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RESEARCH ARTICLE

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Study on Effect of Spacing and Nutrient Management in Cabbage Cultivation in Medium Land Situation of East Medinipur

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ABSTRACT

Background: Cabbage (*Brassica oleracea* var. *capitate* L.) is a nutritionally and economically high-value leafy vegetable. Therefore, the optimum plant density and the judicious application of fertilizers with organic supplements must be ensured to achieve the desired quality and quantity of cabbage.

Methods: A field experiment was conducted in farmers' field to study the effect of spacing and nutrient management on the growth, yield and economics of cabbage in East Medinipur's medium land situation under the lower Gangetic plain of West Bengal during the Rabi season in 2020. Three technology options with three distinct spacing (TO-I: 60 × 30 cm^2 + RDF, TO-II: 60 × 45 cm^2 + RDF and TO-III: 60 × 60 cm^2 + RDF) along with one farmer's practice (FP: Random spacing and fertilization) were evaluated using randomized block design (RBD).

Result: The findings showed that the maximum plant height (37.2 cm), the lowest number of aberrant heads (7.81%) and the highest individual head weight (1.89 kg) were recorded in TO-III. Individual head weight was decreased in the following order: TO-III> TO-II> TO-I> FP. Though TO-I recorded the maximum harvestable (59.45 t/ha) and marketable yield (53.28 t/ha), TO-II had the maximum net return (Rs. 237069 ha^{-1}) and the highest benefit-cost ratio (2.78). In contrast, the lowest net return (Rs. 112115 ha^{-1}) and benefit-cost ratio (1.81) were recorded in FP. The decreasing order of net return, as well as the benefit-cost ratio, was found to be: TO-II> TO-III> TO-I>FP.

Key words: Benefit-cost ratio, Cabbage, Net return, Quality, Spacing.

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L., Family: Brassicaceae) is an important green leafy cool weather vegetable crop (Chaudhary *et al.*, 2015), mainly grown in Uttar Pradesh, West Bengal, Gujarat, Orissa and Bihar. The edible section of cabbage, the crown portion of a compact spherical cluster of immature leaves, generally green, is called the head (Hossain *et al.*, 2015) which is used in a variety of dishes for its naturally spicy flavor. It is rich in protein, vitamin A, vitamin C, thiamine, riboflavin (Singh *et al.*, 2020), vitamin B, potassium and calcium (Hossain *et al.*, 2015).

The microclimate of the crop, or the climatic conditions around the plant from the deep root zone to the highest top canopy, which has a significant impact on the growth and yield of cabbage, is significantly influenced by optimum plant spacing and judicious application of organic and inorganic fertilizers (Islam *et al.*, 2017). To get the most out of the natural resources such as essential nutrients, solar radiation, soil moisture and aeration as well as to ensure satisfactory crop growth and yield, optimal cropping density should be maintained (Ullah *et al.*, 2013). The availability of solar radiation, particularly during the early growth and head formation stage, significantly impacts the yield and quality of cabbage (Paranhos *et al.*, 2016). The optimum plant spacing is determined by various factors, including the growing season, crop cultivars used, soil moisture availability and soil fertility status.

Cabbage, being a heavy feeder crop, has the capacity to uptake a higher amount of soil nutrients (Chatterjee *et al.*, 2016), rendering the soil unable to supply nutrients in the synchrony of growth stages without an external application. Verma and Maurya (2013) reported that total N, phosphorus and potassium uptake by cabbage were 212.7, 48.0 and 296.1 kg ha^{-1}, respectively, under bio-organo-chemical fertilization treatment. It is impossible to achieve desired quality and yield unless the soil fertility is restored through a balanced application of nutrients. To grow a healthy crop, the farmers must take good care of soil health. However, they seldom use organic and micronutrient supplements alongside inorganic fertilizers in a balanced way. Hence, the yield and quality of the cabbage are being compromised. The physiochemical and biological health of the soil must

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be maintained through the conjunctive application of organic and inorganic sources of nutrients (Dhillon and Singh, 2019). In addition to being less expensive and more effective than inorganics, organic materials show considerable potential as sources of multiple nutrients (Gudadhe *et al.*, 2015). Organic manuring is not a substitute for chemical fertilization, but it does help to lower the cost of nutrient management. In comparison to solitary application of inorganics, a precise combination of inorganic sources of nutrients with organics such as farm yard manure (FYM) and biofertilizers such as Azotobacter and phosphorus solubilising bacteria (PSB) etc. results in better uptake of essential nutrients (Kumar and Sharma, 2021). Kumar *et al.* (2012) suggested that the integrated use of inorganic fertilizer and organic elements helps to create a soil condition that is physically and chemically conducive to achieving higher crop productivity. However, under the medium land situation in the lower Gangetic plain of West Bengal, knowledge of the role of plant spacing along with nutrient management in cabbage is meager. The objective of this study was to assess the effectiveness of different cultivation practices with precise spacing and proper nutrient management on growth and yield attributes and the economics of cabbage cultivation over farmers' practice.

MATERIALS AND METHODS

The present investigation under the supervision of Purba Medinipur Krishi Vigyan Kendra was conducted in farmer's field of Rajakhali village in East Medinipur district of West Bengal, which is geographically situated at 22°17′68.4″ N latitude and 87°89′33.5″E longitude. According to the agro-climatic situation, the location under investigation is placed in the Lower Gangetic Plain Region (III) of West Bengal which has a subtropical-subhumid climatic condition. The average daily temperature (°C), rainfall (mm), humidity (%) and cloud (%) throughout the investigation period were recorded to be 26, 85.5, 70 and 20, respectively. The experimental soil belongs to the lower alluvium plains. The surface soil was clay loam in texture and the organic carbon and available NPK were found to be in medium range. The initial soil characteristics are presented in Table 2. The experiment was carried out during the rabi season from 3rd October 2019 to 12th January 2020. The experiment was laid out in randomized block design (RBD) in seven farmers' field and a plot size of 3 m × 2 m. Three technology options, along with one farmer's practice, were choosen for the experiment, which were (a) Farmers' practice: Random spacing (generally 35 × 35 cm^2) and fertilization, (b) Technology Option-I (TO-I): 60×30 cm^2 spacing with RDF, (c) Technology Option-II (TO-II): 60×45 cm^2 spacing with RDF and (d) Technology Option-III (TO-III): 60×60 cm^2 spacing with RDF. In contrast to the farmer's practice, which followed the random application of manures and fertilizers (@ 160:60:30 kg/ha N: P_2O_5: K_2O), the nutrient management methods employed in the experiment for the three technological alternatives are shown in Table 1. Recommended doses of organics were applied through FYM/compost (@10t/ha) and Azotobacter + PSB (@ 15 kg/ha), whereas inorganic fertilizers (@ 200:100:100 kg/ha N: P_2O_5: K_2O) were supplied in the form of urea, single super

Table 1: Manures and fertilizer combination use for the crop.

Name of manures and fertilizers	(Dose/ha)	Time of application	Available nutrients (Kg/ha)		
			N	P_2O_5	K_2O
FYM/Compost	10 ton	At the time of field preparation	5	2	5
Azotobacter+PSB	15 kg	At the time of field preparation	-	-	-
Urea	434 kg	217 kg at the time of field preparation, 108.5 kg at 21 and 40 DAT	200	-	-
SSP (Single super phosphate)	625 kg	All quantity at the time of field preparation	-	100	-
MOP (Muriate of potash)	166 kg	83 kg at the time of field preparation, 41.5 kg at 21and 40 DAT	-	-	100
Micronutrient mixture	2 gm or ml/lit	30 and 45 day after transplanting as a foliar spray	-	-	-
Ammonium molybdate	0.5 gm/lit	30 and 45 day after sowing as a foliar spray.	-	-	-

Table 2: Initial soil characteristics of the experimental site.

Soil parameters	Value	Soil parameters	Value
pH (1:2.5 ratio)	6.23 (Very Little acidic)	B	0.22 ppm (Low)
EC	0.52 dS/m (Normal)	Zn	1.95 ppm (Medium)
Organic carbon	0.58 (Medium)	Cu	1.45 ppm (High)
N	350.42 kg/ha (Medium)	Fe	101.43 ppm (High)
P_2O_5	53 kg/ha (Medium)	SO_4	7.2 ppm (Low)
K_2O	156.25 kg/ha (Medium)	Mn	1.98 ppm (Low)

phosphate (SSP) and muriate of potash (MOP). The micronutrients demand of cabbage was met through a micronutrient mixture (@ 2 g/lt) and ammonium molybdate (@ 0.5 g/lt). Full doses of manure and biofertilizers were applied during the final land preparation. Half of N and P, along with the full dose of K, was applied as basal dose. The remaining half of N and P was top dressed in two equal split doses of 21 and 40 DAT (days after transplanting). Micronutrient supplements were applied at 30 and 45 DAT as a foliar spray.

The experimental field was prepared in the last week of September by ploughing and cross ploughing, followed by laddering. The thirty days old cabbage seedlings of cv. Rare ball (Hybrid) were transplanted into the experimental field on the 3rd of October in the morning. Just after transplanting of seedlings, first irrigation was given and then subsequent irrigation was given at 15 to 20 day intervals, mainly depending upon the growing season and soil conditions. The border strip method of surface irrigation was practiced. Two hand weeding were given to keep the crop weed-free. Fluchloralin was also applied @ 250 ml/100 litre of water at 60 DAT to check the weed growth. Harvesting of matured cabbage heads was done phase-wise, starting from 83 DAT and continued up to 95th days based on the firmness of the head and maturity. Each head was cut with a sharp knife at the base, followed by the removal of outer leaves and stem. For all technology options as well as farmers' practice, ten plants were randomly selected and tagged appropriately for recording the specified data in each plot. Data on growth parameters such as plant height (cm), no of leaves per plant after 80 to 90 DAT depending on maturity and yield parameters such as the abnormal head (%), individual head weight and harvestable and marketable yield (t/ha) at harvest, were recorded and expressed as mean values. The data collected during the experiment were statistically analyzed as per the procedure prescribed by Gomez and Gomez (1984). Finally, the benefit-cost ratio of all the treatments was computed by calculating the cost of production along with net returns and gross income.

RESULTS AND DISCUSSION

Growth characteristics

The growth and yield attributes were significantly influenced by different technology options (Table 3). The maximum height of cabbage (37.2 cm) was gained in TO-III, having wider spacing (60×60 cm^2) with RDF, which was statistically at par with TO-I and TO-II having lesser spacing. The lowest plant height (32.3 cm) was obtained in the case of farmers' practice which was significantly different from all three technology options, *i.e.*, TO-I, TO-II and TO-III. The maximum height of cabbage in TO-III results from decreased intra- or inter-plant competition for growth-inducing elements such as easily accessible soil nutrients, solar radiation, soil moisture and aeration in the wider spacing than that in closer spacing. These results are in agreement with the findings of Moniruzzaman (2011) and Singh *et al.* (2020). According to Haque *et al.* (2015), plant height increased significantly with increased spacing as the wider spacing (50×50 cm^2) produced the tallest plant and the shortest one was in closer spacing (50×30 cm^2). The finding was supported by Ullah *et al.* (2013). The highest number of leaves per plant (16.2) was found in TO-I, which was statistically at par with TO-II (15.8) and the lowest no of leaves per plant (14.3) was obtained in FP (farmers' practice), which was statistically at par with TO-III (14.4). The outer or non-wrapper leaves in closer spacing were more as a result of diminished head size, whereas in the case of wider spacing, the size of non-wrapper leaves was larger, but the number was less.

Yield attributes

All three technology options, as well as farmer's practice, significantly influenced the number of abnormal heads of cabbage (Table 3). The maximum number of abnormal heads (17.2%) was found in farmers' practice, followed by TO-I (14.7%) and TO-II (11.3%). The lowest number of abnormal heads (7.8%) was found in the case of TO-III. This might be due to the availability of solar radiation, proper aeration and less pest and disease infestation provided by wider spacing. Žnidarčič *et al.* (2007) reported that the lowest plant spacing had a severe thrips damage rating resulting in reduced yield. *Thrips tabaci*, the polyphagous insects, prefer to stay within cabbage heads where they are concealed from the sunlight. The individual head weight of cabbage was also significantly influenced by all management practices. The maximum individual head weight (1.9 kg) was found in TO-III and the lowest individual head weight (0.9 kg) was found in the case of farmer's

Table 3: Growth and yield parameters of cabbage cultivation under different spacing and nutrient management options.

Technology option	No of trials*	Growth and yield component					Yield (t/ha)	
		Plant population	Plant height (cm)	No of leaves/plant	Abnormal head (%)	Individual head weight	Harvestable yield	Marketable yield
FP	7	56520	32.26	14.28	17.24	0.934	41.68	35.63
TO-I	7	51586	36.78	16.18	14.65	1.38	59.45	53.28
TO-II	7	34113	36.24	15.78	11.32	1.63	50.73	46.53
TO-III	7	26869	37.16	14.41	7.81	1.89	47.52	43.25
SE(m)	-	858.29	0.938	0.581	0.554	0.227	0.972	2.876
C.D. ($P \leq 0.05$)	-	2674	2.921	N/A	1.727	0.073	3.027	0.923

*The experiment was conducted in 7 farmer's fields across the location.

Table 4: Economics of cabbage cultivation as influenced by spacing and nutrient management (1 ha).

Technology options	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
FP: Random spacing and fertilization	137560	249675	112115	1.81
TO-I: 60 × 30 cm^2 spacing with RDF	140035	358452	218417	2.55
TO-II: 60 × 45 cm^2 spacing with RDF	133480	370549	237069	2.78
TO-III: 60 × 60 cm^2 spacing with RDF	128345	349650	221305	2.72

practice. The decreasing order of individual head weight was: TO-III> TO-II> TO-I> FP. Similar findings were also reported by Stoffella and Fleming (1990) and Abed *et al.* (2015). The maximum head weight in the wider spacing of TO-III might be due to the availability of sunlight and optimum aeration during head formation as a result of wider spacing; and proper absorption, translocation and assimilation of available soil nutrients due to the balanced application of organic and inorganic nutrients, ultimately leading to higher dry matter accumulation in cabbage head. The organic-inorganic combination helps in an efficient transfer of nutrients from source to sink without significant nutritional loss. According to Kumar and Sharma (2021), a higher accumulation of carbohydrates and protein and their transfer to the reproductive organs may have increased as a result of all these favorable circumstances, which ultimately results in satisfactory yield and yield parameters. Vats *et al.* (2001) studied that the application of organic manure along with the optimum NPK fertilizers improves the efficiency of chemical NPK fertilizers, increases crop yield by 16-44% and has a significant residual effect (11-31%) on succeeding crops.

Spacing and nutrient management practices significantly affected the harvestable and marketable yield of cabbage (Table 3). The maximum harvestable yield (59.5 t/ha) was obtained in TO-I, which was 42.6%, 25.1% and 17. 8% higher than FP, TO-III and TO-II, respectively. The lowest harvestable yield (41.7 t/ha) was found in the farmer's practice. Over farmer's practice, there was a 21.7% and 14.0% increase in harvestable yield in TO-II and TO-III, respectively. The maximum marketable yield (53.28 t/ha) was obtained in TO-I which was followed by TO-II and TO-III, having marketable yield of 46.53 t/ha and 43.25 t/ha, respectively. In TO-I, TO-II and TO-III, the marketable yield increased by 49.5%, 30.6% and 21.4%, respectively, over the farmers' practice. These findings of yield parameters are in accordance with Žnidarčič *et al.* (2007), Ullah *et al.* (2013), Chaudhary *et al.* (2015) and Devi *et al.* (2018). According to Abed *et al.* (2015), the greater spacing resulted in a lower harvestable and marketable yield. This finding is similar to Islam *et al.* (2017), who reported that the highest marketable yield (48.75 t/ha) was obtained with a closer plant spacing of 60×40 cm^2. Bhalerao *et al.* (2010) found a similar trend in seed cotton cultivation, where significantly higher yield was recorded in closer spacing (60x30 cm^2) than wider spacing (60×45 cm^2) while growth parameters and yield contributing characters were found superior under wider spacing than closer spacing. The wider spacing did not produce the highest yield as the number of plants was reduced by the unit area, whereas higher plant density, *i.e.*, more number of cabbage heads per unit area in the closer plant spacing (TO-I), resulted in higher harvestable yield as well as marketable yield (Moniruzzaman, 2011). Marketable yield accounted for 85.5%, 89.6%, 91.7% and 91.0% of the harvestable cabbage yield in FP, TO-I, TO-II and TO-III, respectively. A higher percentage of marketable yield in TO-II and TO-III might be due to less no of abnormal heads resulting from proper growth and development of cabbage head in the least competitive environment for space and nutrients. Poor growth and yield parameters in farmers' practice are due to indiscriminate use of fertilizers and random spacing, which will not only affect the yield but also adversely affect the crop as well as soil quality.

Economics

The data in Table 4 shows that the maximum net return of Rs. 237069 ha^{-1} with the highest benefit-cost ratio of 2.78 was recorded under TO-II, followed by TO-III and TO-I having a net return of Rs.221305 and Rs.218417 ha^{-1}, with BCR of 2.72 and 2.55, respectively. The lowest net return of Rs.112115 ha^{-1} and BCR of 1.81 was recorded under farmers' practice. The decreasing order of net return, as well as BCR, was found to be: TO-II> TO-III> TO-I>FP. The maximum net return and highest BCR in TO-II (60×45 cm^2 + RDF) might be due to a higher marketable yield than TO-III and better head quality and desirable head size than TO-I. Similar economics was also obtained by Khatiwada (2001), Haque *et al.* (2015). According to Islam *et al.* (2017), a wider (60×50 cm^2) spacing along with the combined application of organic and inorganic fertilizers has the ability to increase cabbage yield while lowering the amount and dosages of inorganic fertilizer, contributing to a lower cost of cultivation and higher net return. Zargar *et al.* (2021) reported that the integrated use of organic and inorganic fertilizers (75% inorganic nitrogen + Vermicompost + *Azotobacter* + PSB) recorded maximum B:C ratio as compared to control (100% NPK + FYM).

CONCLUSION

According to the experiment's findings summarized above, it can be concluded that cabbage should be cultivated using technology Option-II (TO-II: 60×45 cm^2 spacing + RDF) under conditions in the southern part of West Bengal since this management practice produced the best net return and highest benefit-cost ratio. However, in terms of quality, we may consider cabbage cultivation with wider spacing along with RDF *i.e.*, TO-III (60×60 cm^2 + RDF), as this technology option recorded the highest average head weight with the fewest abnormal ones and lowest pest-disease infestation.

But economically (B: C ratio), one should go for TO-II in order to maximize the net return. High planting densities and random application of fertilisers, mainly inorganics, by farmers are neither economically viable nor ecologically safe; therefore, these random unscientific practices must be avoided. The findings of this experiment showed that planting density along with proper nutrient management strategies significantly impacted the growth and production of cabbage.

Conflict of interest: None.

REFERENCES

Abed, M.Y., El-Said, E.M. and Shebl, E.F. (2015). Effect of planting date and spacing on yield and quality of cabbage (*Brassica oleracea var. capitata* L.). Journal of Plant Production. 6(12): 2093-2102.

Bhalerao, P.D., Patil, B.R., Ghatol, P.U. and Gawande, P.P. (2010). Effect of spacing and fertilizer levels on seed cotton yield under rainfed condition. Indian Journal of Agricultural Research. 44(1): 74-77.

Chatterjee, R.A.N.J.I.T., Choudhuri, P. and Thirumdasu, R.K. (2016). Uptake and availability of major nutrients in cabbage crop amended with organic and inorganic nutrient sources under Eastern Himalayan Region. Journal Basic and Applied Research International. 2: 100-105.

Chaudhary, M.M., Bhanvadia, A.S. and Parmar, P.N. (2015). Effect of integrated nutrient management on growth, yield attributes and yield of cabbage (*Brassica oleracea Var. Capitata* L.) under middle Gujarat conditions. Trends in Biosciences. 8(8): 2164-2168.

Devi, M., Spehia, R.S., Menon, S., Mogta, A. and Verma, A. (2018). Influence of integrated nutrient management on growth and yield of cauliflower (Brassica oleraceae) var. botrytis) and soil nutrient status. International Journal of Chemical Studies. 6(2): 2988-2991.

Dhillon, I.S. and Singh, D. (2019). Effect of integrated nutrient management on productivity and economics of *Rabi* onion (*Allium cepa* L). Journal of Krishi Vigyan. 8(1): 87-91.

Gomez, K.A., Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. (2nd Edn.). John Willey and Sons, Singapore. 28-92.

Gudadhe, N., Dhonde, M.B. and Hirwe, N.A. (2015). Effect of integrated nutrient management on soil properties under cotton-chickpea cropping sequence in vertisols of Deccan plateau of India. Indian Journal of Agricultural Research. 49(3): 207-214.

Haque, F.A., Islam, N., Islam, M.N., Ullah, A. and Sarkar, M.D. (2015). Growth, yield and profitability of cabbage (*Brassica oleracea* L.) as influenced by applied nitrogen and plant spacing The Agriculturists. 13(1): 35-45.

Hossain, M.F., Farhana, T., Raihan, M.Z., Hasan, M.S., Mia, M.M. and Rahman, M.M. (2015). Effect of different fertilization practices on the growth and yield of cabbage. Asian Journal of Medical and Biological Research. 1(2): 182-186.

Islam, M.A., Ferdous, G., Akter, A., Hossain, M.M. and Nandwani, D. (2017). Effect of fertilizers (organic and Inorganic) and plant spacing on the growth and yield of cabbage. Agriculture. 7(4): 31.

Khatiwada, P.P. (2001). Plant spacing: A key husbandry practice for rainy season cabbage production. Nepal Agriculture Research Journal. 48-55.

Kumar, R. and Sharma, S.K. (2021). Effect of integrated nutrient management on cabbage production in dry temperate region of Himachal Pradesh. Scientists Joined as Life Member of Society of Krishi Vigyan. 46.

Kumar, S., Dahiya, R., Kumar, P., Jhorar, B.S. and Phogat, V.K. (2012). Long-term effect of organic materials and fertilizers on soil properties in pearl millet-wheat cropping system. Indian Journal of Agricultural Research. 46(2). 161-166.

Moniruzzaman, M. (2011). Effect of plant spacings on the performance of hybrid cabbage (*Brassica oleracea var. capitata*) varieties. Bangladesh Journal of Agricultural Research. 36(3): 495-506.

Paranhos, L.G., Barrett, C.E., Zotarelli, L., Darnell, R., Migliaccio, K. and Borisova, T. (2016). Planting date and in-row plant spacing effects on growth and yield of cabbage under plastic mulch. Scientia Horticulturae. 202: 49-56.

Singh, A., Kumar, A., Yadav, S. and Singh, S. (2020). Effect of integrated nutrient management on growth and yield of cabbage (*Brassica oleracea* var. capitata L.). IJCS. 8(3): 1196-1200.

Stoffella, P.J. and Fleming, M.F. (1990). Plant population influences yield variability of cabbage. Journal of the American Society for Horticultural Science. 115(5): 708-711.

Ullah, A., Islam, M.N., Hossain, M.I., Sarkar, M.D. and Moniruzzaman, M. (2013). Effect of planting time and spacing on growth and yield of cabbage. International journal of Bio-resource and Stress Management. 4(2): 182-186.

Vats, M.R., Sehgal, O.K. and Mehta, O.K. (2001). Integrated effect of organic and inorganic manuring on yield sustainability in long-term fertiuzer experiments. Indian Journal of Agricultural Research. 35(1): 19-24.

Verma, R.A.J.H.A.N.S. and Maurya, B.R. (2013). Effect of bio-organics and fertilizers on yield and nutrient uptake by cabbage. Annals of Plant and Soil Research. 15(1): 35-38.

Zargar, J., Kumar, M., Kumar, S., Chopra, S., Kumar, S., Bhushan, A. and Gupta, R. (2022). Integrated nutrient management studies in cabbage (*Brassica oleracea*) under subtropical plains of Jammu. The Indian Journal of Agricultural Sciences. 92(1): 59-62.

Žnidarčič, D., Kacjan-Maršiæ, N., Osvald, J., Požrl, T. and Trdan, S. (2007). Yield and quality of early cabbage (*Brassica oleracea* L. *var. capitata*) in response to within-row plant spacing. Acta agriculturae Slovenica. 89(1): 15-23.