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EFFECT OF TRANSPLANTING DATE AND SPACING ON SEED PRODUCTION OF BROCCOLI *(Brassica oleracea* var. *italica* Plenck*)* AT CHITWAN, NEPAL

Saraswati Shrestha [1,*], Arvind Shribastava[2] and Mohadatta Sharma[2]

[1] Ministry of Industry, Agriculture and Cooperative, Koshi Province, Nepal.
[2] Agriculture and Forestry University, Rampur, Chitwan, Nepal.

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*Correspondence:
saraswatish@yahoo.com
Tel:+977-9852080278

ABSTRACT

A study was conducted at the Agriculture and Forestry University, Rampur, Chitwan during the winter season, to find out the suitable transplanting dates and spacing for quality seed production of broccoli (Brassica oleracea var. italica) Cv. Calabrese. The experiment was laid out in split plot design with three replications, where main plot treatment consisted of transplanting dates (November 1, November 15 and November 30) and sub plot treatment consisted of spacing (60 cm × 50 cm, 60 cm × 60 cm, 60 cm × 75 cm). Since transplanting time and spacing affect vegetative traits, which are very important for seed yield. The highest seed yield (1.09 mt./ha) was obtained with November 1st planting at the spacing of 60 cm × 50 cm. So that transplanting date of November 1st with spacing 60 cm × 50 cm is better for seed production of broccoli in plain areas of Chitwan, Nepal.

1. INTRODUCTION

Broccoli, member of the Brassicaceae family, is a compact, rapidly developing floral vegetable that is usually harvested when the flowering heads are immature (Gray, 1982). It is one of the best and economically lucrative vegetable and more nutritious than any other vegetables of the same genus. It is a good source of carotene (575 µg), vitamin C (87 mg /100 g raw flesh), riboflavin (vitamin B2) and also rich in dietary fiber (Rashid, 1996). Broccoli also contains high concentrations of carotenoids, which are believed to have preventive qualities with regards to human cancer. It may also play a role in reducing levels of serum cholesterol. Broccoli contains a high level of sulforaphane glucosinates, which is cancer inhibiting chemicals.

Broccoli sprouts are loaded with concentrated form of sulforaphanes that enhances the cancer protective capacity of animal (Fahey *et al*., 1997). Three-day old young broccoli sprouts contains 20-50 times more chemoprotective compounds than mature broccoli heads (Nestle, 1997). The American Cancer Society suggested the inclusion of broccoli in the human diet to reduce the risk of developing cancer (Lindsay *et al*., 1988).The seed production is difficult in the areas having severe winter (Sinohara, 1984). So, the suitable place for seed production is recognized where the winter is mild, spring comes earlier and rainfall is less during flowering and ripening period (Sinohara,1984). However, one of the major problems associated with this crop in Nepal is lack of availability of high quality seeds of desired varieties (Devkota, 2000).

The total production of the vegetable seeds is 7.73 mt by government sector and 1265 mt by the private sector but the total demand of the seeds of different vegetables is 2026 mt (VDD, 2010). It is estimated that good quality seeds of improved varieties can contribute about 25-40% increase in yield (Kanwar *et al*., 2010). Methods of seed production and planting density are two important factors which affect the quality and quantity of seed produced in cole crops. In situ method of seed production is practice in broccoli and cauliflower whereas in cabbage transplanting method is followed. These methods affect the quantity and quality of seed produced significantly (Verma & Sharma, 2000). However, in sprouting broccoli no such methods to improve the quality of seed have been studied.

The seed production of cole crops can be done in Nepal from Terai to high hilly region (VDD, 1990). In case of the broccoli Calabrese is one of the variety whose

seed production is possible in Chitwan condition (256m above sea level). Limited researches were carried out on Calabrese seed production esp. on nutrition management, techniques of seed production, time of planting and spacing. Therefore it is a very high time to carry out research on this aspect as little work has been conducted to to assess the effect of date of transplanting and spacing on broccoli seed production under Rampur, Chitwan.

2. MATERIALS AND METHODS

2.1. Experimental site

The field experiment was conducted in Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal during September, 2014 to April, 2015. Chitwan valley falls under a humid subtropical type of climate. The maximum winter temperature rises up to 27°C. The hottest part of the year is April/May and June when the maximum temperature ranges between 37°C to 42° C. Rainy season starts from June and continues up to September, receiving the highest rainfall (up to 150 mm in 24 hours in some years) during June and July. The experimental site is geographically levelled at 27° 37' to 27° 46' north latitude and 83° 35'' to 84° 48'' east longitude with altitude of the about 256 meter above mean sea level.

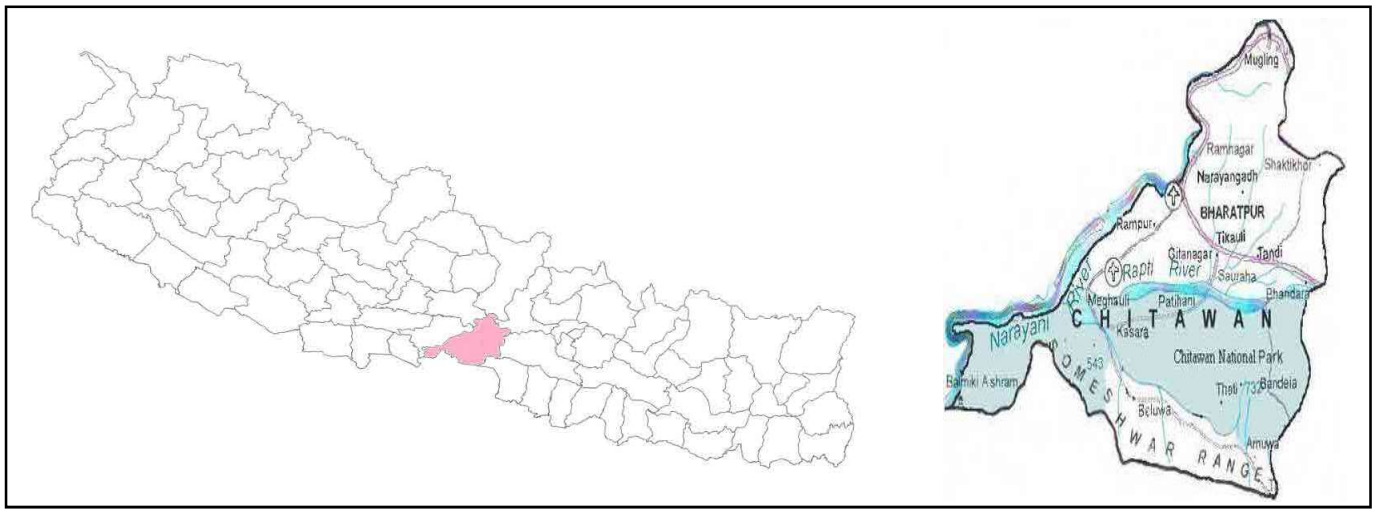

Figure 1. Experimental site

2.2. Cropping history of the experimental field

The experimental field was fallow before this planting.

2.3. Soil properties

Composite soil sample taken from the experimental area was air dried, ground and sieved through 2 mm sieve and subjected to soil test at soil science laboratory, Hariharbhawan, Lalitpur. The soil of experimental site sandy loam with pH value 5.4 and have low organic matter content.

Table 1. Physicochemical properties of experimental soil

Physical properties of soil	Content (%)	Rating
Sand content	68.9	
Silt content	19.85	
Clay content	11.25	
Soil texture	Sandy loam	
Chemical properties of soil		
Soil pH	5.4	Acidic
Total organic matter (%)	2.18	Low
Total nitrogen (%)	1	Medium
Available phosphorus (kg ha^{-1})	63.9	High
Available potassium (kg ha^{-1})	362.4	High

Source: Soil Science Laboratory, Hariharbhawan, Lalitpur

2.4. Agro-climatic condition of the study site

The climatic parameters like maximum and minimum temperature, average temperature, total rainfall and Relative Humidity (RH) were recorded from the agro-meteorological station of National Maize Research Center (NMRC), Rampur.

The average maximum temperature during the coldest month of the year (December to February) reached to 27^{0}C whereas the minimum temperature during this period ranges between 6 to 10 ^{0}C. Similarly, the maximum temperature during the hottest month of the year (May to June) was measured up to 42^{0}C. There is ample sunshine during the rainy and spring season while for winter season foggy weather prevails in most of the days. The rainy season starts from June and ends up to October. The early months (June, July, and August) of rainy season receive most of the total annual rainfall (around 80%) and winter receives occasional rainfall from the Western monsoon. The percentage of Relative humidity (RH) rises up from May (Average 50 %) and reaches maximum (100%) in some weeks of December and January (Thapa and Dangol, 1988).

2.5. Experimental details (Field experiment)

The field experiment was conducted between 1st October, 2014 to 30th April, 2015. The variety used was Calabrese (an open pollinated variety) which was being maintained in the Horticulture farm of the Agriculture and Forestry University, Rampur, Chitwan.

The split plot design was followed with three replication and a total of nine treatments. There were 30, 25, 20 number of plants in each experimental plot among which 12 ,9, 6 and 18, 16, 14 number of plants were experimental plants and boarder plants at 50 cm × 60 cm, 60 cm× 60 cm and 60 cm× 75 cm spacing respectively. The size of individual plot was 9 m^2 (3 m × 3 m). The plot between the treatments was separated by 0.5 m and the replication was separated by 1m and the total area of the experiment field was 402 m^2.

Table 2. Details of the treatments

Factor A (Time of planting)	Factor B spacing(cm^2)
T1 = Nov.1	S1 = 60x50
T2 = Nov.15	S2 = 60×60
T3 = Nov.30	S3 = 60x75

2.6. *Data collection and analysis*

Vegetative, phenological and yield attributing data measurements were taken from each plot, five inner plants were selected randomly as the sample plants and vegetative data were recorded of plant height and number of leaves. whereas phenological measurements recorded were days to 100% flowering, 100% pod formation, number of primary and secondary branches per plant, pod length(cm), number of pod per plant, number of seed per pod and seed yield per plant (gram).

The data obtained were tabulated using MS EXCEL. Then analysis of this data was done by using computer software MSTAT-C. Mean separation was done by Duncan's Multiple Range Test (DMRT) with 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Effect on seed yield

Effect of time of planting on seed yield was highly significant (Table 3). Mean table shows that the maximum seed yield was obtained from November 1st planting (736.08 kg ha^{-1}). But there was no significant difference between seed yield of November 15 (542.56 kg ha^{-1}) and November 30th planting (458.80 kg ha^{-1}) in Broccoli.The influence of spacing on seed yield was highly significant. The highest yield was obtained with spacing of 60 cm × 50 cm (815.60 kg ha^{-1}) followed by 60 cm × 60 cm (510.84 kg ha^{-1}) and 60 cm × 75 cm spacing (411.00 kg ha^{-1}).

Table 3. Effect of time of planting and spacing on seed yield of broccoli in Chitwan, Nepal, 2014/2015

Treatment	Seed yield per plant(g)	Seed yield per ha (kg ha^{-1})
Date of transplanting		
Nov 1	27.83^a	736.08^a
Nov 15	20.25^b	542.56^b
Nov 30	14.89^c	458.80^b
SEm(±)	1.13	29.71
LSD	4.44**	116.70**
Spacing		
60×50	18.54^b	815.60^a
60×60	19.73^b	510.84^b
60×75	24.70^a	411.00^c
SEm(±)	1.27	22.26
LSD (0.05)	3.91*	68.59**
Interaction (date of transplanting × Spacing)	<0.05	<0.01
CV, %	18.11	11.53
Grand Mean	20.99	579.15

s- not significantly different from each other based on DMRT at 5% level of significance

* and** indicate Significant at 0.05 and 0.01 level respectively.

LSD-Least Significance Difference

3.2. Interaction Effect Of Time Of Planting And Spacing On Seed Yield Per Plant

The result of statistical analysis showed that the interaction effect between time of planting and spacing on seed yield per plant was significant (Table 4). The highest seed yield per plant was obtained with spacing of 60 cm × 75 cm planted on 1st November which was significantly higher than the seed yield per plant recorded from other planting dates at different closer spacings. There is no significant difference in seed yield of November 30 planting with spacing 60 cm × 50 cm and 60 cm × 75 cm, while there is no significant difference on November 1st planting.

The interaction effect between time of planting and spacing on seed yield per ha was found to be highly significant (Table 5). Mean table shows that the Broccoli plant transplanted on November 1st with 60 cm × 50 cm spacing have highest seed yield per ha (1080.2 kg ha^{-1}) which was significantly higher than the seed yield recorded from rest of the other planting dates and spacings. Mean table clearly indicates that despite of spacing, early planting (November 1st) resulted in significantly higher seed yield compared to other planting dates and spacing. The mean seed yield obtained from Nov 1st plant at different spacings was 736.08 kg ha^{-1} where as it was 542.56 kg ha^{-1} in November 1st planting and 458.8 kg ha^{-1} in November 30th planting. The minimum seed yield was at spacing of 60 cm × 75 cm in November 30 planting.

Table 4. Interaction between time of planting and spacing on seed yield per plant of broccoli in the plain area of Chitwan, Nepal, 2014/2015.

Spacing	Transplanting date			Mean
	Nov 1	Nov 15	Nov 30	
60×50	26.00^{b}	16.28^{c}	13.33^{d}	18.54
60×60	23.81^{bc}	17.37^{cd}	18.00^{cd}	19.73
60×75	33.67^{a}	27.11^{ab}	13.33^{d}	24.70
Mean	27.83	20.25	14.89	
SEm (±)	2.19*			
LSD (=0.05)	6.76			

s- not significantly different from each other based on DMRT

at 5% level of significance

* and ** indicate Significant at 0.05 and 0.01 level respectively.

LSD-Least Significance Difference

Table 5. Interaction between time of planting and spacing on seed yield per ha of broccoli in the plain area of Chitwan, Nepal, 2014/2015.

Spacing	Transplanting dates			Mean
	Nov 1	Nov 15	Nov 30	
60×50s	1087.20^{a}	728.40^{b}	631.20^{bc}	815.60
60×60	575.64^{cd}	460.08 ^{de}	496.80^{de}	510.84
60×75	545.40^{cde}	439.20^{e}	248.40^{f}	411.00
Mean	736.08	542.56	458.80	
SEm (±)	38.56			
LSD (=0.05)	38.56 **			

s- not significantly different from each other based on DMRT at 5% level of significance

*and** indicate Significant at 0.05 and 0.01 level respectively.

LSD-Least Significance Difference

3.3 Effect on seed yield per plant and seed yield per ha

The November 1st planting had the highest seed weight per plant (27.827 g) and seed yield per ha (736.080 kg ha^{-1}). November 1st planting have tall plants with vigorous growth, profuse branching, more number of flowering with longest pod length this might contribute towards more seed yield while delay planting reduced seed yield. The seedling planted on November 1st might receive the favorable weather for growing and flowering as compare to the delay plantings, which help in better seed development in pod (Kazi *et al.,* 2002). November 30 planting resulted in minimum number of flower stalks, number of pods, shortest length of pod (Firoz *et al.,* 2000).

The maximum yield of seed per plant (24.70) was observed with spacing of 60 cm × 75 cm followed by spacing of 60 cm × 60 cm (19.73 g) and 60 cm × 50 cm (18.54 g). Wider spaced plant produced higher seed yield per plant (Mehta *et al.,*2015). It was observed that the number of leaves, number of branch per plant was higher in plants with wider spacing and the lower in closely spaced plants. This was probably due to inter plant competition in respect of light, nutrient and resources result in more seed yield per plant in wider spacing as compare to closer spacing (Mohanty & Srivastava, 2002).

As more number of leaf, stem diameter, branches and number of pod per plant were recorded at the widest spacing which contribute to increased seed yield per plot. The highest yield was recorded with spacing of 60 cm × 50 cm (815.60 kg ha^{-1}) followed by 60 cm ×

60 cm (510.84 kg ha^{-1}) and 60 cm × 75 cm (411.00 kg ha^{-1}). Seed yield was maximum at closer spacing and minimum at wider spacing though seed yield per plant was maximum at wider spacing due to more number of plant per ha were recorded at closer spacing (Mihov and Antonova,2009).

November 1st planting with spacing of 60 cm × 75 cm produced maximum (33.67 g) seed per plant where as the highest seed yield per ha was obtained with the spacing of 60 cm × 50 cm in the November 1st planting (1080.2 kg ha^{-1}). This might be due to less number of plants per ha accommodated in wider spacing while more number of plants in closer spacing and more favorable condition accompanied by November 1st planting.

4. CONCLUSION

The findings revealed that among three different time of planting November 1st planting was found as the appropriate date for seed production of broccoli in Chitwan. The time of planting and spacing played a crucial role in growth and development of vegetative, reproductive growth and seed development of broccoli plants. Delaying on time of planting resulted in reduction in seed production. Similarly, spacing of 60 cm × 50 cm produced the maximum seed yield per ha though the seed yield per plant were found maximum with the spacing of the 60 cm × 75 cm. From this study, it can be concluded that November 1st transplanting with spacing of the 60 cm × 50 cm was found to be the best combination for producing broccoli seeds in plain areas of Chitwan.

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