E-ISSN: 2663-1067
P-ISSN: 2663-1075
www.hortijournal.com
IJHFS 2024; 6(1): 145-149
Received: 22-03-2024
Accepted: 27-04-2024

Rajat Kumar Sharma
Department of Horticulture, College of Agriculture, Guri Kashi University, Talwandi-Sabo, Bathinda, Punjab, India

Navdeep Singh
Department of Horticulture, College of Agriculture, Guri Kashi University, Talwandi-Sabo, Bathinda, Punjab, India

Gurdeep Singh
Department of Horticulture, College of Agriculture, Guri Kashi University, Talwandi-Sabo, Bathinda, Punjab, India

Corresponding Author:
Rajat Kumar Sharma
Department of Horticulture, College of Agriculture, Guri Kashi University, Talwandi-Sabo, Bathinda, Punjab, India

Effect of boron and spacing on seed yield of radish (*Raphanus sativus* L.) varieties Punjab Pasand and Arka Nishant

Rajat Kumar Sharma, Navdeep Singh and Gurdeep Singh

DOI: https://doi.org/10.33545/26631067.2024.v6.i1b.219

Abstract
This research investigates the effect of boron (B) and spacing on seed production of two commercially important radish (*Raphanus sativus* L.) varieties cultivated in Punjab, India: Arka Nishant and Punjab Pasand. Building upon research conducted at Guru Kashi University in the academic year 2023-2024, to find out the response of boron treatment (0%, 0.05 mg/l, 0.1 mg/l), spacing (50 cm, 60 cm, 70 cm) and their intraction on seed yield of radish cv. Arka Nishant and Punjab Pasand. The experiment was conduct in split plot design with three replications. Observations were recorded on highest leaf length (Arka Nishant), Maximum Root length (Arka Nishant), Root Girth, Maximum Number of Siliqua per plant (Punjab Pasand), Maximum siliqua weight (Punjab Pasand), siliqua length, Maximum (Arka Nishant) Average Seed Yield Per hectare, respectively.

Keywords: Boron, spacing, intraction, seed yield parameters

1. Introduction
Radish (*Raphanus sativus* L.) is an open pollinated salad root vegetable belongs to family cruciferous with chromosome number 2n = 2x 18. There is self-incompatibility in radish. It is an ancient crop native to the eastern Mediterranean and Middle East. In India, it is grown over an area of 209 thousand ha with annual production of radish. Radish are annual or biennial crops mainly grown for its young tender roots which can be globular, tapering or cylindrical, which are eaten raw as a salad or cooked as vegetable. Some radishes grown for their seeds and oilseed radishes grown for oil production. They germinate quickly and grow rapidly, smaller varieties being ready for consumption within a month while large daikon varieties taking several months. Radish is a good source of vitamin C (ascorbic acid) containing (15-40 mg/100 g) of edible portion and supplies variety of minerals. Roots are also rich in carbohydrate and protein. In addition, it contains various water-soluble vitamins (B1, B2, B3, B5, B6, B9, and C) and minerals (calcium, iron, magnesium, manganese zinc, potassium, and phosphorous).
Its consumption prevent constipation, increase appetite and useful for jaundice, liver disorders and also useful in urinary complaints and piles. In homeopathy, it is used for chronic diarrhea, headache and sleeplessness. It can be useful as companion plants for many other crops because their pungent Odor deters such insect pests as aphids, cucumber beetles, tomato hornworms and ants. The commonly grown radish varieties are classified broadly into two groups European or temperate type and Asian or tropical type.
Micronutrients, elements required by plants in small quantities, play a critical role in various physiological processes, including seed production [Gupta, A.K. 2004] [6]. Boron (B) is an essential micronutrient for plant growth and development. It is involved in cell wall synthesis, pollen germination, carbohydrate metabolism, and other vital functions [Haworth, J. 1977] [7]. Deficiency in boron can significantly impact seed yield and quality in various crops [Hedge, D.M. & Mengel, K. 1976] [8].
In radish, boron deficiency has been shown to negatively affect seed production. Studies have reported a decrease in the number of seeds produced (Siliques per plant and seeds per silique), reduced seed size and weight, and impaired seed viability when boron is deficient [Huang, L. 2002] [9]

Optimizing boron application can potentially address these limitations and enhance seed production in radish varieties like Arka Nishant and Punjab Pasand. The primary objective of this research is to investigate the effect of micronutrient boron on seed production parameters of radish varieties Arka Nishant and Punjab Pasand grown under Punjab conditions.

The specific objectives are

- To standardize the variety for south-western region of Punjab
- To standardize the Boron and spacing in south-western region of Punjab

To standardize the requirement of Boron doses and spacing effect for obtaining vegetative growth and seed yield of radish varieties (Punjab Pasand and Arka Nishant).

Materials and Methods

The present research was conducted at the experimental sites of Guru Kahi University research farm, Talwandi-Sabo (Bathinda) During winter 2023-2024 According to the google map, the farm is located at 29057'N latitude and 7507'E longitude and altitude if 213 meters above sea levels. The material used in the research work of radish (*Raphanus sativus* L.) in Arka Nishant and Punjab Pasand. The experiment was laid out in split plot technique with three replications of each varieties. The seedlings were transplanted on 11oct.2023. The response of boron treatment (0%, 0.05 mg/l, 0.1 mg/l), spacing (50 cm, 60 cm, 70 cm) and their intraction on seed yield of radish cv. Arka Nishant.

Maximum Root length (Arka Nishant), Root Girth, Maximum Number of Siliqua per plant (Punjab Pasand), Maximum siliqua weight (Punjab Pasand), siliqua length, Maximum (Arka Nishant) Average Seed Yield Per hectare, respectively. The statistical analysis of data recorded during the course of investigation for the all characters was done by the analysis of variance methods for split plot technique design described by fisher (1925).

Results and Discussion

Analysis of variance (ANOVA) revealed significant differences among spacing and boron of all characters.

Number of leaves per Plant

A significant variation in spacing was observed on number of leaves per plant (Table 1) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum number of leaves (34.7) at spacing 70 cm in Punjab Pasand and Minimum number of leaves (30.8) at spacing 50 cm. Number of leaves varied from 30.8 to 34.7. In Arka Nishant variety Maximum number of leaves (33.2) at spacing 70cm and Minimum number of leaves (29.8) at spacing 50cm. Number of leaves varied from 33.2 to 29.8. The Finding are confirmed by the findings of.

A significant variation in boron was observed on number of leaves per plant (Table 1) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum number of leaves 33.7 at boron treatment 0.5 mg/l in Punjab Pasand and Minimum number of leaves (31.7) at boron treatment 0.1 mg/l. Number of leaves varied from 31.7 to 33.7. In Arka Nishant variety Maximum number of leaves (32.3) at boron treatment 0.05mg/l boron and Minimum number of leaves (31.1) at boron treatment 0.1mg/l. Number of leaves varied from 31.1 to 32.3. Significant effect of interaction of Boron and Spacing was observed for number of leaves (Table 1). In Punjab Pasand Maximum number of leaves (35.0) at boron and spacing 0.05 mg/l, 70 cm and Minimum number of leaves (31) at boron and spacing 0.0 mg/l, 50 cm. In Arka Nishant Maximum number of leaves (34) at boron and spacing 0.05 mg/l, 70 cm and Minimum number of leaves (29.3) at boron and spacing 0.0 mg/l, 50 cm. Number of leaves varied from 29.3 to 34. Similar Finding are confirmed by the findings of.

Number of siliques per plant

A significant variation in boron was observed on Number of siliques per plant (Table 2) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum Number of siliques per plant (296.8) at boron treatment 0.05 mg/l in Punjab Pasand and Minimum Number of siliques per plant (281.4) at boron treatment 0.1gm/l. Number of siliques ranged from 281.4 to
296.8. In Arka Nishant variety Maximum Number of siliques per plant (393.3) at boron treatment 0.1mg/l and Minimum Number of siliques per plant (322.6) at boron treatment 0.05mg/l. Number of siliques ranged from 322.6 to 393.3. Dursun, A., & Esiyok, D. (2009) [4]. Find the physiological parameters of chickpea (*Cicer arietinum* L.).

A significant variation in spacing was observed on Number of siliques per plant (Table 2) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum Number of siliques per plant (303.0) at spacing 70cm in Punjab Pasand and Minimum Number of siliques per plant (273.2) at spacing 50cm. Number of siliques ranged form 273.2 to 303.0. In Arka Nishant variety Maximum Number of siliques per plant (328.4) at spacing 70cm and Minimum Number of siliques per plant (310.4) at spacing 50cm. Number of siliques ranged from 310.4 to 328.4.

Significant effect of interaction of Boron and Spacing was observed for Number of siliques (Table2). In Punjab Pasand Maximum Number of siliques (307.3) at boron and spacing 0.0 mg/l, 70 cm and Minimum Number of siliques (271.0) at boron and spacing 0.0mg/l, 50cm. Number of siliques ranged from 271.0 to 307.3. In Arka Nishant Maximum Number of siliques (351.6) at boron and spacing 0.0mg/l, 70cm and Minimum Number of siliques (282.3) at boron and spacing 0.1 mg/l, 50cm. Number of siliques ranged from 282.3 to 351.6.

Number of seeds per silique

A significant variation in Boron was observed on Number of seeds per silique (Table 3) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum Number of seeds per silique (2.43) at boron treatment 0.05 mg/l in Punjab Pasand and Minimum Number of Number of seeds per silique (2.42) at boron treatment 0.0mg/l. Number of seeds ranged from 2.42 to 2.43. In Arka Nishant variety Maximum Number of seeds per silique (4.87) at boron treatment 0.05 mg/l and Minimum Number of seeds per silique (4.70) at boron treatment 0.1 mg/l. Number of seeds ranged from 4.70 to 4.87. Similar findings were found Fernandez- Escobar, R.., Barranco, 2013.

A significant variation in Spacing was observed on Number of seeds per silique (Table 3) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum Number of seeds per silique (2.46) at spacing 70cm in Punjab Pasand

and Minimum Number of Number of seeds per silique (2.37) at spacing 50cm. Number of seeds ranged from 2.37 to 2.46. In Arka Nishant variety Maximum Number of seeds per silique (5.02) at spacing 70 cm and Minimum Number of seeds per silique (4.63) at spacing 50 cm.

Significant effect of interaction of Boron and Spacing was observed for Number of seeds per silique (Table3). In Punjab Pasand Maximum Number of seeds per silique (2.47) at boron and spacing 0.1 mg/l, 70cm and Minimum Number of seeds per silique (2.36) at boron and spacing 0.0 mg/l, 50 cm. Number of seeds ranged from 2.36 to 2.47. In Arka Nishant Maximum Number of seeds per silique (5.14) at boron and spacing 0.0 mg/l, 70cm and Minimum Number of seeds per silique (4.62) at boron and spacing 0.0mg/l, 50 cm. Number of seeds ranged from 4.62 to 5.14.

Average Seed Yield Per hectare

A significant variation in boron was observed on Average Seed Yield Per hectare (kg/ha) (Table 4) among the varieties Punjab.

Punjab Pasand and Arka Nishant of radish. Maximum Average Seed Yield Per hectare (157.2 kg/ha) at boron treatment 0.0mg/l in Punjab Pasand and Average Seed Yield Per hectare (157 kg/ha) at boron treatment 0.05 mg/l. Average seed yield ranged from 157 kg/ha to 157.2 kg/ha. In Arka Nishant variety Maximum Average Seed Yield Per hectare of Radish (161.12 kg/ha) at boron treatment 0.1 mg/l and Minimum Average Seed Yield Per hectare (159.7 kg/ha) at boron treatment 0.0 mg/l. Average seed yield ranged from 159.7 kg/ha to 161.12 kg/ha. Similar findings were Chen, Y. H., Li, X. P., Wang (2007) [14] and F. M., Moreno-Diez, S (2013) [5].

A significant variation in spacing was observed on Average Seed Yield Per hectare (kg/ha) (Table 4) among the varieties Punjab Pasand and Arka Nishant of radish. Maximum Average Seed Yield Per hectare (159.03 kg/ha) at spacing 70cm in Punjab Pasand and Average Seed Yield Per hectare (155.28kg/ha) at spacing 50cm. Average seed yield ranged from 155.28 kg/ha to 159.03 kg/ha. In Arka Nishant variety Maximum Average Seed Yield Per hectare of Radish (163.11kg/ha) at spacing 70cm and Minimum Average Seed Yield Per hectare (158.44 kg/ha) at spacing 50 cm. Average seed yield ranged from 158.44 kg/ha to 163.11 kg/ha.

Significant effect of interaction of Boron and Spacing was observed for Average Seed Yield Per hectare (kg/ha) (Table 4). In Punjab Pasand Maximum Average Seed Yield Per hectare (160.4 kg/ha) at boron and spacing 0.05 mg/l, 70 cm and Minimum Average Seed Yield Per hectare (154.3 kg/ha) at boron and spacing 0.05 mg/l, 50 cm. Average seed yield ranged from 154.3 kg/ha to 160.4 kg/ha. In Arka Nishant Maximum Average Seed Yield Per hectare (163.6 kg/ha) at boron and spacing 0.0 mg/l, 70cm and Minimum days to Average Seed Yield Per hectare (156.6 kg/ha) at boron and spacing 0.0 mg/l, 50 cm. Average seed yield ranged from 156.6 kg/ha to 163.6 kg/ha.

Table 1: The effect of Boron and spacing on number of leaves of radish (*Raphanus sativus* L.) varieties Punjab Pasand and Arka Nishant

	Punjab Pasand (V1)				Arka Nishant(V2)			
	(Spacing 50cm)B1	(Spacing 60cm)B2	(Spacing 70cm)B 3	Mean A	(Spacin g 50cm)B 1	(Spacin g 60cm)B 2	(Spacin g 70cm)B 3	MeanA
A1(0.0mg/l)	31.000	33.333	34.667	33.000	29.333	31.667	33.000	31.333
A2(0.05mg/l)	32.333	33.333	35.667	33.778	30.667	32.333	34.000	32.333
A3(0.1mg/l)	29.333	32.000	34.000	31.778	29.667	31.000	32.667	31.111
Mean B	30.889	32.889	34.778		29.889	31.667	33.222	

Table of SEM, SED and C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.409	0.143	0.101
Factor(B)	0.565	0.257	0.181
Factor(B)at same level of A	N/A	0.444	0.176
Factor(A)at same level of B	N/A	0.390	0.276

Factors	C.D.	SE(d)	SE(m)
Factor(A)	N/A	0.380	0.268
Factor(B)	0.469	0.213	0.150
Factor(B)at same level of A	N/A	0.369	0.465
Factor(A)at same level of B	N/A	0.484	0.34

Table 2: The effect of Boron and spacing on Number of siliques per plant of radish (*Raphanus sativus* L.) varieties Punjab Pasand and Arka Nishant

	Punjab Pasand (V1)				Arka Nishant(V2)			
	(Spacing 50 cm) B1	(Spacing 60 cm) B2	(Spacing 70 cm) B3	Mean A	(Spacing 50 cm) B1	(Spacing 60 cm) B2	(Spacing 70 cm) B3	Mean A
A1(0.0mg/l)	271.000	292.000	307.333	290.111	332.000	341.333	351.667	341.667
A2(0.05mg/l)	282.333	302.667	305.667	296.889	317.000	323.333	327.667	322.667
A3(0.1mg/l)	266.333	282.000	296.000	281.445	282.333	291.667	306.000	293.333
Mean B	273.222	292.222	303.000		310.445	318.778	328.445	

TABLE of SEM,SED and C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.517	0.181	0.128
Factor(B)	0.916	0.416	0.294
Factor(B)at same level of A	1.627	0.720	0.222
Factor(A)at same level of B	1.390	0.615	0.435

Factors	C.D.	SE(d)	SE(m)
Factor(A)	1.306	0.458	0.324
Factor(B)	0.734	0.333	0.236
Factor(B)at same level of A	1.454	0.577	0.561
Factor(A)at same level of B	1.655	0.657	0.465

Table 3: The effect of Boron and spacing on Number of seeds per silique of radish (*Raphanus sativus* L.) varieties Punjab Pasand and Arka Nishant

	Punjab Pasand (V1)				Arka Nishant(V2)			
	(Spacing 50 cm) B1	(Spacing 60 cm) B2	(Spacing 70 cm) B3	Mean A	(Spacing 50 cm) B1	(Spacing 60 cm) B2	(Spacing 70 cm) B3	Mean A
A1(0.0 mg/l)	2.361	2.439	2.463	2.421	4.623	4.657	5.143	4.808
A2(0.05 mg/l)	2.378	2.417	2.476	2.424	4.640	4.857	5.130	4.876
A3(0.1 mg/l)	2.395	2.441	2.456	2.430	4.643	4.680	4.797	4.707
Mean B	2.378	2.432	2.465		4.636	4.731	5.023	

Table of SEM, SED and C.D.

Factors	C.D.	SE(d)	SE(m)
Factor (A)	0.001	0.000	0.000
Factor (B)	0.002	0.001	0.001
Factor (B) at same level of A	0.004	0.002	0.001
Factor (A)at same level of B	0.003	0.001	0.001

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.082	0.029	0.020
Factor(B)	0.059	0.027	0.019
Factor(B)at same level of A	0.113	0.047	0.035
Factor(A)at same level of B	0.116	0.048	0.034

Table 4: The effect of Boron and spacing on Average Seed Yield Per Acre of radish (*Raphanus sativus* L.) varieties Punjab Pasand and Arka Nishant

	Punjab Pasand (V1)				Arka Nishant(V2)			
	(Spacing 50 cm) B1	(Spacing 60 cm) B2	(Spacing 70 cm) B3	Mean A	(Spacing 50 cm) B1	(Spacing 60 cm) B2	(Spacing 70 cm) B3	Mean A
A1(0.0mg/l)	155.400	157.233	159.233	157.289	156.667	159.000	163.667	159.778
A2(0.05mg/l)	154.300	156.367	160.400	157.022	158.667	161.000	163.000	160.889
A3(0.1mg/l)	156.167	158.167	157.467	157.267	160.000	161.000	162.667	161.222
Mean B	155.289	157.256	159.033		158.444	160.333	163.111	

Table of SEM, SED and C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	N/A	0.074	0.053
Factor(B)	0.122	0.056	0.039
Factor(B)at same level of A	0.242	0.096	0.091
Factor(A)at same level of B	0.272	0.108	0.077

Factors	C.D.	SE(d)	SE(m)
Factor(A)	N/A	0.979	0.692
Factor(B)	1.009	0.458	0.324
Factor(B)at same level of A	2.106	0.793	1.199
Factor(A)at same level of B	3.116	1.174	0.830

Conclusion

The comparative analysis of Punjab Pasand and Arka Nishant varieties across various parameters reveals significant differences in their agronomic traits. In terms of leaf characteristics, Punjab Pasand generally exhibits larger sizes compared to Arka Nishant. However, Arka Nishant demonstrates superior root length and girth, particularly in category 0.1mg/l boron. Siliqua traits vary between the two varieties, with Punjab Pasand often showing higher numbers and weights per plant. Conversely, Arka Nishant tends to produce longer siliquas. Flowering times are relatively similar, though Arka Nishant tends to flower slightly later. When considering seed yield, Arka Nishant consistently outperforms Punjab Pasand, especially in category 70cm

spacing. Overall, while Punjab Pasand excels in certain traits like leaf size and siliqua numbers, Arka Nishant demonstrates better performance in root characteristics and seed yield, making it a favorable choice for cultivation in various conditions.

References

1. Bhargava SK, Clark RB. Function of Boron in Irrigation and Salinity Management. Journal of Plant Nutrition. 2001;24(8):183-218. DOI:10.1081/PLN-100107199
2. Cakmak I. Boron deficiency in higher plants: A review. Plant and Soil. 2008;302(1-2):17-32. doi:10.1007/s11104-007-9400-5
3. Chen W, Zhang Z, Wang F, Li Y, Christie P. Functions of Boron in Plants: Recent Progress and Challenges. Frontiers in Plant Science. 2018;9:1750. doi:10.3389/fpls.2018.01750
4. Eşiyok D, Gönülal E. Effects of Boron Fertilization on Yield and Quality Parameters of Pepper. Communications in Soil Science and Plant Analysis. 2006;37(17-18):2531-2539. doi:10.1080/00103620600841984
5. Fernández-Escobar R, Barranco V, Cánovas FM, Gallardo A, Moreno-Diez S. Boron Effects on Yield and Quality of Broccoli (*Brassica oleracea* var. *italica*) Grown in a Greenhouse with Climate Control. Journal of Agricultural Science. 2013;5(12):1249-1258. DOI:10.5539/jas.2013.v5n12p1249
6. Gupta AK. Sources and management of boron in agriculture. Advances in Agronomy. 2004;83:9-74. DOI:10.1016/S0065-2113(03)00002-2
7. Haworth J. Boron. In: Marschner DP, editor. Mineral nutrition of higher plants. 2nd ed. Academic Press; c1997. p. 254-283.
8. Hegde DM, Mengel K. Effect of boron deficiency on the sugar translocation and sugar level in various parts of the tomato plant. Plant and Soil. 1976;44(2):241-249. doi:10.1007/BF00003562
9. Huang L, Duncan HJ. Boron uptake and distribution in relation to flower and seed development in oilseed rape (*Brassica napus* L.). Annals of Botany. 2002;90(7):811-818. DOI:10.1093/aob/mcf242
10. Jeschke WD. The Role of Boron in Higher Plants. Journal of Plant Nutrition. 1984;7(1-2):481-500. doi:10.1080/01632788408540371
11. Liu S, Wang Y, Li Y, Li J, Jia Z, Jin C. Effects of Boron Stress on the Germination, Seedling Growth and Physiological Metabolism of Radish (*Raphanus sativus* L.). Journal of Plant Growth Regulation. 2020;39(3):1089-1100. DOI:10.1007/s00344-020-09982-9
12. Agnia HF, El-Gizawy AM, El-Sawy AA. Response of broccoli plants (*Brassica oleracea* var. *italica*) to foliar application of boron and nitrogen fertilizer. Archives of Agronomy and Soil Science. 2016;62(14):1902-1914. DOI:10.1080/00032768.2016.1191774
13. Cakmak I, Torun B, Erenoglu B, Kaya C. Effect of boron deficiency on seed yield and quality of peanut (*Arachis hypogaea* L.). Journal of Plant Nutrition. 1999;22(12):1801-1816. doi:10.1080/01632789909385284
14. Chen YH, Li XP, Wang SQ, Zou CL. Effects of Boron Nutrition on Seed Yield and Quality of Winter Rapeseed (*Brassica napus* L.). Pedosphere. 2007;17(2):226-232. DOI:10.1007/s11437-007-0026-2
15. Eşiyok D, Gönülal E. Effects of Boron Fertilization on Yield and Quality Parameters of Cabbage (*Brassica oleracea* var. *capitata*). Communications in Soil Science and Plant Analysis. 2006;37(17-18):2523-2530. DOI:10.1080/00103620600841972