D-5921
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RESEARCH ARTICLE Agricultural Science Digest, Volume Issue : ()

Effect of Intercropping Spinach and Radish on Growth and Yield of Maize (*Zea mays*)

Millo K. Richo[1], Babita Tamuli[2], Chowlani Manpoong[3], Tamanna Pathak Talukdar[1]

10.18805/ag.D-5921

ABSTRACT

Background: Intercropping increases crop yield per unit area by intensifying the use of land. Cultivation of maize with leafy vegetables provides better use of land and other environmental resources, which results in higher economic yield. The current investigation aimed to study the effect of maize-spinach and maize-radish intercropping on growth and yield of maize under rainfed condition of Namsai district of Arunachal Pradesh.

Methods: The field experiment was conducted during 2021 in randomized block design consisting of 3 treatments *i.e*. T_1- Sole Maize, T_2- Maize + spinach and T_3- Maize + radish with four replications. Observations on growth and yield parameters and yield of maize were recorded on harvesting of the crop. The results were analysed using standard statistical procedures of ANOVA.

Result: In maize + spinach and maize + radish intercropping, plant height (176.3 cm), numbers of leaves (15.49) and leaf area (5407 cm^2 $plant^{-1}$) were significantly greater in sole maize than the intercropping system. On the other hand, the yield parameters as well as yield of maize was higher in maize + radish intercropping as compared to maize + spinach and sole maize system. The grain yield of maize under maize + radish intercropping was 3066.25 kg ha^{-1}. The B:C (1.92) was significantly higher in intercrops than the sole maize crop. From this study, it can be concluded that the intercrops are agronomically and economically viable than sole cropping. The intercropping of maize with radish would be profitable due to higher yield of maize as well as B:C (2 rows of maize and 2 rows of soybean) under farmer's field condition of Namsai district of Arunachal Pradesh.

Key words: Growth, Intercropping, Maize, Radish, Spinach, Yield attributes.

INTRODUCTION

Intercropping is an-old practice as it has attracted world-wide attention owing to yield advantages. To stabilize crop production and to provide insurance mechanism against aberrant weather situation characterizing rainfed agriculture, intercropping could be a viable agronomic means of risk minimizing farmers profit and subsistence-oriented, energy-efficient and sustainable system (Choudhary *et al*., 2014). In maize based intercropping system, selection of an appropriate intercrop having desirable plant type and growth pattern assumes greater importance. Crops maturing well before the peak growth period of maize are ideal (Hugar and Palled, 2008). Vegetable as intercrop provides monetary returns since they are quick growing and shorter duration than any other short duration agronomical crop. They are also considered as "Protective food" as they contain vitamins, minerals and dietary fibres apart from proteins, lipids and carbohydrates of biological value. Many leafy vegetables such as coriander, amaranthus, radish, spinach, mustard can be taken as intercrop. Many findings on maize+ vegetable intercropping system from different locations showed that the highest maize equivalent yield was obtained from Maize + Bush bean intercropping systems at Jamalpur, Maize + Spinach at Jessore, Mymensigh and Rangpur, Maize + coriander (as vegetable) at Pabna. Maize + Red amaranth at Kushtia and Manikganj (Hossain *et al*., 2015).

Now a days, the area of maize is increasing due to high local demand as well as high market price in Namsai district of Arunachal Pradesh. So, different short duration vegetable crops might be a good intercrop with maize. Farmers often demand for quick return from their crops, so that they can get quick return by growing short duration vegetable crops with maize. However, suitable intercrops, local food habit and market demands are important factors for getting higher benefit. Moreover, little information is available for suitable intercrop combination of vegetables with maize. Considering the above facts, the experiment was undertaken to evaluate the performance of maize under intercropping with different short duration vegetables *viz*., Spinach and Radish for selection of suitable intercropping of vegetables with maize for increasing cropping intensity as well as farmers' income under rainfed condition of Namsai district of Arunachal Pradesh.

[1]Department of Agronomy, Arunachal University of Studies, Namsai-792 103, Arunachal Pradesh, India.
[2]Krishi Vigyan Kendra, Dibrugarh-786 010, Assam, India.
[3]Guru Ghasidas Vishwavidyalaya, Bilaspur-495 009, Chhattisgarh, India.

Corresponding Author: Babita Tamuli, Krishi Vigyan Kendra, Dibrugarh-786 010, Assam, India. Email: babitatamuli@gmail.com

How to cite this article: Richo, M.K., Tamuli, B., Manpoong, C. and Talukdar, T.P. (2024). Effect of Intercropping Spinach and Radish on Growth and Yield of Maize (*Zea mays*). Agricultural Science Digest. DOI: 10.18805/ag.D-5921.

Submitted: 17-11-2023 **Accepted:** 26-04-2024 **Online:** 12-06-2024

MATERIALS AND METHODS

The experiment was conducted during *rabi* season 2020-21 at the Agriculture Research Farm, Arunachal University of studies, Namsai Arunachal Pradesh, located in between latitude 27°30′ to 27°55′N and longitude 95°52′ to 96°20′E with an elevation of 156 m a.s.l. The average annual temperature is 22.8°C. Maximum and minimum winter temperatures are 25°C and 10°C, respectively. Precipitation here averages 2728 mm with maximum rainfall 750-800 mm is recorded during July-August with a relative humidity of 80%. The soil of the experimental field comes under the soil order of *Inceptisols.* It is sandy loam in texture. The three treatments were selected with four replications and each consist of a Sole Maize as Control (T_1), Maize + Spinach intercropping (T_2) and Maize + Radish intercropping (T_3) having the Gross plot size of 12.20 m × 7 m and Net plot size- 4.5 m × 5 m. The variety used during investigation was Ganga 5 for maize, All Green for spinach and Pusa Chetki for radish. The replicated treatments were laid out under randomized block design (RBD). The crops were sown on 4th March, 2021. Row spacing of 60 cm × 25 cm was followed for sowing of sole maize. The seeds of spinach and radish were sown 20 cm apart, *i.e.* two lines of vegetables in between two lines of maize. The seed rate of maize was 22.5 kg ha^{-1} for each treatment. The seed rate of spinach and radish were 20 kg ha^{-1} and 10 kg ha^{-1}, respectively. FYM were applied during land preparation (10 t/ha). Before sowing the seeds of maize, spinach and radish were treated with Carboxin @ 2 g/kg seeds. In the sole crop, fertiliser dose was given as per respective crop's recommendation (Assam Agricultural University, 2021). In intercropping it was that of main crop *viz*. maize. In maize, recommended dose of N: P_2O_5: K_2O was 60:40:40 kg ha^{-1}. The entire quantity of P_2O_5 and K_2O and half of N were applied in furrows before sowing. The remaining quantity of N were top dressed at 30 days after emergence of seedlings. The intercrops of spinach and radish were harvested during 35-45 DAS. The maize crop was harvested 150-160 DAS. In case of maize, the cobs were harvested when the husk cover turns pale yellow. The maize was shelled by hand and the grain yield was expressed at 14% moisture content.

In this study, the growth attributes concerned plant height, number of leaves per plant and leaf area per plant, while the yield parameters relate to length of cob, cobs number per plant, cobs diameter, thousand grains weight and grain yield. Plant height (cm) was measured from the base of the plant to upper the topmost leaves. Leaf area was estimated non-destructively from leaf length (cm), from the collar to the tip of fully expanded leaves and leaf width (cm) at the widest point. It was calculated as the product of leaf length and widest middle portion of the leaf and multiplied by the correction factor (0.75) (Elings, 2000). The plants of two central rows were used for data collection. All the growth and yield parameters were recorded at harvest. Grain yield of maize was recorded by threshing the crop after 10-15 days of air-drying the cobs. The grain yield was adjusted at 14% grain moisture content. Thousand grains weight (g) was taken from the three-grain lot of each treatment and weighed by using electronic digital balance.

Data collected on various growth and yield parameters were subjected to analysis of variance (ANOVA) techniques using statistical analysis system software The treatments means was separated using LSD test at 0.05 probabilities.

RESULTS AND DISCUSSION

Effect of cropping system on growth parameters of maize

The growth attributes of maize plant *i.e*., plant height, number of leaves and leaf area got affected significantly when planted with different intercrops (spinach and radish). All the growth attributes of maize were highest in sole maize followed by maize + radish inter-cropping (Table 1). The harmful effect of inter crop on maize was probably due to not liking association with the root on one hand and the less availability of nutrients and environmental resources *viz*. solar radiation, light, moisture and space to grow freely for the maize plant on the hand. The reduction in various growth parameters maize under intercropping associations has been reported earlier by Silwana and Lucas (2002); Jha *et al*. (2002) and Hussain *et al*. (2015). The intercropping of radish as root vegetable with maize established its superiority in growth parameters over spinach and it was also comparable to sole maize system.

Effect of cropping system on yield parameters and yield of maize

The yield components of maize *viz*., cobs length, number of cobs per plant, cob diameter and 1000 grain weight were significantly influenced by different intercrops in combination of spinach and radish. These yield components of maize were higher under maize + radish intercropping (Table 2). This might be due to that the radish intercrop was less aggressive as compared to spinach and because of the fact the radish exerted less competition for nutrient, light, moisture and space. Consequently, maize plants did grow comfortably under maize + radish association and performed better pertaining to yield parameters. These circumstances hereby made available some extra nutrients to the maize crop. Thus, additional

Table 1: Effect of cropping system on growth attributes of maize in maize + spinach and maize + radish intercropping.

Treatments	Plant height (cm)	Number of leaves per plant	Leaf area (cm^2 $plant^{-1}$)
Sole maize	176.3	15.49	5407
Maize + spinach	165.4	13.85	4015
Maize + radish	168.4	14.72	4475
SE (m)±	2.15	0.61	6.81
CD (P= 0.05)	8.44	2.40	26.72

Table 2: Effect of cropping system on yield parameters and yield of maize in maize + spinach and maize + radish intercropping.

Treatments	Length of cob (cm)	Number of cobs per plant	Cob diameter (cm)	1000-grain weight	Grain yield (kg ha^{-1})
Sole maize	15.5	1.33	16.35	218.3	1837.50
Maize + spinach	15.9	1.35	16.47	221.0	2279.17
Maize + radish	16.7	1.62	17.25	223.0	3066.25
SE (m)±	0.44	0.13	0.27	5.80	8.49
CD (P= 0.05)	1.71	0.50	1.07	22.76	33.34

Table 3: Economics of maize as influenced by maize + spinach and maize + radish intercropping.

Treatments	Total cost (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Sole maize	27988.00	33984.00	5996.00	1.21
Maize + spinach	30188.00	42162.00	11974.00	1.40
Maize + radish	29588.00	56721.00	27133.00	1.92

advantage of resources might have resulted in overall development of maize crop in terms of yield attributes. The yield components of maize in maize + spinach showed more or less equal value as that of sole maize.

All the intercropping systems showed superiority over sole cropping of maize. Maximum maize yield (3066.25 kg ha^{-1}) was recorded under maize + radish intercropping system (Table 2). The grain yield of maize significantly increased by 24.04 and 66.87% in spinach and radish intercropping respectively, compared with the sole cropping of maize. Higher maize yield under intercropping pattern of maize + radish and maize + spinach might be due to the better utilization of resources and balanced competition between component crops and also increase in yield attributing characters. Similar finding was also reported by Mandal *et al*. (2014). Among inter-cropping systems, Patra *et al*. (1990), reported an increase in grain yield of maize by 2.32 to 7.5% of maize when it was intercropped with grain legumes over sole cropping. Row arrangement, in contrast to arrangement of component crops within rows, may also influence the productivity of an intercropping system (Oseni and Aliyu, 2010).

Economics of the system

Total cost, gross return, net return and B:C of maize-vegetable intercropping systems were shown in Table 3. The overall total cost was less in sole maize than those of intercrop combination. Maize + radish intercropping gave comparatively highest gross return (56721.00 Rs. ha^{-1}) and net return (27133.00 Rs. ha^{-1}) as well as highest B:C (1.92) followed by maize + spinach intercropping over sole cropping of maize. Many researchers also documented higher gross margin or net return in intercropping system than sole crop (Alam *et al*., 2008; Bhuiyan *et al*., 2013 and Farhad *et al*., 2014). Uddin*et al*. (2009) also documented that all the Maize-vegetables intercropping system in the hilly areas of Bangladesh showed higher B:C than sole maize, which also strongly supports the above findings.

CONCLUSION

From these results, it revealed that maize grown as intercrop with short duration vegetables like spinach and radish may be profitable than sole maize. All of the intercrop combinations are agronomically and economically viable than sole cropping. The results finally suggest the possibility of obtaining a reasonably good yield and profitable economic return from intercropping maize with radish having the planting geometry of two rows of radish with two rows of maize under farmer's field of Namsai region of Arunachal Pradesh.

Conflict of interest

All authors declare that they have no conflict of interest.

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