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Studies on Growth, Productivity and Economics of Baby Corn as Influenced by Crop Diversification of Baby Corn-based Cropping Systems

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ABSTRACT

A field experiment was conducted at the Agricultural Farm of Institute of Agriculture, Birbhum, West Bengal, India during winter from November to January of 2021–22 and 2022–23 respectively to evaluate growth, productivity and economics of baby corn as influenced by baby corn-based cropping systems. The experiment was laid out in randomized block design with seven treatments (viz., baby corn-sesame, baby corn–green gram, baby corn–baby corn, baby corn–okra, baby corn–groundnut, baby corn–black gram and baby corn–cowpea) where each treatment was replicated thrice. Growth attributes, viz. LAI, dry matter accumulation, CGR, corn fresh weight and dry weight, yield components, yield and economics of baby corn. were significantly influenced by baby corn based cropping sequence on pooled data basis. Among different baby corn based-cropping sequences, baby corn in baby corn-groundnut cropping sequence exhibited significantly higher growth attributes, yield components (corn fresh weight and dry weight) and yield viz., cobs plant^{-1} (3.1), number of corns ha^{-1} (250667 ha^{-1}) and green fodder (28.2 t ha^{-1}) of baby corn than all other cropping sequences except baby corn-cowpea and baby corn-green gram sequence which was at par with each other. Baby corn in baby corn-groundnut cropping sequence fetched significantly higher gross return (₹ 3,07,105 ha^{-1}), net return (₹ 2,53,122 ha^{-1}), return rupee^{-1} invested (₹ 5.7) and economic efficiency (₹ 3,693 unit area^{-1} day^{-1}) than all other baby corn-based cropping sequences except baby corn-cowpea which was at par with each other. So, inclusion of legumes (like groundnut, cowpea and green gram) was better proposition than inclusion of non-legumes in baby corn-based cropping sequences.

KEYWORDS: Baby corn, crop sequence, diversification, economics, growth, yield

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Maize production in South Asia is growing due to its year-round growth, high yield potential, and market demand, replacing winter wheat and rice, and its resilience to climatic changes. (Ghosh et al., 2020). Baby corn, an unfertilized, dehusked cob, is a recent development in maize farming, allowing farmers to diversify and add value to their crops, contributing to the growth of food processing industries. (Mahapatra et al., 2018). In India, especially in peri-urban agglomeration, maize is taking place by replacing the other non-remunerative crops. Among the specialty corns, baby corn is becoming very popular owing to higher market demand, economic returns, export and huge employment generation potential (Meena et al., 2023, Singh et al., 2018 and Lodh et al., 2024). To feed the increasing population, agricultural intensification and area has increased rapidly raising a big question mark on agricultural sustainability (Verma et al., 2015). Huge burden on agriculture to (1) manage food insecurity to feed the increasing population, (2) address adverse impacts of global climate change, and (3) maintain the resource base and soil quality improvement (Meena et al., 2015). Diversification and intensification of cereal-based production system with the inclusion of short duration crops along with conservation, effective soil and crop management practices also increased the land, water, and nutrient productivity in Indo Gangetic plains (Hazra et al., 2018; Dalal and Shankar 2022) and coastal region of India (Singh et al., 2021) under conventional management system with assured irrigation facilities. Sole cropping, small farmers are unable to address their diversified domestic needs to sustain normal living from their limited land, water and economic resources. (Baishya et al., 2019 and Mullaimaran et al., 2019). Maize with a legume cropping system has been recorded with significantly improved soil health and farm productivity as compared to the sole maize system (Yadav et al., 2018; Panwar et al., 2021). Under the present dispensation of demand for high value crops, addressing the constraints faced by small holders is vital for their inclusion in the development process of Indian agriculture and rural India. Hence, there is a need to diversify the cropping pattern from the traditional cereal crops to high value crops such as legume and vegetables. (Gummagolmath et al., 2020 and Negi et al., 2016) Adoption of different maize-based cropping systems i.e maize-wheat-green manure, maize-potato-summer moong, maize-potato-onion can help in increasing the farmers' income and alleviating the soil heath degradation (Mal and Chaudhary, 2024 and Singh et al., 2018 legume plays a key role in cropping systems (Stagnari et al., 2017 and Meena et al., 2022). Cropping systems improve soil quality, fix atmospheric nitrogen, and enhance nutrient recycling, especially for coarse-textured soils. Established root systems support plant nutrition and water requirements, reducing greenhouse gas emissions up to 25% (Ma et al., 2018 and Sadashivanagowda et al., 2021).

Various cropping systems, such as rice-wheat, groundnut, sugarcane, chickpea, arhar, soybean, and winter maize, require diversification for sustainability and resource conservation. (Kumar et al., 2024; Banjara et al., 2022; Tetarwal et al., 2023) Diversification of cropping systems are necessary to get higher yield and return, to maintain soil health, preserve environment and meet daily requirement of human and animals (Saha et al., 2020 and Shahane and Shivay, 2019). Crop diversification in maize through maize-based cropping systems is beneficial in improving the productivity and profitability with efficient utilization of inputs (Khanam et al., 2018 and Sinha et al., 2018)

Keeping in view the above mentioned idea the present experiment was attempted to study on growth productivity and economics of baby corn on influenced by various baby corn based cropping sequences in red and lateritic soil.

2. MATERIALS AND METHODS

2.1. Experimental period and location

A field experiment was conducted at agricultural farm of Palli Shiksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal, India during *kharif* for the month November to January of 2021–22 and 2022–23. The experimental soil was acidic in reaction (pH 5.8), low in available nitrogen (157.4 kg ha^{-1}) and available phosphorus (14.7 kg ha^{-1}) and medium in available potassium (157.3 kg ha^{-1}) and experimental site lies in a sub-humid and semi-arid area of West Bengal situated at $23^0$66'N latitude, $87^0$65'E longitude with an altitude of 58.9 m from mean sea level.

2.2. Experimental design and treatment details

The experiment was conducted in a randomized block design with seven treatments (viz. T_1 baby corn–sesame, T_2 baby corn–green gram, T_3 baby corn–baby corn, T_4 baby corn–okra, T_5 baby corn–groundnut, T_6 baby corn–black gram and T_7 baby corn–vegetable cowpea) each with three replications.

2.3. Package and practices

A total of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} were applied to the baby corn. Total quantity of P_2O_5, K_2O and half quantity of total nitrogen was applied as basal dose during final land preparation and top dressing of the remaining half of nitrogen was done at the time of earthing up at 30 DAS (day after sowing). Sowing was done following all the recommended agronomic package of practices. The summer crops were raised as per recommended package of practices for each crop after harvest of baby corn as succeeding crops.

2.4. Observations and procedure of data recorded

The biometric observations for different growth parameters, yield attributes and yield of baby corn were recorded at regular interval. The crop was harvested as green fodder after the completion of cob picking. Plant height, leaf area index, dry matter accumulation and CGR were measured and recorded. Whereas, at maturity period the yield parameters like cob and corn length, cob and corn girth, cob and corn fresh weight, cob and corn dry weight, no of cob plant^{-1}, no of cob ha^{-1}, green fodder yield were measured and recorded for estimation of yield of baby corn. The cost of cultivation, gross return, net return and return rupee^{-1} invested (gross return/cost of cultivation) economic efficiency (the ratio of net return to the no. of day in cropping period) were calculated on the basis of prevailing market price of different inputs and selling price of crop product.

2.5. Methods of statistical analysis

Statistical analysis of the experimental data was done as described by (Gomez and Gomez, 1984) at 5% level of significance. Two years data were subjected to pooled analysis and the pooled data are been presented in tables.

3. RESULTS AND DISCUSSION

3.1. Growth attributes

The growth attributes of baby corn viz. leaf area index, dry matter accumulation and CGR at different growth stages were significantly influenced by crop diversification in various baby corn–based cropping sequences on pooled data basis (Table 1). The parameters such as plant height, dry matter and CGR were found to have an increasing trend with the advancement of crop growth and highest values was attained at harvest stage except CGR which was highest at 30–60 DAS. However, LAI of baby corn had an increasing trend only up to 60 DAS and declined at harvest irrespective of the treatments. At all stages of growth, baby corn plant height (Table 1) did not vary significantly, however higher plant height was recorded in baby corn–groundnut sequence over the other baby corn based cropping sequences treatments.

Highest LAI of baby corn in baby corn–groundnut (3.4) sequence was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram, baby corn–green gram and baby corn–baby corn sequences and significantly higher than baby corn–sesame (3.0) and lowest LAI was recorded in baby corn–okra cropping sequence. This might be attributed to increased light interception, absorption and utilization of solar radiation thus enhancing photosynthesis which was reflected in LAI and dry matter production as mentioned by Mahapatra et al. (2018). A decline in leaf area after 60 DAS was recorded in the crops irrespective of the treatments mainly due to leaf senescence which was reported by Mohan et al. (2015).

The treatment baby corn–groundnut sequence proved significantly superior in terms of dry matter produced by baby corn. Highest dry matter accumulation was found in baby corn–groundnut sequence (584.6 g m^{-2}) which was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram and lowest dry matter accumulation was recorded in baby corn in baby corn–okra sequence. Dry matter accumulation increased progressively with progressive increase in growth and development and the value attained peak at harvesting stage. Dry matter accumulation production was largely a function of photosynthetic surface, which was favorably influenced by N–fertilization. Jena et al. (2022) was in enformity with the finding that legumes in the cropping system helped in positive correlation between N rates and dry matter yield in maize. Rapid division and elongation of cells with increasing fertility level particularly N and greater availability of nitrogen at higher fertilizer doses which improved photosynthesis ultimately led to increased dry matter accumulation on growth of maize grown for baby corn.

Table 1: Growth attributes of baby corn as influenced by various baby corn-based cropping sequences

Treatment	Plant height (cm) at harvest	LAI at harvest	Dry matter accumulation (g m^{-2}) at harvest	CGR (g m^{-2} day^{-1}) at 30–60 DAS
T_1: Baby corn–Sesame	123.8	3.0	499.2	15.6
T_2: Baby corn–Green gram	132.3	3.1	527.3	16.3
T_3: Baby corn–Baby corn	128.0	3.1	500.8	15.6
T_4: Baby corn–Okra	122.6	2.8	488.9	15.3
T_5: Baby corn–Groundnut	135.3	3.4	584.6	18.0
T_6: Baby corn–Black gram	128.7	3.1	516.7	16.0
T_7: Baby corn–Veg.cowpea	132.3	3.3	563.4	17.3
SEm±	4.3	0.1	17.3	0.6
CD (p=0.05)	NS	0.3	53.2	1.8

Comparing the results of CGR the highest CGR at 30–60 DAS of baby corn was observed in baby corn–groundnut (18.0 g m^{-2} day^{-1}) sequence which was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram corn sequences and significantly higher than baby corn–green gram and baby corn–baby and lowest dry matter accumulation was recorded in baby corn–okra cropping sequence. Rest of the treatments could not reach the level of significance. This might to be attributed to legumes in the cropping system which helped in direct nitrogen transfer, residual fixed nitrogen, nutrient availability and uptake and on soil properties resulted in acceleration of growth parameters of plants as reported by Jena et al. (2022). Similar results in terms of higher growth attributes in baby corn (*Zea mays* L.)–hyacinth bean (*Lablab purpureus* var. *typicus*) cropping system and rice was reported by Preetham et al. (2020) and Saha et al. (2020). These results also confirmed with the findings of Meena et al. (2022).

3.2. Yield components and yield of baby corn

Yield attributes viz., cob length, cob girth, cob fresh weight, cob dry weight, corn length and corn girth was not influenced significantly. A significant difference was found in corn fresh and dry weight, no. of cobs $plant^{-1}$, no. of cobs ha^{-1} and green fodder yield and yield of baby corn on pooled data basis (Table 2). In baby corn significantly highest corn fresh weight was obtained in baby corn–groundnut (11.5 g) sequence which was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram , baby corn–green gram and lowest corn fresh weight was recorded in baby corn–okra and highest corn dry weight was obtained in baby corn–groundnut (1.4 g) sequence which was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram, and lowest corn dry weight was recorded in baby corn–okra. Significant improvement in yield attributes of baby corn during crop period can be attributed to gradual availability of nitrogen through inclusion of leguminous crop in cropping sequence and recommended fertilizer dose of nitrogen during growing season with minimum losses resulting better plant growth and higher photosynthates accumulation. And this might be attributed to legume crops taking part in fixing atmospheric nitrogen biologically and can supply available nitrogen to current season crop as well as succeeding crops which enhanced 9.7–20.5% residual nitrogen content in field as mentioned by Yu et al. (2014).

Highest number of cobs $plant^{-1}$ was obtained in baby corn–groundnut (3.1) sequence which was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram and lowest corn dry weight was recorded in baby corn–okra and highest number of corns ha^{-1} was obtained in baby corn–groundnut (2,50,667 ha^{-1}) sequence which was at par with baby corn in baby corn–vegetable cowpea, baby corn–black gram. Higher baby corn yield could be attributed to more efficient utilization of nitrogen from leguminous crop sources in different cropping sequences compared to the single source viz. recommended fertilizer dose of nitrogen. The highest green fodder yield was obtained in baby corn–groundnut sequence (28.2 t ha^{-1}) which was at par with baby corn in baby corn–vegetable cowpea, but significantly higher when compared to other crop sequences, viz. baby corn–green gram, baby corn–black gram, baby corn–baby

Table 2: Yield components, yield of baby corn as influenced by various baby corn–based cropping sequences

Treatment	Cob length (cm)	Cob girth (cm)	Cob fresh weight (g)	Cob dry weight (g)	Corn length (cm)	Corn girth (cm)	Corn fresh weight (g)	Corn dry weight (g)	No. of cobs $plant^{-1}$	No of cobs ha^{-1}	Green fodder yield (t ha^{-1})
T_1: Baby corn–Sesame	22.7	7.7	46.2	10.5	10.9	5.5	9.8	1.2	2.6	210667	25.0
T_2: Baby corn–Green gram	23.4	8.1	46.8	10.6	11.3	5.8	10.7	1.4	2.8	224000	25.8
T_3: Baby corn–Baby corn	22.8	7.8	46.6	10.5	10.9	5.6	10.0	1.3	2.7	216000	25.4
T_4: Baby corn–Okra	22.5	7.5	45.0	10.4	10.8	5.4	9.5	1.1	2.6	205333	24.4
T_5: Baby corn–Groundnut	24.3	8.2	48.0	10.8	11.9	6.1	11.5	1.4	3.1	250667	28.2
T_6: Baby corn–Black gram	23.4	8.1	46.6	10.6	11.1	5.7	10.3	1.3	2.7	218667	25.7
T_7: Baby corn–Veg. cowpea	23.6	8.1	46.9	10.6	11.5	5.8	11.1	1.4	2.9	234667	27.3
SEm±	0.67	0.35	1.5	0.3	0.3	0.2	0.4	0.0	0.1	8661	0.77
CD (p=0.05)	NS	NS	NS	NS	NS	NS	1.2	0.1	0.3	26686	2.36

corn and baby corn–sesame and lowest green fodder was recorded in baby corn–okra. Upadhaya et al. (2022) was in enformity with the finding that increase in yield observed with inclusion of legumes was due to improvement in yield resulted in better translocation, utilization and partitioning of photosynthates. Moreover, improvement in soil physico–chemical and biological properties in baby corn based–cropping sequences resulted in better performance of baby corn than inclusion of non–legumes in the system. The higher yield components of baby corn in baby corn– legume sequences might be attributed to the 'nitrogen effect' of the associated legume crop through N provision from BNF. Kumar et al. (2024) also reported similar results in potato when it was grown in potato–legume sequences and these results confirmed the findings of Meena et al. (2023).

3.3. Economics

During two years of field experiments, gross return, net return, return per rupee investment and economic efficiency in baby corn were significantly influenced by various baby corn–based cropping sequences (Table 3). The highest gross return in baby corn was achieved in baby corn–groundnut (₹ 307105 ha^{-1}) sequence which was statistically at par with baby corn–vegetable cowpea and lowest gross return was recorded in baby corn–okra. These findings ware in conformity with findings of Hiremath et al. (2016). Baby corn–groundnut cropping sequence recorded significantly higher net return (₹ 253122 ha^{-1}) in baby corn which was statistically at par with baby corn–vegetable cowpea and lowest net return was recorded in baby corn–okra. These findings were in conformity with findings of Hiremath (2016).

The return rupee^{-1} investment of baby corn was highest in baby corn–groundnut sequence (₹ 5.7) which was statistically at par with baby corn–vegetable cowpea. These findings ware in conformity with findings of Maske et al. (2020). This result was due to highest number of corns ha^{-1} and prevailing market price of baby corn. Inclusion of legume and vegetable crops in a sequence enhanced the economic efficiency. Highest economic efficiency was achieved in baby corn–groundnut sequence (₹ 3693 unit area^{-1} day^{-1}) which was statistically at par with baby corn–vegetable cowpea. These findings ware in conformity with findings of Maske et al. (2020) and Samant (2015).

Table 3: Economics of baby corn as influenced by various baby corn–based cropping sequences

Treatment	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Return per rupee invested (₹)	Economic efficiency (₹ unit area^{-1} day^{-1})
T_1: Baby corn–Sesame	53983	258020	204038	4.8	2978
T_2: Baby corn–Green gram	53983	275611	221629	5.1	3235
T_3: Baby corn–Baby corn	53983	266880	212898	4.9	3107
T_4: Baby corn–Okra	53983	256806	202823	4.8	2960
T_5: Baby corn–Groundnut	53983	307105	253122	5.7	3693
T_6: Baby corn–Black gram	53983	269967	215985	5.0	3152
T_7: Baby corn–Veg.cowpea	53983	283904	229921	5.3	3356
SEm±	-	9213.43	9213.43	0.17	134.7
CD (p=0.05)	-	28389.41	28389.41	0.53	414.9

1US$=78.09 INR (average monthly value of January, 2022 and 2023)

4. CONCLUSION

Among various baby corn based cropping sequences, baby corn in baby corn groundnut sequence performed best with respect to growth attributes, yield attributes and yield gross return, net return, return per rupee investment, and economic efficiency.

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