1.52	1.44	1.48	60.47	57.40	58.94	590.86	563.25	577.05
SEm+	**0.16**	**0.16**	**0.10**	**0.024**	**0.026**	**0.016**	**0.018**	**0.023**	**0.013**	**0.53**	**0.55**	**0.34**	**6.19**	**6.47**	**4.00**
CD(0.05)	**0.48**	**0.47**	**0.29**	**0.069**	**0.076**	**0.045**	**0.052**	**0.066**	**0.037**	**1.54**	**1.59**	**0.97**	**17.79**	**18.59**	**11.25**
Boron															
B1	14.78	13.44	14.11	2.20	2.10	2.15	1.54	1.46	1.50	49.20	46.47	47.84	480.51	453.79	467.15
B2	15.87	14.48	15.17	2.34	2.26	2.30	1.69	1.61	1.65	53.89	51.12	52.50	526.22	499.18	512.70
B3	16.78	15.45	16.11	2.47	2.39	2.43	1.82	1.74	1.78	56.95	54.65	55.80	556.65	537.74	547.19
SEm+	**0.20**	**0.21**	**0.12**	**0.029**	**0.032**	**0.020**	**0.022**	**0.028**	**0.016**	**0.66**	**0.67**	**0.42**	**7.58**	**7.92**	**4.90**
CD(0.05)	**0.57**	**0.58**	**0.35**	**0.084**	**0.093**	**0.055**	**0.064**	**0.081**	**0.045**	**1.89**	**1.95**	**1.19**	**21.78**	**22.77**	**13.78**
SXB															
S1B1	16.87	15.49	16.18	2.38	2.30	2.34	1.73	1.66	1.69	43.54	41.40	42.47	425.17	404.29	414.73

S1B2	17.75	16.36	17.06	2.50	2.41	2.46	1.85	1.76	1.81	46.23	44.09	45.16	451.49	430.60	441.04
S1B3	18.62	17.25	17.93	2.62	2.52	2.57	1.96	1.87	1.91	48.90	46.77	47.84	477.53	456.78	467.15
S2B1	12.69	11.38	12.04	2.02	1.90	1.96	1.35	1.26	1.31	54.87	51.54	53.20	535.85	503.30	519.57
S2B2	13.98	12.60	13.29	2.18	2.10	2.14	1.53	1.45	1.49	61.54	58.14	59.84	600.95	567.75	584.35
S2B3	14.94	13.65	14.29	2.33	2.27	2.30	1.68	1.62	1.65	65.00	62.53	63.77	635.76	618.71	627.24
SEm+	**0.25**	**0.24**	**0.17**	**0.036**	**0.040**	**0.028**	**0.027**	**0.034**	**0.023**	**0.808**	**0.831**	**0.60**	**9.28**	**9.70**	**6.93**
CD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**