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Research Article

Effects of Seeding Density on Growth Attributes of Broadleaf Mustard in Nursery Bed

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Abstract

The productivity of crops is highly affected by the seedling quality, which is governed by seeding density in the nursery. So, an experiment was conducted to explore the effect of seedling spacing in the growth attributes of Broad Leaf Mustard cv. "Marpha Chauda Paate" at IAAS, Lamjung Campus, during Oct 2018. Four spacing treatments viz 0.5 cm × 1 cm, 1 cm × 1 cm, 1.5 cm ×1.5 cm and 2 cm × 2 cm were arranged in RCB Design with 5 replications. Observation of seedling height, leaf area, leaf number, shoot & root fresh weights, shoot dry matter, and dry matter percentage from twenty-three days old seedlings were recorded. The total leaf area was estimated using the Image-J package. Data were tabulated in MS Excel and analyzed by Gen Stat. Treatments differed significantly in seedling height, shoot and root fresh weight, leaf area, root length, and shoot dry weight, while the number of leaves and dry matter percentage did not differ statistically. Maximum shoot fresh weight (1.09 g), shoot dry weight (0.11 g), leaf area (48.24 cm^2), root length (4.89 cm), root fresh weight (0.03 g) per plant and shoot dry matter percentage (9.24%) were found in widest spacing (2 cm × 2 cm). However, seedling height was recorded higher in closer spacing. Therefore, the study of the overall characteristics asserted that the seed spaced at 2 cm × 2 cm produced superior seedling over all other spacings.

Keywords: Broad Leaf Mustard; Nursery; Seedling; Density; Spacing

Introduction

Mustard (*Brassica juncea)* is a cool-season crop that is grown for its green leaf, and in its maturity, it produces seeds that can be used for oil production. It is well known for its composition, i.e. for protein, vitamin C, antioxidant, carotenoid, Iodine, Selenium, Iron and other vitamins and minerals as a leafy vegetable (Golubkina *et al.*, 2018; Krumbein *et al.*, 2005; Lee *et al.*, 2010; Makus & Lester, 2002; Van Wyk, 2005). It is commonly grown as a transplanted crop from the nursery. The broadleaf Mustard is found to be the most common vegetable crop in Nepal; about 70% of vegetables cultivating farmers cultivate this crop (CBS, 2010). In Nepal, Broad Leaf Mustard, commonly known as 'Rayo,' occupies the first position in terms of production and coverage area among the leafy vegetables; however, it holds 4.2% of the total area under vegetable and 4.1% of total vegetable production (CBS, 2010). The productivity of Mustard is profoundly affected by prevailing weather conditions throughout its lifecycle. Besides, maintaining optimum plant density is also a critical practice to improve crop productivity through efficient utilization of light, water, nutrients by the plant (Pandey *et al*., 2017). The optimum seeding density also helps to obtain vigorous seedlings through maintaining a uniform standard and better seedling establishment and adds more to the productivity of the crop.

The yield potential of the variety alone is not sufficient for increasing the yield; several factors contribute to growth and development. Seedling density is one of the most important but least studied agronomic factors affecting plant productivity. Researchers had studied about different factors affecting the productivity of broadleaf Mustard only in the main field and are giving low priority to the factors affecting seedling growth in nursery. So, this research emphasized the effect of seedling density for better production of the crop.

Objectives

- To study the effect of seeding density in growth attributes of seedlings
- To determine the best plant spacing in the nursery to enhance seedling vigor and subsequent crop establishment

Methodology

This research was conducted both in the lab and field of the Institute of Agriculture and Animal Science (IAAS), Lamjung, and was in the act from October 2018 to December 2018.

1. Lab Test

The experiment was conducted in the horticulture lab at IAAS, Lamjung Campus. Before sowing seed in the nursery, 1000 weight of grain, seed purity, seed diameter, and germination percentage of seed were calculated. For calculating the germination percentage of the seed, two Petri plates, each containing 25 seeds was taken. These particulates were kept in the incubator where the temperature was 30° C and was maintained 12 hours' light followed by 12 hours' dark condition. Then, data were collected every 24 hours. Germination percentage was calculated by using the following formula.

$$\text{Germination \%} = \frac{\text{Number of Seed Germinated}}{\text{Total Seed Used for Testing}} \times 100\%$$

2. Field Experiment

Planting Material

Materials required were arranged locally within the university, whereas the seed needed for the operation was brought from an Argo-vet located at the nearby market, i.e., Sundarbazar. Seeds of *Brassica juncea*, cultivar 'Marpha Chauda Paate' was used for this experiment.

Design of Experiment and Treatment Details

Each plot had 0.9 m^2 area (0.3 m length and 0.3 m breadth). The treatments assigned randomly to the plots in a block, where a total of five blocks was made and presented as replications. The design of the experiment was RCBD with five replications and four treatments (Table 1).

Table 1: Treatment details for nursery experiment of broadleaf mustard cultivar 'Marpha Chauda Paate', 2018

S.N.	Treatment	Spacing
1	Treatment 1 (T_1)	0.5 cm × 1.0 cm
2	Treatment 2 (T_2)	1.0 cm × 1.0 cm
3	Treatment 3 (T_3)	1.5 cm × 1.5 cm
4	Treatment 4 (T_4)	2.0 cm × 2.0 cm

Nursery Bed Preparation

Raised nursery bed was prepared by proper primary tillage. Transparent plastic supported with a bamboo pole was used to make a plastic tunnel. The field was drenched with SAAF (5 g L^{-1}) and left up to 3 days for solarization.

Nutrient Management

Vermicompost 1.5 kg for 0.9 m^2 was applied after 3 days of solarization. Also, to enhance the availability of nutrients in the nursery bed, urea, MOP, and DAP were with the recommended dose of 40:40:30 kg NPK ha^{-1}.

Plant Protection

For plant protection, Cypermethrin and SAAF were used. Cypermethrin, 2 ml L^{-1} was sprayed ten days after sowing, and SAAF 5 g L^{-1} was sprayed 13 days after sowing.

Seed Sowing

Seeds in each row were sown, separated with thread to maintain in a straight line. For better seeding, the nursery bed was covered with the skinny layer of a mixture of sand, vermicompost, and soil in the ratio of 1:1:1.

Crop Management

Straw mulching was done to prevent moisture loss from the nursery bed and suppress weed. Then weed-free condition was maintained by periodic manual weeding. Weeding was done by pinching to reduce damage caused during weeding and not to disturb the spacing that was maintained. For adequate availability of moisture, light irrigation twice a day was applied.

3. Observations

Observations were recorded for different growth parameters of the seedling of broadleaf Mustard. It was taken from 23 days old seedling by a destructive sampling method. All the observations are an average of 20 random samples from each plot.

- Seedling height: Seedling height was measured from the collar region with the help of a measuring scale.
- Root length: At first root was cleaned by dipping into the water to remove mud, and then its length was measured using the measuring scale.
- Leaf number: The total number of leaves per plant was counted.

- Leaf area: The total leaf area was measured by using Image-J software.
- Fresh weight of shoot and root: Fresh weight of shoot and root was measured by using a digital weighing machine.
- Dry weight of shoot: Shoot dry weight was measured after oven drying fresh shoot for 48 hours at 68^0 c.

Data Analysis

For data analysis data were tabulated in MS Excel and analyzed by Gen Stat. All the mean comparisons were done using Duncan's Multiple Range Test (DMRT).

Result and Discussion

1. Lab Test

In lab physical characteristics of seeds were tested, so the following results were recorded

Seed color: Reddish

Seed diameter: 1.429 mm

Seed purity: 97%

1000 seed weight: 1.5 g

Germination percentage: 65%

2. Field Experiment

Effect of Spacing on Plant Height and Root Length

Seedling height varied significantly due to different levels of seedling spacing. Significantly higher seedling height (3.054 cm) was recorded from the closest spacing of 0.5 cm × 1 cm, but shortest height was observed in the larger spacing of 2 cm × 2 cm and was statistically similar with T_2 (1 cm × 1 cm) and T_3 (1.5 cm × 1.5 cm) (Table 2). A similar response of plant height to plant density was reported by Kumari (2009) in Mustard, Rahman *et al*. (2011) in soybean and Badi *et al*. (2004) in lettuce. The increment of plant height at lower spacing is probably because of competition for photosynthetically active radiation, which stimulates growth and results in stem elongation. In line with this observation, Arif *et al*. (2012) also recorded maximum height not in widest spacing in Mustard. In contrary to this result, Sharma, Chaudhary, and Pandey (2001) have found maximum height in wider spacing and shortest height in closer spacing and have explained as due to low-density plant get proper light nutrient and space for their growth.

Significant variation was found in the case of root length per seedling due to the effect of spacing. Most extended root length (4.891 cm) was obtained from T_4 (2 cm × 2 cm), showing a statistically similar result with T_3 (1.5 cm × 1.5 cm). The shortest length of root (4.049 cm) was obtained from T_1 (0.5 cm × 1 cm), which was statistically similar to T_2 (1 cm × 1 cm). Jimba and Adedeji (2003) and South *et al*. (1990) also reported wider spacing in nursery increases seedling biomass and root biomass. In this case, increasing plant density may have resulted in a decrease in light interception per plant, which in turn may have reduced photosynthesis per plant and biomass accumulation. In closer spacing, there will also be high competition for mineral and water between the roots of the seedling. Because plants in the high densities are competing for light, they may have grown taller. As the plants are investing in shoot growth, they are not able to invest in root growth. So that, carbon distributed to the roots can highly be reduced at a higher plant density. That would lead the total length of plant roots to reduce under high plant density. So, due to imbalanced root and shoot growth, seedlings become weak and tall in closer spacing.

Table 2: DMRT of plant height and root length of Broadleaf mustard seedling, Lamjung campus, 2018

Treatment	Plant height (cm)	Root length (cm)
T_1(0.5 cm × 1 cm)	3.054^a	4.049^b
T_2(1 cm × 1 cm)	2.606^b	4.066^b
T_3(1.5 cm × 1.5 cm)	2.542^b	4.669^a
T_4(2 cm × 2 cm)	2.534^b	4.891^a
LSD	0.262	0.480
F-test	*	*
CV%	11	8.1
SEM±	0.138	0.160
Grand mean	2.684	4.418

* = Significant (P<0.05), ** = Highly significant (P<0.01), NS: Non significant, means in column followed by same letter(s) are not significantly different

Effect of Spacing on Number of Leaves and Leaf Area

Table 3 shows that the number of true leaves was not affected by seedling spacing. Insignificantly a greater number of true leaves were observed in the spacing of 1 cm × 1 cm, while the least number of true leaves was found in the spacing of 1.5 cm × 1.5 cm, which is statistically similar to the spacing of 2 cm × 2 cm. A similar result was found by Bonaparte and Brawn (1976). In contradiction to this result, Al-Ramamneh *et al*. (2013) found an increase in the number of the leaf with the decrease in plant density in strawberries as wider spacing is supposed to receive more light by their canopy than plants in close spacing. The variation in the number of leaves due to plant densities might be due to variation in inter-plant competition, which increases with the increase in planting density. This variation caused lower crop growth and etiolated due to the shading effect that led to a reduction in the number of leaves (Ameri *et al*., 2007). Hasan *et al*. (2017) also states enough space for vertical and horizontal growth in the optimum spacing leads towards the maximum number of leaves per plant in comparison with the closer spacing

Leaf area of broadleaf Mustard varied significantly with seedling spacing. Significantly higher leaf area (48.24 cm^2) was found from wider spacing (2 cm × 2 cm), and smaller

(12.58 cm^2) was found in closer spacing, which was statistically similar to T_2 (1 cm× 1 cm) and T_3 (1.5 cm× 1.5 cm). A similar result was found by Maboko and Du Plooy (2009) in lettuce. Lower plant density has greater available space for growth resource procurement and sinks development and results for an increase in leaf area (Henderson *et al*., 2000). An increase in leaf area in wider spacing might also be due to the optimum availability of light, which results in more accumulation of photosynthetic assimilates in leaf and results in better growth of leaf.

Table 3: DMRT of number of leaves and leaf area of Broadleaf mustard seedling, Lamjung campus, 2018

Treatment	Number of leaves ($plant^{-1}$)	Leaf area (cm^2 $plant^{-1}$)
T_1(0.5 cm × 1 cm)	2.715	12.58^b
T_2(1 cm × 1 cm)	3.000	19.01^b
T_3(1.5 cm ×1.5 cm)	2.560	25.10^b
T_4(2 cm × 2 cm)	2.640	48.24^a
LSD	0.329	12.970
F-test	NS	**
CV%	8.7	35.9
Grand mean	2.729	26.200

* = Significant (P<0.05), ** = highly significant (P<0.01), NS: Non significant, means in column followed by same letter(s) are not significantly different

Effect of Spacing on Fresh Weight of Shoot and Fresh Weight of Root

Shoot fresh weight of broadleaf Mustard responded significantly (P<0.05) to the effects of different spacing. Fresh weight of shoot was highest (1.09 g) in T_4 (2 cm × 2 cm) while the minimum fresh weight (0.31 g) of the shoot was observed from T_1 (0.5 cm × 0.5 cm), which was statistically similar with T_2 (1 cm × 1 cm) (Table 4). A similar result was observed by Sharma *et al*. (2001) in lettuce. So, from this, it was observed that with the increases in spacing, the fresh weight of shoot increases. In the case of the wider spacing plant, receive enough light and nutrients, which leads to attaining the maximum fresh weight of plant (Hasan *et al*., 2017).

There was a significant difference in the fresh weight of root due to seedling spacing. Significantly maximum fresh weight (0.029 g) was observed in the spacing of 2 cm× 2 cm, which is statistically similar with a spacing of 1.5 cm× 1.5 cm, while the least fresh weight (0.017 g) was found in the spacing of 0.5 cm × 0.5 cm. An increase in plant density reduces light interception per plant, leading to low photosynthesis and biomass accumulation in plants. Therefore, carbon distributed to the roots can be reduced highly under high plant density. As a result, the total fresh weight of the roots is reduced under high plant density. A similar result was found by El-Desuki *et al*. (2005); they also reported a low weight of root in high-density planting.

Table 4: DMRT of fresh weight of shoot and fresh weight of root of Broadleaf mustard seedling, Lamjung campus, 2018

Treatment	Fresh weight of shoot (g $plant^{-1}$)	Fresh weight of root (g $plant^{-1}$)
T_1(0.5 cm × 1 cm)	0.319^c	0.017^c
T_2(1 cm × 1 cm)	0.673^{bc}	0.022^b
T_3(1.5 cm× 1.5 cm)	0.729^b	0.027^a
T_4(2 cm × 2 cm)	1.092^a	0.029^a
LSD	0.361	0.005
F-test	*	**
CV%	37.2	14.2
SEM±	0.117	0.001
Grand mean	0.703	0.023

* = Significant (P<0.05), ** = highly significant (P<0.01), NS: Non significant, means in column followed by same letter(s) are not significantly different

Effect of Spacing on Dry Weight of Shoot and Dry Matter Percentage

The dry weight of the shoot was significantly affected by seedling spacing. Significantly higher dry weight of shoot (0.11 g) was found in wider spacing (2 cm × 2 cm), and lowest dry weight (0.01 g) was found in closer spacing (0.5 cm x 1.0 cm) which was statistically similar with T_2 (1×1 cm) and T_3 (1.5 × 1.5 cm), which means Dry weight of shoot increases with a decrease in plant density (Table 5). Al-Barzinjy *et al*. (1999) also reported an increase in dry weight per plant with a decrease in plant density; this might be due to less competition for nutrients, water, and light. A similar result was explained by Kumari (2009); Sharma *et al*. (2001) and Al-Ramamneh *et al*. (2013).

Table 5: DMRT of shoot dry weight, and dry matter percentage of Broadleaf mustard seedling, Lamjung campus, 2018

Treatment	Dry weight of shoot (g $plant^{-1}$)	Dry matter percentage of shoot (%)
T_1(0.5 cm × 1 cm)	0.017^b	6.198
T_2(1 cm × 1 cm)	0.034^b	7.155
T_3(1.5 cm × 1.5 cm)	0.056^b	7.831
T_4(2 cm × 2 cm)	0.114^a	9.246
LSD	0.047	2.382
F-test	*	NS
CV%	62.4	22.7
SEM±	0.015	0.773
Grand mean	0.055	7.61

* = Significant (P<0.05), ** = highly significant (P<0.01), NS: Non significant, means in column followed by same letter(s) are not significantly different

There was no significant difference in the dry weight percentage of the shoot. However, the difference is not substantial; maximum dry weight percentage (9.24%) was found in wider spacing (2 cm); which was statistically similar with the spacings of 1.5 cm and 1 cm while the least dry weight percentage (6.19%) was found in the spacing of 0.5 cm. A similar result was obtained by M. Sharma (1992); they maintained that with the increase of spacing, dry matter content (%) showed increasing trend because of less competition for nutrients among the plants during growth stages.

Conclusion

The seeding spacing of broadleaf Mustard significantly affects seedling height, root length, leaf area, fresh weight of shoot and root, and dry weight of shoot of broadleaf Mustard in the nursery. By increasing seeding spacing up to 2.0 cm × 2 cm, seedling quality can be improved substantially to produce the twenty-three days old seedling in a nursery. Thus, more studies with wider spacing should be conducted to find out the optimum spacing to produce vigorous broadleaf Mustard seedling in the nursery within the desirable or limited time.

Author's Contribution

N. Niraula_designed the research plan; N. Niraula & A. Timilsina_performed experimental works, collected the required data & analysed the data; N. Niraula_prepared the manuscript. A. Timilsina critically revised and finalized the manuscript. Final form of manuscript was approved by both authors.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

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