

Original Research Article

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An Economics Analysis of Harvest Index, Cost and Return of *Zea mays* L. Crop in Jollang Region of Arunachal Pradesh, India

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ABSTRACT

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The experiment was conducted at Jollang during the *rabi* season of 2022 with seven treatments on the effect of organic fertilizers and bio fertilizers on *Zea mays* L. row spacing of 60 cm x 20 cm with Vermicompost 0.5 Kg/ha + Phosphorus solubilizing bacteria 0.5 Kg/ha + *Azotobacter* 0.5 Kg/ha was observed best in harvest index (46.43 %). Highest net return (45925.00/- ha⁻¹) and B: C ratio (2.82) was observed in treatment T₇ (60 cm x 20 cm + Vermicompost 0.5 Kg/ha + PSB 0.5 Kg/ha + *Azotobacter* 0.5 Kg/ha) compared with other treatment combinations. So, On the basis of research findings, it may be concluded that organic fertilizer (Vermicompost), row spacing 60 cm x 20 cm with vermicompost 0.5 Kg/ha + PSB 0.5Kg/ha + *Azotobacter* 0.5Kg/ha has the best performance for obtaining harvest index (46.43%) and economic benefits.

Introduction

Maize is one of the most important cereal crops of the world in terms of its global production. It ranks second to wheat and equal to rice. Globally, 67 percent of maize is used for livestock feed, 25 percent for human consumption and industrial purposes, while 5 percent is used for seed purposes to sow next crop (Jiskani, 2004). Shankar *et al.*, (2013) reported that the starch content of the maize was maximum in seedling treated with phosphorus solubilizing bacteria (PSB) when compare to control crops. The results of PSB inoculation in the

protein content showed a greater increase in PSB plants than in control seedlings. All the morphological and biochemical measurement shows a great response in PSB treated plants thus confirming the efficiency of the selected isolate PSB as a phosphate solubilizer bacteria.

As a general rule, the amount of stover produced is about the same as the amount of grain produced which is expressed in ratio called harvest index. Maize is an important fodder crop of summer and rainy season and suitable for silage making. It is the fast growing crop grown for both fodder and gain.

Materials and Methods

The experiment was conducted during the *rabi* season of 2022 at Himalayan University, Itanagar. The farm is located in Jullang University campus. The Crop Research Farm is situated at 27.140 N latitude and 93.620 E longitudes and at an altitude of 320 m above mean sea level. The soil was sandy loam in texture with acidic nature and also rich in organic matter. The mechanical, chemical and physio-chemical properties of the soil of experimental field, and the methods used. The meteorological data of weather parameter, temperature, rainfall, relative humidity and sunshine hours recorded during the period of experimentation from November to February during the year 2022-2023 were obtained from meteorological observatory. The mean minimum and maximum temperature recorded during the cropping season was 12°C and 22°C, respectively. The average relative humidity in the morning hours was 91% and 70% in the evening. The average bright sunshine hour was 8.3. For germination test Twenty-five seeds were tested before nursery sowing to ascertain the germination of maize seeds. Germination test was done using cotton and petri dish under laboratory conditions. The overall germination percentage was 98%. In order to facilitate sowing, the experimental field was thoroughly ploughed and harrowed and brought to fine tilth. Stubbles and weeds were picked up from the field and the land was leveled with the help of rake and the plots were demarcated according to layout. The preparation of land and the operations carried out in the field before sowing. Organic manure was applied as broadcasting at the time of sowing. The nutrient source was vermicompost, used to fulfill the NPK requirement. The recommended dose of 250 kg ha⁻¹ of vermicompost was applied. *Zea mays* L. hybrid maize master 1323 was selected for sowing which takes around 80-100 days to mature. Seeds were covered with soil immediately after sowing the seeds. The spacing adopted was (plant to plant 60 cm and row to row 20 cm) and the seeds were drilled at 3-4 cm depth

Harvest index was obtained by dividing the economic yield (grain) by biological yield (grain + straw). It was calculated for each of the plot and was represented in percentage. The following formula was used (Donald, 1962). Treatment details includes T₁: Control, T₂: Vermicompost 0.5 Kg/ha + Phosphorus solubilizing bacteria 0.5Kg/ha, T₃: Poultry manure 0.5Kg/ha + Azotobacter 0.5Kg/ha, T₄: Compost 0.5Kg/ha+ Phosphorus solubilizing bacteria 0.5Kg/ha+ Azotobacter

0.5Kg/ha, T₅: Compost 0.5Kg/ha + Phosphorus solubilizing bacteria 0.5Kg/ha, T₆: Poultry manure 0.5Kg/ha + Azotobacter 0.5Kg/ha, T₇: Vermicompost 0.5Kg/ha + Phosphorus solubilizing bacteria 0.5Kg/ha + Azotobacter 0.5Kg/ha. Harvest index was obtained by dividing the economic yield (grain) by biological yield (grain + straw). It was calculated for each of the plot and was represented in percentage. The following formula was used

Harvest Index (%) = Economic yield / Biological yield x 100

Statistical Analysis

The experiment was laid out in Randomized Block Design. The data recorded during investigation were subjected to statistical analysis as per method of Analysis of Variance (Skeleton). The significance and non-significance of the treatment effect were judged with the help of 'F' variance ratio test. Calculated 'F' value (variance ratio) was compared with the table value of 'F' at 5% level of significance. If calculated value exceeded the table value, the effect was significant.

CD = SE (m) × (t) error d.f. at 5%

S.Em (±) = 2x MSSE / r

t = Treatment, r = Replication, d.f. = Degree of freedom, S.E. = Standard error, SS= Sum of square, TSS= Treatment sum of square, RSS= Replication sum of square, TSS=Total sum of square, MSS = Mean sum of squares, MSSR= Mean sum of square (Replication), MSST=Mean sum of square (Treatment), MSSE= Mean sum of square (Error), F-Tab = Tabulated value of F, F-Cal = Calculated F value.

Economics Analysis

Cost of cultivation, gross return, net return and benefit cost ratio were worked out to evaluate the economics of each treatment, based on the existing market prices of inputs and output. The cost of cultivation (Rs ha⁻¹) for each treatment was worked out separately; taking into consideration all the cultural practices followed and costs of inputs used in the cultivation in ha⁻¹. Gross returns (Rs ha⁻¹) the gross return from each treatment was calculated in Rs ha⁻¹. The net profit from each treatment was calculated separately, by using the following formula:

Net return = Gross income (Rs. ha⁻¹) – Cost of cultivation (Rs. ha⁻¹).

Benefit: Cost ratio = Net return (Rs. ha⁻¹) / Total cost of cultivation (Rs. ha⁻¹).

Gross income (Rs. ha⁻¹) = Sale cost of seed (Rs. ha⁻¹) + Sale cost of stover (Rs. ha⁻¹).

Results and Discussion

The harvest index (%) recorded at harvest, is presented in Table.2. The data shows that there was a significant effect of different treatments on the harvest index (%). The significant and highest harvest index was recorded in T₇ (Vermicompost 0.5 Kg/ha+ Phosphorus Solubilizing Bacteria 0.5 Kg/ha+ Azotobacter 0.5Kg/ha) i.e., 46.43 % and T₂ (Vermicompost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha) i.e., 46.40 %, T₄(Compost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha + Azotobacter 0.5 Kg/ha) i.e., 45.56 %, T₅ (Compost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha) i.e., 45.19 %, T₆ (Poultry manure 0.5 Kg/ha + Phosphorus Solubilizing Bacteria0.5 Kg/ha) i.e., 43.98 %, T₃ (Poultry manure 0.5 Kg/ha + Azotobacter 0.5 Kg/ha) i.e., 43.82 %. Lowest harvest index (%) was observed in treatment T₁ (Control) i.e., 42.65%. The probable reason for recording higher harvest index (%) under treatment T₇ (Vermicompost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha + Azotobacter 0.5 Kg/ha) is due to the increased temperature and moisture principally during early growth vermicompost increase the harvest index in maize Zaremanesh *et al.*, (2017) and the synergistic action of organisms which increased the phosphorous uptake Singh (2011) and seedling treated with Azotobacter inoculants responded greatly and was significantly increases stem diameter, fresh and dry weight of seedling and it is ecofriendly El-douby *et al.*, (2000). Harvest index is the proportion of percentage of grain yield to total biomass. It is a novel trait which directly associated with yield and the capacity of a crop for diverting the total dry matter into economic yield. The harvest index of different grain crops couldn't achieved to the range of upper limit value. The HI is variable to genetic factors and environmental factors. The genetic mode of expression of HI also substantially varies among crops which assist breeder to determine breeding strategy for enhancement of crop productivity. Improvement of this trait offer higher grain yield among some crop species.

Hence, greater emphasis could be placed on breeding program for high harvest indexes for crop species to identify conditions and genotypes associated with a stable, higher harvest index and higher yield simultaneously (Gemechu, 2019). Yield of a crop is the function of biomass x harvest index. Different authors indicated, yield improvement associated with increasing harvest index (Sharma and Ghildiyal, 2005). Low crop harvest index is the major cause of less crop yield and vice versa. The HI may increase or decrease if seed yield changes more or less rapidly than total dry matter (TDM). Increase in fodder yield might be due to increase in plant height, leaf area index and total biomass due to increased cell division, cell enlargement and elongation.

Application of organic and inorganic fertilizers improved crop growth rate and better harvest index though it varies significantly depending upon soil condition, geographical location and climatic conditions prevailing during span of crop growth and maturity. Donald (1962) defined harvest index as the ratio between weight of grains and the weight of total dry matter and later described it as a measure of partitioning of photosynthates (Donald, 1968). The chemical composition of different grains differs and the composition of grains and the residual dry matter of plants (straw) are not the same. Thus, the same amount of photosynthate (assuming it to be carbohydrate) would produce dry matter of different compositions and consequently the harvest index based on dry matter cannot be a true measure of partitioning of photosynthates in all cases. In cereals harvest index expressed on an energy basis was close to that expressed on a dry matter basis. This could be because of a close similarity in the composition of residual dry matter and grains.

Economics of different treatment combination of organic fertilizers and biofertilizers on *Zea mays* L.

Observations regarding the economics of treatments of maize are given in table.3. Significant difference with regard to net returns and B: C ratio were observed in Treatment was recorded in treatment T₇ (Vermicompost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5Kg/ha + Azotobacter 0.5Kg/ha) i.e., 2.82 was significantly superior to other treatments with highest net return value ₹ 26000:00 ha⁻¹. However, minimum net return value of ₹ 21000.00 ha⁻¹ and minimum B: C 2.54 was observed in treatment T₁ (Control).

Table.1 Analysis of Variance (ANOVA) of Randomized Block Design.

Source of variation	df	SS	MSS	F Cal	Ftab at 5%
Due to treatments	t-1	Tr.SS	TSS/(t-1)	MSST/MSSE	-
Due to replication	r-1	RSS	RSS/(r-1)	MSSR/MSSE	-
Due to error	(r-1) (t-1)	ESS	ESS/(r-1) (t-1)	-	-
Total	(rt-1)	TSS	-	-	-

Standard error (S.E.) and critical difference (C.D.) values are calculated by using the following formula: -

Table.2 Effect of organic fertilizers and biofertilizers on harvest index of *Zea mays* L.

Treatments	Harvest Index (%)
T ₁ - Control	42.65
T ₂ - Vermicompost 0.5 Kg/ha+ Phosphorus Solubilizing Bacteria 0.5 Kg/ha	46.40
T ₃ - Poultry manure 0.5 Kg/ha + Azotobacter 0.5 Kg/ha	43.82
T ₄ - Compost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha + Azotobacter 0.5 Kg/ha	45.56
T ₅ - Compost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha	45.19
T ₆ -Poultry manure 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha	43.98
T ₇ -Vermicompost 0.5 Kg/ha + Phosphorus Solubilizing Bacteria 0.5 Kg/ha + Azotobacter 0.5 Kg/ha	46.43
F test	S
SEm(±)	0.75
CD(P = 0.05)	1.64

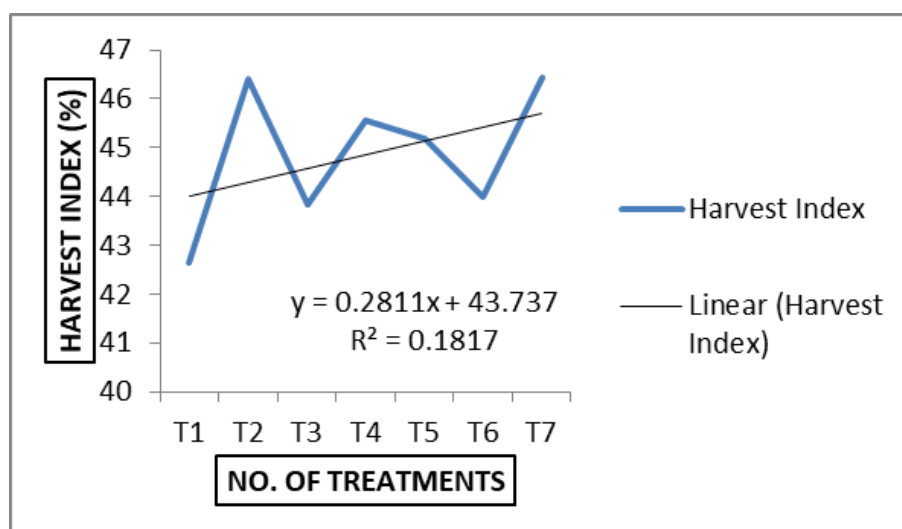


Table.3 Economics of different treatment combination of organic fertilizers and biofertilizers on *Zea mays* L.

Treatments	Cost of Cultivation	Gross return	Net return (ha ⁻¹)	B: C ratio
T ₁	21000.00	53400.00	32400.00	2.54
T ₂	24000.00	67650.00	43650.00	2.82
T ₃	21400.00	58150.00	36750.00	2.71
T ₄	23800.00	63850.00	40600.00	2.68
T ₅	23000.00	62900.00	40050.00	2.73
T ₆	22300.00	61475.00	38475.00	2.75
T ₇	26000.00	71925.00	45925.00	2.76

Highest net return (45925.00/- ha⁻¹) and B: C ratio (2.82) was observed in treatment T₇ (60 cm x 20 cm + Vermicompost 0.5Kg/ha + PSB 0.5 Kg/ha+ Azotobacter 0.5Kg/ha) compared with other treatment combination.

The probable reason for recording higher net return and B: C ratio under treatment T₇ (Vermicompost 0.5 kg/ha + Phosphorus Solubilizing Bacteria 0.5kg/ha + Azotobacter 0.5kg/ha) was because of use of organic fertilizers and biofertilizers have resulted in the greatest grain yield, they revealed that 50% of required nitrogen and phosphorous fertilizers could be replaced by bio fertilizer and organic fertilizers, because bio fertilizer and organic fertilizers improved the use efficiency of recommended nitrogen and phosphorous fertilizers and reduced the cost of chemical fertilizers, also prevented the environment pollution from extensive application of chemical fertilizers Habibi *et al.*, (2011) and the nitrogen prevents the weeding cost which finally improved the B: C ratio by reducing cost of cultivation and improving net return Gerwing *et al.*, (2004).

Considering the salient findings in perspective, the study revealed that application of organic fertilizers and biofertilizers on harvest index (46.43 %), Highest net return (45925.00/- ha⁻¹) and B: C ratio (2.82) were found maximum with the application of Vermicompost @ 0.5Kg/ha + PSB@ 0.5Kg/ha + Azotobacter @0.5 Kg/ha compared with other treatment combination.

Author Contributions

Kasinam Doruk: Investigation, formal analysis, writing—original draft. Bengia Kawak: Validation, methodology, writing—reviewing. Tadang Meena:— Formal analysis, writing—review and editing. Chukhu Mercy: Investigation, writing—reviewing. Sonbeer Chack: Resources, investigation writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

Disclaimer: Author(s) hereby declare that No generative AI technologies such as large language models (Chat GPT), COPILOT etc) and text to image generators have been used during the writing or editing of this manuscript

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