# Effect of establishment method and nutrient management on growth and yield of baby corn (*Zea mays* L.) in *Tarai* region of Uttarakhand

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**ABSTRACT:** Baby corn is a one group of the specialty maize and now very popular in India too for high nutritional and marketable values. It is mainly grown Kharif season but its sensitivity of high moisture affects its production. Therefore, the present study was carried out in Kharif season-2019 to optimize the establishment method and its nutrient management. The experimental results indicated that ridge planting with application of 75%RDF+25%VC gave significantly higher plant stand, plant height, dry matter accumulation, LAI, CGR, RGR, chlorophyll content, baby corn yield and green fodder yield, however it was very close to 100% RDF. Therefore, the baby corn may be planting on ridges with application of 75%RDF+25%VC for higher baby corn and quality green fodder in *Tarai* region of Uttarakhand.

**Key words:** Baby corn, CGR, chlorophyll content, green fodder, LAI, RGR

Maize (*Zea mays* L.) is one of the most versatile cereals with wider adaptability growing in all seasons for food, feed, biofuel, fodder and other industrial uses. It is well distributed to different climatic regions starting from tropical to temperate regions. Presently maize is cultivated on 190 mha area with production of 1076.18 Mt and productivity of 5.65 Mt/ha globally. In India maize occupies 9.22 mha area with production and productivity of 28.72 Mt and 3.12 Mt/ha, respectively. Baby corn is now very popular in India too for high nutritional and marketable values. It is young finger like unfertilized cob with 1-3 cm emerged silk preferably harvested within 1-3 days after silk emergence, depending on the growing season. Das *et al.* (2009) reported that 100 g of baby corn contains 89.1% moisture, 0.2 g fat, 1.9 g protein, 8.2 mg carbohydrate, 0.06 g ash, 28 mg calcium, 86 mg phosphorus and 11 mg ascorbic acid. It can be eaten as a raw salad, chutney, soup, mix vegetable, pickles, candy, murabba, soup, kheer and halwa. Besides, it has lower glycemic index than corn so it is good for sugar patients. It is a dual purpose crop which can be used for vegetable and fodder purpose and its short duration nature makes it suitable for fitting it in most of the cropping systems and crop diversification. Green fodder obtained from baby corn is more nutritious than normal corn (Joshi and Pal, 2019).

Maize is a very sensitive to high moisture, so its optimum planting method requires special attention for boosting its production. Ridge sowing causes better grain yield, less lodging and better water productivity than flat–bed planting due to better conditions for root growth and nutrient uptake (Bakht *et al.,* 2011) with 20-30% water saving and higher water productivity. Besides, it is a $C_4$ plants and responds to higher doses of fertilization. Since baby corn is planted densely compared to common maize, so requires higher fertilization. Optimum dose of N: $P_2O_5$:$K_2O$ i.e. 150-180:60-70:40-50 kg/ha has been reported in different parts of the country (Singh *et al*., 2010). Narang *et al.* (1989) reported that maize responded up to 120 kg/ha in rainy and up to 180 kg/ha in winter season in soils of Punjab. Therefore the present study was carried out to study the effect of establishment methods and nutrient management on baby corn production in Tarai region of Uttarakhand.

## MATERIALS AND METHODS

Field experiment was carried out at Instructional Dairy Farm, Nagla, G. B. Pant University of Agriculture and Technology, Pantnagar in *Kharif* season 2018 to study the 'Effect of establishment method and nutrient management on productivity, profitability and quality of baby corn (*Zea mays* L.). The experimental site was located in the *Tarai* region of Shivalik range of Himalayas in between latitude of 29° N to longitude of 79.3° E and at an altitude of 243.84 meter above the mean sea level. During the experimental period, weekly mean maximum and minimum temperature was ranged between 37.2° C and 24.1° C with relative humidity from 76.4 to 93.6%. An average 93mm rainfall was received during the crop season. The soil was slightly silty clay loam in texture with granular structure having soil pH 7.16, EC 0.190dS/m, organic carbon 0.47%, available nitrogen, phosphorus and potassium, 282.51, 28.16 and 235.00 kg/ha, respectively. The experiment consisted of 03 establishment methods i.e. 'flat', 'flat+earthing' (flat flowed by earthing) and 'Ridge planting' and 4 nutrient

management options i.e. 'control' (no organic and chemical fertilizer application), '100% VC@10t/ha' (VC-vermicompost), 100% RDF (recommended dose of fertilizers i.e. 180:60:40::N:$P_2O_5$:$K_2O$ kg/ha, '50% RDF+50%VC' and '75%RDF+25%VC' was planted in three replications. The dose of vermicompost was decided on nitrogen equivalent basis which also fulfilled the required amount phosphorus and potassium. The vermicompost used for experiment had 1.8, 0.72 and 0.84% nitrogen, phosphorus and potassium, respectively was applied one week before sowing, while full dose of phosphorus and potassium was applied as a basal but nitrogen was applied in 3 splits; one third basal, one third at knee high stage and one third at pre tasseling stage. 'VL-Baby Corn-1' variety was sown manually in 60 cm x 15cm planting geometry at 4cm sowing depth. Prior to sowing, seed was treated with carbendazim @ 3g per kg seed. Pendimethalin @ 1 kg a.i./ha pre emergence herbicide was sprayed on second day of sowing with the help of knap sack sprayer followed by one hand weeding at 30 days after sowing. One spray of chlorpyriphos @ 2 ml per liter water was also done at 30 days after sowing to protect the crop from sucking pests.

The plant growth attributes i.e. plant height, plant stand, dry matter accumulation, LAI, crop growth rate (CGR) and relative growth rate (RGR), chlorophyll content (SPAD values) at tasseling stage and yield and yield attributes i.e. baby cob yield, baby corn yield and green fodder yield were studied and recorded with standard methodology. The plant growth attributes were studied based on randomly selected five plants from each plat at different growth stages, while the yield was based on net plot and converted into hectare basis. The chlorophyll content is a index of greenness was measured by SPAD meter. The formula used for calculating above parameters is given below;

1. Leaf area ($cm^2$) = length × width × correction factor (0.75)
2. LAI = Leaf area /plant ($cm^2$)/Ground are ($cm^2$)
3. Mean CGR=(Dry matter ($w_2$) at $t_2$ - Dry matter ($w_1$) at $t_1$)/ ($t_2 - t_1$)x (1/A(leaf area/plant)
4. Mean RGR = ($\log e\, w_2 - \log e\, w_1$) / ($t_2 - t_1$).

Where, $w_1$ and $w_2$ are the dry weight of plant at $t_1$ and $t_2$ time, respectively.

## RESULTS AND DISCUSSION

### Effect of Establishment methods

***Plant growth studies***

The establish methods had significant effect on plant population, mortality percentage, plant height, dry matter accumulation (Table 1), LAI, mean CGR, mean RGR and chlorophyll content of baby corn (Table 2). The plant population at harvest differed significantly under different establishment methods in which the ridge planting method had significantly higher plant population than flat planting that was statistically at par with flat+earthing mainly due to flat method of planting witnessed significantly highest mortality percentage i.e.12 and 13% higher than flat+earthing and ridge method, respectively. The higher plant population and lower mortality percentage under ridge planting was caused due to better aeration and protection of plants from water logging. Painyuli *et al.* (2013) also reported higher plant population of sweet corn at ridge planting followed by flat+earthing and flat planting.

The tallest plants of baby corn were recorded under ridge planting at harvest that was at par with flat+earthing and the flat planting produced significantly shorter plants. The

**Table 1: Effect of establishment method and nutrient management on plant population, mortality percentage, growth and yield of baby corn.**

| | Treatment | Pl Population ('000 pl/ha) | Mortality (%) | Pl ht (cm) | Dry matter (g/pl) | Baby cob yield (kg/ha) | Baby corn yield (kg/ha) | Green fodder yield (q/ha) |
|---|---|---|---|---|---|---|---|---|
| A | Establishment Mehtods | | | | | | | |
| | Flat | 94.85 | 9.54 | 224 | 131.27 | 4862 | 1235 | 155 |
| | Flat+Earthing* | 97.88 | 8.40 | 235 | 141.10 | 5269 | 1341 | 168 |
| | Ridge | 98.89 | 8.30 | 240 | 147.48 | 5668 | 1440 | 180 |
| | S Em | 1.00 | 0.22 | 1.4 | 1.06 | 42 | 11 | 03 |
| | LSD (0.05) | 3.00 | 0.90 | 06 | 4.30 | 170 | 44 | 12 |
| B | Nutrient Management | | | | | | | |
| | Control | 96.03 | 8.85 | 192 | 129.19 | 2647 | 674 | 84 |
| | 100% VC@10t/ha) | 97.00 | 8.80 | 231 | 136.23 | 4926 | 1256 | 160 |
| | 100% RDF | 97.98 | 8.50 | 251 | 144.31 | 6402 | 1630 | 203 |
| | 50%RDF+50%VC | 97.06 | 8.70 | 239 | 139.94 | 5730 | 1458 | 183 |
| | 75%RDF+25%VC | 97.98 | 8.60 | 252 | 150.09 | 6626 | 1686 | 210 |
| | SEm | 0.52 | 0.14 | 2.0 | 1.39 | 60 | 15 | 02 |
| | LSD (0.05) | NS | NS | 06 | 4.07 | 177 | 45 | 06 |

* Flat + earthing = Flat followed by earthing

ridging and earthing had better drainage and creating suitable environment for root development thus it enhanced nutrient uptake and ensured better water availability. The ridge planting also produced significantly higher dry matter accumulation while the lowest values were in flat planting. At harvest, ridge planting accumulated 4.5 and 12% higher dry matter than flat+earthing and flat method, respectively. The higher dry matter production was due to better plant growth including higher plant height mainly because of ridges provided greater aeration and moisture availability. Similar observations were also reported by Singh and Vashist (2015).

The highest LAI of baby corn was recorded under ridge planting method followed by flat+earthing and the lowest LAI was found in flat planting method at all the growth stages. The higher LAI was the result of higher leaf area. Balsaubramaniyan and Palaniappan(2001) also reported higher LAI of maize at ridge planting method and supported by Manea *et al*. (2015). The chlorophyll content i.e. SPAD reading was measured highest under ridge planting followed by flat+earthing and significantly lowest reading was under flat planting method. The higher SPAD reading was mainly due to more chlorophyll content i.e. greenness of leaves. The ridge planting had significantly higher mean CGR and RGR at 25-45 DAS followed by flat+earthing and flat method, respectively but at 45DAS-harveststage, the reverse trend was observed i.e. flat method recorded higher values followed by flat+earthing and ridge establishment methods though both were non-significant to each other. The CGR is the index of rate of dry matter accumulation per day per unit area so higher CGR was due to higher dry matter accumulation per unit area per unit time.

***Yield and yield attributes***

The baby cob yield, baby corn yield and green fodder yield were influenced significantly by establishment methods (Table.1).The baby cob yield was influenced significantly by establishment methods and the significantly highest baby cob yield was recorded at ridge planting with 7 and 16.5% higher than flat+earthing and flat method, respectively. Similarly, flat+earthing produced 8.5% higher baby cob yield than flat method. The higher cob yield was the result of higher length and girth of cobs. Rasheed *et al*. (2003) also reported higher grain yield of maize at ridge planting. Similarly the baby corn yield was recorded significantly higher at ridge planting followed by flat+earthing and flat method with 7 and 14% higher baby corn yield than flat+earthing and flat method, respectively. Similarly, flat+earthing produced 8.5% higher baby corn yield than flat method. Manea *et al*. (2015) also reported that raised bed planted baby corn produced 12.5% higher baby corn than flat bed planted crop.

iii. ***Green fodder yield***

The green fodder production differed significantly among establishment methods. The ridge planted baby corn produced significantly highest green fodder followed by flat+earthing and significantly lowest under flat planting. Ridge planting produced 7.5 and 16.0% higher green fodder than flat+earthing and flat method, respectively. Similarly, flat+earthing produced 7.9% higher green fodder than flat planting method. The variation in green

**Table 2: Effect of establishment method and nutrient management on leaf area index, mean CGR, mean RDR and SPAD values at different growth stages of baby corn**

| | Treatment | Leaf Area Index | | | CGR (g/m²/day) | | RGR (g/g/day) | | SPAD |
|---|---|---|---|---|---|---|---|---|---|
| | | 25 DAS | 45 DAS | Harvest | 25-45DAS | 45-Harvest | 25-45DAS | 45-Harvest | value (Tasseling stage) |
| A | Establishment Methods | | | | | | | | |
| | Flat | 0.17 | 3.54 | 3.39 | 50.86 | 13.881 | 0.070 | 0.010 | 44.17 |
| | Flat+Earthing* | 0.18 | 3.75 | 3.49 | 58.85 | 10.255 | 0.090 | 0.007 | 45.00 |
| | Ridge | 0.28 | 4.38 | 4.12 | 62.68 | 9.105 | 0.090 | 0.006 | 45.78 |
| | SEm | 0.01 | 0.12 | 0.13 | 0.72 | 1.020 | 0.003 | 0.001 | 0.07 |
| | LSD (0.05) | 0.04 | 0.47 | 0.55 | 2.90 | NS | 0.010 | 0.003 | 0.28 |
| B | Nutrient Management | | | | | | | | |
| | Control | 0.16 | 3.17 | 2.97 | 55.44 | 8.01 | 0.084 | 0.009 | 41.79 |
| | 100%VC @ 10t/ha) | 0.19 | 3.65 | 3.49 | 56.93 | 10.75 | 0.087 | 0.008 | 43.92 |
| | 100% RDF | 0.23 | 4.18 | 4.02 | 58.04 | 11.96 | 0.092 | 0.007 | 46.29 |
| | 50% RDF +50% VC | 0.22 | 4.07 | 3.79 | 57.56 | 10.77 | 0.088 | 0.008 | 45.34 |
| | 75% RDF +25% VC | 0.24 | 4.36 | 4.07 | 59.35 | 13.90 | 0.093 | 0.007 | 47.59 |
| | SEm | 0.01 | 0.14 | 0.12 | 0.74 | 1.25 | 0.002 | 0.001 | 0.15 |
| | LSD (0.05) | 0.02 | 0.42 | 0.34 | 2.18 | 3.68 | 0.006 | NS | 0.45 |

* Flat + earthing = Flat followed by earthing

fodder yield was caused due to difference in plant population, plant height and dry matter accumulation and similar findings were also reported by Joshi and Pal (2019).

**Effect of nutrient management**

***Plant growth studies***

The nutrient management had significant effect on plant population, mortality percentage, plant height, dry matter accumulation (Table.1), LAI, mean CGR, mean RGR and chlorophyll of baby corn content (Table.2). The plant population and mortality percentage did not differ significantly among different nutrient management options, however the highest plant population was recorded with equal values at both 75%RDF+25%VC and 100%RDF followed by 50%RDF+50%VC, 100%VC and lowest in control. The highest and lowest mortality percentage was recorded at control and 100% RDF, respectively. The variation in plant population was mainly due varied field emergence. The tallest plants were recorded at 75%RDF+25%VC but it did not differ significantly with 100% recommended dose of fertilizers. The 50%RDF+50%VC produced significantly taller plants than 100%VC. Taller plants were due to better availability of essential nutrients and increased photosynthetic formation. The treatment having 50% and 100%VC had lower plant height mainly due to slow release of nutrients that did not match with crop demand. These results are in close conformity with the results observed by Dadarwal *et al.* (2009)**.** The dry matter accumulation was recorded significantly highest under 75%RDF+25%VC followed by 100%RDF. It did not differ significantly between 100% RDF and 50%RDF+50%VC. The higher plant height and leaf area index resulted into higher biomass accumulation. Prasad and Naik (2013) also reported higher dry matter production through the integration of fertilizers with vermicompost. Significantly highest LAI was recorded under 75%RDF+25%VC but it was significantly equal to 100%RDF. The higher LAI was the result of higher leaf area and more number of leaves. Haq (2006) also reported the higher LAI at integrated nutrient management with organics. The lower LAI at harvest stage was caused due to increasing trend of leaf senescence. Kumar (2016) also reported lower LAI of maize at harvest.

The SPAD reading was recorded significantly highest at 75%RDF+25%VC followed by 100% RDF, 50%RDF+50%VC and 100%VC. Greater availability of essential nutrients including nitrogen improves the greenness of leaves resulting into higher SPAD reading. Pallavi *et al.* (2016) also reported higher SPAD values in fingermillet at 75%RDF+25%VC. The significantly highest CGR was recorded under 75%RDF+25%VC at 0-25 and 25-45 DAS but it remained non-significant with 100%RDF, 50%RDF+50%VC however, at 45-harvest 100%VC also became non-significant with these treatment. The significantly lowest value was recorded under control at all the stages that was statistically at par with 100% VC and 50%RDF+50%VC. The higher CGR was due to more dry matter accumulation under 100% RDF and its substitution with vermicompost however, at later stage 100%VC also gave equivalent CGR as it started releasing nutrients that was used for plant dry matter production.

The highest mean RGR was recorded significantly under 75%RDF+25%VC at 25-45 DAS that remained statistically at par with 100%RDF, 50%RDF + 50%VC and 100%VC and significantly lowest under control that was significantly similar to 100%VC and 50%RDF+50%VC. At 45 DAS-harvest, nutrient management had non-significant effect on RGR however, numerically highest and lowest RGR was recorded at control and 100% RDF and 75%RDF+25%VC, respectively. The treatments with higher dose of inorganic fertilizer were leading towards maturity earlier than control and resulted in declined rate of translocation of phtotosynthates in their tissues due to faster drying of cell sap which might be responsible for lower RGR in these treatments at later stages. Das *et al.* (2009) also observed similar trend of RGR under nutrient management.

***Yield and yield attributes***

The total baby cob yield was found significantly highest at 75% RDF+25% VC followed by 100%RDF, 50%RDF+50%VC and 100%VC, respectively and significantly lowest at control. The treatment 75%RDF+25%VC produced 3.5 and 15.6% higher baby cob yield than 100%RDF and 50%RDF+50%VC, respectively. Application of 100%RDF was found superior than 100%VC and produced 30% higher baby cob yield. The baby cob yield was increased nearly by 86 and 141% higher under 100%VC and 100%RDF, respectively than control.

The yield improvement through integration of vermicompost with fertilizers was caused due to timely availability of essential nutrients along with increased microbial activity and plant soil microbes interaction. Nanjappa *et al.* (2001) also reported significantly higher maize yield at 75%RDF+2.5t/ha vermicompost application than sole application of organic and chemical fertilizers.

The baby corn yield was recorded significantly highest at 75%RDF+25%VC followed by 100%RDF, 50%RDF+50%VC, 100%VC and control, with 3, 13.0, 25.0 and 60.0% higher value, respectively. Similarly, baby corn yield was increased nearly by 58.6, and 46.3% higher

under 100%RDF and 100%VC, respectively than control. The higher baby corn yield was attributed to higher dry matter accumulation/plant and baby cob yield. Similar findings were also

***Green fodder yield***

The green fodder yield was recorded significantly highest at 75%RDF+25%VC followed by 100%RDF, 50%RDF+50%VC and 100% VC, respectively. On an average, application of 75%RDF+25%VC produced 3, 13 and 23% higher green fodder yield than 100%RDF, 50%RDF+50%VC and 100%VC, respectively. The yield increment at 100%RDF and 100%VC over control gave nearly same values as in case of baby cob yield. The higher green fodder yield was attributed to better plant growth.

## CONCLUSION

The experimental results indicated that ridge planting with application of 75%RDF+25%VC gave significantly higher plant stand, plant height, dry matter accumulation, LAI, CGR, RGR, chlorophyll content, baby corn yield and green fodder yield and it was very close to 100% RDF. Therefore it is concluded that baby corn may be grown on ridges with application of 75%RDF+25%VC for higher baby corn and fodder in *Tarai* region of Uttarakhand.

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