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Agronomic and economic evaluation of baby corn under varying row spacing and phosphorus levels in irrigated black soils of Andhra Pradesh

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Abstract
An efficient production technology is essential for maximizing remunerative yields of baby corn, including both ear and fodder (green and dry) components. Optimal crop geometry enhances productivity by improving resource-use efficiency and light interception. Additionally, the crop's high plant density and short growth duration further emphasize the need for timely and adequate nutrient supply. In light of this, a field experiment was conducted at the Fodder Production Farm, Livestock Research Station, Lam, Guntur to study the effect of different row spacing (40 × 15, 45 × 15, and 50 × 15 cm) and phosphorus levels (40, 50, and 60 kg ha^{-1}) on the yield and economics of baby corn. The results of experiment revealed that, baby corn at a spacing of 50 × 15 cm with the application of 50 kg ha^{-1} phosphorus at sowing is beneficial for farmers in the Krishna Zone of Guntur, Andhra Pradesh, as it ensures higher net returns along with ample green fodder availability.

Keywords: Baby corn, spacing, phosphorus, yield, B:C ratio, economics, fodder

Introduction

With the improvement in living standards and the advancement of science and technology, there has been a notable shift from the traditional use of maize primarily as a staple grain towards increased consumption of green ears, particularly in urban and peri-urban areas.

Baby corn is the dehusked immature cob of maize, harvested 2–3 days after silk emergence, prior to fertilization, to ensure tenderness and suitability for vegetable use. Being a C4 plant, baby corn efficiently converts nutrients into biomass and is a rich source of folate, vitamin B, and other essential nutrients (Rakesh Kumar and Jintendra Singh B. 2014) [1]. One baby corn can be compared with an 'egg' in terms of minerals (Mythili Teja. RPS *et al.*,2021) [2]. It is a low calorie high fibre vegetable that is cholesterol free (Kumar *et al.*, 2006) [3].

Baby corn cultivation has been effectively integrated with dairy farming systems in several countries. Notably, only 13-20% of the fresh ear weight is utilized for human consumption, while the remaining biomass (husk, silk, and green stalk) serves as a valuable source of green fodder. This multifunctional utilization significantly contributes to enhancing livestock productivity and overall farm efficiency (Ravichandra K *et al.*, 2022) [4]. Due to its multiple advantages, baby corn is cultivated year-round under irrigated conditions in India. It is prized not only for its tender cobs consumed as a vegetable but also for its considerable contribution to green fodder supply, supporting integrated crop-livestock systems. As a nutrient-rich vegetable crop with the added benefit of fulfilling livestock feed requirements, baby corn offers a strategic opportunity for resource-poor farmers to diversify their farming practices and improve income generation.

Adoption of scientifically proven agronomic techniques enhances both cob yield and biomass quality, supporting sustainable intensification of baby corn-based farming systems, especially under irrigated conditions. Among various agronomic practices, crop geometry is regarded as a critical factor in optimizing the interception of solar radiation and efficient utilization of soil resources. As a nutrient-demanding crop, its productivity is highly influenced by the timely and adequate supply of essential nutrients (Neelam *et al.*,2018) [5]. Further, phosphorus plays a key role in root development, energy transfer, and cob formation, particularly in phosphorus-deficient black soils commonly found in the Krishna agro-climatic zone of Andhra Pradesh.

By adopting improved agronomic practices, farmers can achieve a fresh green fodder yield of 40 to 45 tonnes per hectare, resulting in a net income of ₹40,000 to ₹45,000 per hectare. This can serve as a significant livelihood booster, particularly for small and marginal farmers, by enhancing their socio-economic status. (Kuamr *et. al.,* 2015) [6].

Although spacing and phosphorus requirements are well established for grain and fodder maize, limited information exists on their impact on the performance of baby corn varieties. To maximize monetary benefits for baby corn growers, it is essential to ensure optimal spacing and nutrition. Considering these factors, a field experiment was conducted to evaluate the impact of different row spacings and phosphorus application levels on the yield and economics of baby corn grown under irrigated conditions in the black soils of the Krishna Zone, Andhra Pradesh (India).

Materials and Methods

Field experiment was conducted under irrigated conditions during *Rabi* season of 2020 at the Fodder Production Farm of Livestock Research Station, Sri Venkateswara Veterinary University, Lam, Guntur (Andhra Pradesh). The soil properties of the experimental field are mentioned in Table. No.1.

The field experiment consists of 9 treatment combinations which were replicated thrice and laid out in randomized black design. The treatments comprise T1:40 x 15 cm Row spacing + 40 kg. ha^{-1} P_2O_5; T_2:40 x 15 cm Row spacing + 50 kg. ha^{-1} P_2O_5;T_3:40 x 15 cm Row spacing + 60 kg. ha^{-1} P_2O_5; T_4:45 x 15 cm Row spacing + 40 kg. ha^{-1} P_2O_5; T_5:45 x 15 cm Row spacing + 50 kg. ha^{-1} P_2O_5; T_6:45 x 15 cm Row spacing + 60 kg. ha^{-1} P_2O_5; T_7:50 x 15 cm Row spacing + 40 kg. ha^{-1} P_2O_5; T_8:50 x 15 cm Row spacing + 50 kg. ha^{-1} P_2O_5; T_9:50 x 15 cm Row spacing + 60 kg. ha^{-1} P_2O_5.

A hybrid baby corn variety, G 5414, developed by Syngenta Pvt. Ltd. was selected for the study. Sowing was carried out manually using the dibbling method, ensuring adherence to the specified spacing for each treatment. To ensure a uniform plant stand and to minimize the occurrence of missing hills, two seeds were sown per planting hole. At 13 days after sowing (DAS), thinning was carried out by retaining the more vigorous and healthy seedling, while the weaker seedling was removed from each hill. Nitrogen was applied in the form of urea in two equal splits: 50% at the time of sowing and the remaining 50% at 30 days after sowing (DAS), corresponding to the knee-height stage of the crop.The entire dose of phosphorus, applied in the form of single super phosphate (SSP), was incorporated as a basal application at the time of sowing using the side dressing method (Chowdary A *et al.*, 2013) [7]. All other crop management practices, such as hand weeding, irrigation, hoeing, and pest management were implemented uniformly and in a timely manner across all plots, in accordance with the recommended agronomic practices for baby corn cultivation.

Harvesting of baby corn was carried out three days after silking, as recommended by Moreira *et al.*, (2010) [8], and this practice was followed for two consecutive harvests. Stover was harvested from the net plot area immediately after baby corn ear collection and weighed using a precision digital balance. Fresh weight was recorded in tonnes per hectare (t/ha) (Karlen *et al.*, (2012) [9], Neelam *et al*., (2018) [5]) and standardized to 30% moisture content as per FAO (2017) [10] guidelines, considering its use as fresh fodder.

Gross and net returns were calculated based on prevailing market prices of inputs (fertilizers, seeds), land preparation, sowing, weeding, plant protection, harvesting and Produce (baby corn and green fodder). The benefit:cost ratio was calculated using the formula given below.

Benefit: cost ratio = Net return (Rs. ha^{-1})/Cost of cultivation (Rs. ha^{-1}).

Results and Discussion

According to the findings in Table 2, the interaction between row spacing and phosphorus application under irrigation circumstances had a substantial impact on the production of baby corn, both for corn and green fodder.

The treatment (T_8), which had plants spaced 50 x 15 cm apart and received 50 kg ha-1 of phosphorus as a basal application during sowing, produced the highest baby corn yield of all the treatments, measuring 6843.33 kg ha-1. With plants growing 40 x 15 cm spacing and 40 kg ha^{-1} of phosphorus applied, the treatment (T_1) had a reduced baby corn yield, 2473.16 kg ha^{-1}.

Similarly, treatment T_8 produced the maximum yield of green fodder (35537.00 kg. ha^{-1}) with plants spaced 50 x 15 cm apart with 50 kg.ha^{-1} phosphorus applied as basil during the planting process. The treatment T_2, which maintained row pacing of 40x15 cm with a basal application of 50 kg. ha-1 of phosphorus, had the lowest values of green fodder *i.e* 27127.25 kg.ha^{-1}.

The increment in corn and green fodder yield might be due to the combined effect of spacing and phosphorus application. Wider row spacing and increased Phosphorus levels led to better light interception, absorption and utilization of available nutrients and most importantly the soil moisture which empowered the plant to manufacture more quantities of photosynthates and accumulating enhanced sink capacity thus attributed in the corn yield hike.Phosphorus application is the another reason for the increase in green fodder for reel due to plant hormones responsible for cell division and enlargement and higher facility in development of photosynthetic operators that captures the incident light more efficiently (Patil *et al.*, 2018) [11].

Coarse- textured soils have lower water content than fine textured soils at any matrix suction, and therefore less diffusion of phosphorus towards the root (Olivers *et al.*, 2018) [12]. The absorption of phosphorus by plants increases when the matrix section of the soil decreases which agrees with the concept that the transfer of the nutrient to the roots is carried out by means of water (Bertorelli. M *et al.*, 2020) [13]. The amount of labile or exchangeable Phosphorus will be less in coarse textured soils than those with a fine texture which have a higher anion absorption capacity. (Olivers *et al.*, 2020) [14]. Based on these findings, it can be inferred that the crop, grown in fine black soils under irrigated conditions, likely benefited from favorable factors such as enhanced availability of labile phosphorus and improved light interception. These conditions may have contributed to increased yields of both baby corn and green fodder.

From the farmer's perspective, economic viability is the primary factor influencing the decision to adopt a new technology.

The cost of cultivation for the various treatment combinations was estimated based on prevailing local market rates for labour and agricultural inputs. The corresponding data are presented in Tables 3, 4. From the total cost of cultivation of baby corn data (table.4) it is observed that the highest cost of cultivation was recorded with increased Phosphorus levels *i.e* 60 kg. ha^{-1} and the values were noted as 99.0006.75 Rs. ha^{-1} whereas the lowest cost of cultivation of baby corn was recorded as 97,694.25 Rs. ha^{-1} in the treatments received 40 kg Phosphorus ha^{-1}.

The data in Table 5 makes it clear that applying 50 kg of phosphors per hectare and increasing row spacing resulted in a significant rise in gross return, net return, and benefit:cost ratio. Based on this data regarding economics of baby corn presented in table.6 revealed that highest gross (Rs. 566555 ha^{-1}), net returns (Rs 468205 ha^{-1}) and benefit cost ratio (4.76) were recorded front he treatment T_8 where the row spacing maintained at 50 x 15 cm and received 40 kg. ha^{-1} Phosphorus as basal application at the time of sowing. This might be the result of increased yields of corn and green fodder, which were clearly correlated with the benefit-cost ratio and net net return. These results are in line with the findings of Dutta *et al.*, (2015) [15].

Table 1: Soil Properties of the Experimental Field

Nature	black clay
pH	8.5
EC	0.45
Organic carbon	0.42% dms^{-1}
Available N	288 kg. ha^{-1}
Available P_2O_5	17.4 kg. ha^{-1}
Available K_2O	418 kg. ha^{-}

Table 2: Effect of row spacing and levels of phosphorus on corn and green fodder yield of baby corn

Tr. No.	Treatments	Corn yield (kg/ha)	Green Fodder Yield (kg/ha)
T_1	40 x 15 cm Row spacing + Phosphorus (40 kg/ha)	2473.16	27630.25
T_2	40 x 15 cm Row spacing + Phosphorus (50 kg/ha)	3800.09	27127.25
T_3	40 x 15 cm Row spacing + Phosphorus (60 kg/ha)	5743.30	28565.50
T_4	45 x 15 cm Row spacing + Phosphorus (40 kg/ha)	4250.77	29715.75
T_5	45 x 15 cm Row spacing + Phosphorus (50 kg/ha)	4009.98	28567.50
T_6	45 x 15 cm Row spacing + Phosphorus (60 kg/ha)	6261.62	30625.00
T_7	50 x 15 cm Row spacing + Phosphorus (40 kg/ha)	4533.32	31179.25
T_8	50 x 15 cm Row spacing + Phosphorus (50 kg/ha)	6843.33	35537.00
T_9	50 x 15 cm Row spacing + Phosphorus (60 kg/ha)	5711.68	32967.00
	S.Em (±)	86.26	193.19
	CD (P=0.05)	250.3	560.6

Table 3: Common cost of cultivation particulars of Baby corn

	Particular	Unit/ha	Qty. (No.)	Frequency	Unit Cost (Rs.)	Total cost (Rs./ha)
A	Land preparation					
	Ploughing	Hours	8	1	310	2,480.00
	Levelling	Hours	4	1	300	1,200.00
B	Seed & Sowing					
	Seed (Variety: G-5141)	kg	13	1	1060	13,780.00
	Labour charges for Sowing	No	10	1	400	4,000.00
C	Fertilizers					
	Urea (120 kg/ha)	kg	261	1	5	1,305.00
D	Irrigation					
	Labour Charges for Irrigation	Labour	2	3	400	2,400.00
E	Weed Control					
	Hand Weeding	Labour	15	2	400	12,000.00
F	Chemicals					0.00
	Atrazine	kg.	1.25	1	413	516.25
	Emamectin benzoate 5%	kg	0.247	1	4000	988.00
	Labour Charges for Application of Chemicals	Labour	2	3	400	2,400.00
G	Harvesting					
	Picking	Labour	25	3	400	30,000.00
	De-husking & Packing	Labour	20	3	400	24,000.00
	Total					**95,069.25**

Table 4: Treatment wise total cost of cultivation (Rs.ha^{-1})

Tr. No.	Fixed Cost (Rs. /ha)	Variable Cost of *Phosphorus (Rs/ha)	Total Cost of Cultivation (Rs./ha)
T_1	95,069.25	2,625.00	97,694.25
T_2	95,069.25	3,281.25	98,350.50
T_3	95,069.25	3,937.50	99,006.75
T_4	95,069.25	2,625.00	97,694.25
T_5	95,069.25	3,281.25	98,350.50
T_6	95,069.25	3,937.50	99,006.75
T_7	95,069.25	2,625.00	97,694.25
T_8	95,069.25	3,281.25	98,350.50
T_9	95,069.25	3,937.50	99,006.75

(* Single Super Phosphate (SSP) was used as the source of phosphorus, and its cost was considered as ₹525.00 per 50 kg bag, based on the rates provided by the District Co-operative Marketing Society, Guntur, Andhra Pradesh.)

Table 5: Economics of baby corn as influenced by the row spacing and different levels of phosphorus application.

Tr. No.	Corn Yield (kg/ha)	Green fodder yield (kg/ha)	Grass return from Corn (Rs.ha^{-1})	Gross return from fodder (Rs.ha^{-1})	Total gross return (Rs.ha^{-1})	Cost of cultivation (Rs.ha^{-1})	Net return (Rs.ha^{-1})	Benefit cost ratio
T_1	2473.2	27630.3	185487	41445	226932	97,694.25	129238	1.32
T_2	3800.1	27127.3	285007	40691	325698	98,350.50	227347	2.31
T_3	5743.3	28565.5	430748	42848	473596	99,006.75	374589	3.78
T_4	4250.8	29715.8	318808	44574	363381	97,694.25	265687	2.72
T_5	4010.0	28567.5	300749	42851	343600	98,350.50	245249	2.49
T_6	6261.6	30625.0	469622	45938	515559	99,006.75	416552	4.21
T_7	4533.3	31179.3	339999	46769	386768	97,694.25	289074	2.96
T_8	6843.3	35537.0	513250	53306	566555	98,350.50	468205	4.76
T_9	5711.7	32967.0	428376	49451	477827	99,006.75	378820	3.83

Corn=Rs.*75/Kg, Green Fodder= Rs.*1.5/Kg

(*The prices presented herein correspond to the prevailing rates observed in the local markets of Guntur District, Andhra Pradesh)

Conclusion

Due to its dual-purpose nature, baby corn emerges as a suitable option for livestock farmers, offering remunerative returns from cultivation while ensuring adequate fodder availability, which can contribute to enhanced milk production. Hence, it may be concluded that cultivating baby corn at a spacing of 50 × 15 cm with the application of 50 kg ha^{-1} phosphorus at sowing is beneficial for farmers in the Krishna Zone of Guntur, Andhra Pradesh, as it ensures higher net returns along with ample green fodder availability.

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