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EFFECT OF SPATIAL PATTERN AND NITROGEN SCHEDULING ON ECONOMIC INDICES AND PARTIAL BUDGETING IN MAIZE (*ZEA MAYS* L)

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ABSTRACT

Field experiments were conducted at Agricultural College and Research Institute, Coimbatore to study the economic viability of various altered spatial pattern and nitrogen scheduling approaches adopted in maize. The experiments were laid out in split plot design and replicated thrice. Spatial pattern allotted to main plots with six levels viz., M_1- 60 x 25, 30 x 30, 35 x 35, 40 x 40, 45 x 45 and 50 x 50 cm. Three nitrogen scheduling approaches N_1- Recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} in 3 splits, N_2- RDN @ 150 kg ha^{-1} in 4 splits and N_3- Leaf Colour Chart (LCC) based N scheduling were assigned to sub plots. Profitability analysis indicated that square planting of 35 x 35 cm with LCC based N scheduling (M_3N_3) fetched higher gross return (` 110462 and 159074 ha$^{-1}$) net income (` 70290 and 114180 ha^{-1}) and BCR (2.75 and 3.54) and reduced total variable cost compared to conventional approach. Partial budgeting analysis revealed that among proposed changes M_3N_3 treatment combination increased added returns, reduced cost and gave maximum net gain of 22.1 and 18.6% more than recommended practice during the course of study. Based on the results 35 x 35 cm and LCC based N management could sustain the productivity and profitability in maize.

KEYWORDS: Economics, Leaf Colour Chart, Nitrogen, Partial budgeting, Square planting

1. INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal, next to rice and wheat in the world as well as in India. It is one of the most versatile crops and can be grown under diverse environmental conditions and also diversified uses as human food (17%), animal feed (61%) and source of large number of industrial products (22%) *viz*., starch, ethanol, oil, alcoholic beverages, food sweeteners, pharma and cosmetics, etc. [1]. Maize grains have greater nutritional value as it contains 72 % starch, 10% protein, 4.8% oil, 8.5% fibre, 3.0% sugar and 1.7% ash [2] With increased demand for maize as food, feed and industrial products, it could become an important cereal in terms of area and production in the next few decades. It is predicted that by 2025, the total global maize demand will exceed the demand for rice and wheat and in India the demand will touch 42 million tones. It is the crop of future as mentioned by the father of the green revolution, renowned nobel laureate Dr. Norman E. Borlaug.

Spatial pattern is important agronomic attribute, wider and closer pattern affected the yield performance and reduced economic returns. Optimum planting pattern is essential for higher productivity and profitability. The yield increase due to N fertilization was substantial (92%) in maize compared to rice (47%) and wheat (50%) [3]. Application of higher level of N fertilizer is very common among Indian farmers, who attribute maize crop greenness and growth response to N application. Hence, farmers tend to apply more nitrogenous fertilizers and which in turn increase the cost incurred for fertilizers. The LCC based real time N management beneficial in terms of productivity and profitability [4]. The economic impact of proposed changes can be evaluated using partial budgeting tool. Hence the economic analysis of various planting pattern and N scheduling approaches were calculated. The analysis was made to assess the net profitability of proposed changes in maize.

2. MATERIALS AND METHODS

Field experiments were conducted at the Department of Agronomy, Agricultural College and Research Institute, Coimbatore. The region is characterized as semi-arid tropical (SAT) climate, located at 11^0 8’ N latitude and 77^0 8’ E longitude. The mean annual rainfall (52 years) at Coimbatore is 713 mm distributed over about 47 rainy days with a 30 % annual coefficient of variation. The experiment was laid out in a split plot design and the treatments were replicated thrice. Single cross maize hybrid NK 6240 was used as test crop. The details of treatments is as follows

2.1.Treatments

Main plot: Spatial pattern

M_1 : 60 × 25 cm

M_2 : 30 × 30 cm

M_3 : 35 × 35 cm

M_4 : 40 × 40 cm

M_5 : 45 × 45 cm

M_6 : 50 × 50 cm

Sub plot: Nitrogen scheduling

N_1 : Recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} in 3 splits as 25, 50 and 25% at basal, 25 and 45 DAS, respectively (control)

N_2 : RDN @ 150 kg ha^{-1} in 4 splits each 25% at basal, 15, 30 and 45 DAS

N_3 : Leaf colour chart (LCC) based nitrogen scheduling (whenever LCC critical value falls below 5, top dressing of N @ 30 kg ha^{-1})

2.2. Economic Indicators

2.2.1. Total variable cost (TVC)

The cost incurred from field preparation to harvest including the cost of other inputs was worked out for each treatment of the study and expressed as ` ha^{-1}.

2.2.2. Gross returns

The grain and stover yield was computed per hectare and the total income (` ha^{-1}) worked out based on the market rate prevalent during the period of study.

2.2.3. Net returns

Net return was obtained by subtracting TVC from gross return as detailed below and expressed as ` ha^{-1}.

Net returns (` $ha^{-1}$) = Gross returns (` ha^{-1}) – Total variable cost (` ha^{-1})

2.2.4. Benefit-cost ratio (BCR)

BCR was calculated based on gross return and variable cost of cultivation as given below.

$$\text{BCR} = \frac{\text{Gross returns (` ha}^{-1}\text{)}}{\text{Total variable costs (` ha}^{-1}\text{)}}$$

2.3. Partial Budgeting

This refers to estimating the outcome or returns for a part of the business, *i.e.*, on or few activities. A partial budget is used to calculate the expected change in profit for a proposed change in the farm activities. A partial budget contains only those income and expense items which will change if the proposed modification in the treatment is implemented. Only the changes in income and expenses are included and not the total values. The final result is an estimate of the increase or decrease in profit.

3. RESULTS AND DISCUSSION

3.1. Economic Indices

The economic analysis of different treatments revealed large variations in cost of cultivation, gross return and net return in maize (Table 1). The cost of cultivation was the highest (` 40761 and 45482 ha^{-1}) during 2011 and 2012, respectively under treatment combination of M_2N_3 (30 × 30 cm with LCC based N application). When the spacing was narrowed down, the cost of cultivation increased proportionately. In any investment economics, net returns as well as BC ratio are more important to compare the profitability of the system as well as to identify input technologies to improve the same. Perusal of data showed that highest gross income (` 110462 and 159074 ha$^{-1}$), Net income (` 70290 and 114180 ha^{-1}) and BCR (2.75 and 3.54) during 2011 and 2012, respectively were recorded with optimum spacing of 35 × 35 cm with maize nourished through LCC based N (M_3N_3). Higher yield levels under M_3N_3 positively influenced the gross return. Due to higher gross returns of the above treatment and little variation of TVC has substantially increased the net income. Similarly, BC ratio was also higher with M_3N_3 due to higher gross returns with reduced or same cost invested. Planting density of 83,333 plants ha^{-1} with LCC based N application recorded higher economic indices over recommended practices in maize [4].

3.2. Partial Budgeting

The computed mean data on partial budgeting (` ha^{-1}) due to various treatment combinations over years are presented in Table 2. Among the treatment combinations evaluated, maize crop maintained at 30 × 30 cm with LCC based N scheduling (M_2N_3)

observed higher added cost (` 2333 and 2771 ha$^{-1}$ during 2011 and 2012, respectively). Whereas, wider spacing of 50 × 50 cm and RDN @ 150 kg ha$^{-1}$ in 3 splits ($M_6N_1$) observed the total reduced cost (`4238 and 4971 ha^{-1} during 2011 and 2012, respectively).

The added return was more (`17793 and 34385 ha$^{-1}$) during 2011 and 2012 respectively under $M_3N_3$ (35 × 35 cm and LCC based N scheduling). However, $M_6N_1$ showed reduced return (` 32536 and 33110 ha^{-1}). The more net gain (16049 and 32202 during 2011 and 2012, respectively) was observed under the treatment combination of M_3N_3 and it was followed by M_1N_3 (60 × 25 cm with LCC based N management) than other combinations. All of the wider spacing combinations showed negative values. The percentage increase over M_1N_3 (60 × 25 cm with LCC based N scheduling) was 22.1 and 18.6 during 2011 and 2012, respectively. This might be due to higher yield and economic return with more or less same cost of cultivation which lead to more net gain. The profit increase over change in current practice (55, 555 plants ha^{-1}) into optimum (88,888 plants ha^{-1}) recorded higher net gain than 1, 11,111 plants ha^{-1} were documented by [5] and [6] in maize. Economic benefits of LCC based N management [7] and [8] was also reported earlier.

4. CONCLUSIONS

The results showed that square planting with LCC based N management fetched higher gross return, net return and BCR with reduced TVC. Partial budgeting analysis indicated that altering spatial from rectangular to square pattern increased added cost marginally and LCC based N scheduling resulted N saving which reflected in reduced cost. Added return and reduced cost under this practice gave higher net gain in maize.

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Table 1. Economics of maize influenced by Spatial pattern and Nitrogen Scheduling approaches

Treatments	2011				2012			
	TVC (` ha^{-1})	Gross returns (` ha^{-1})	Net returns (` ha^{-1})	B:C	TVC (` ha^{-1})	Gross returns (` ha^{-1})	Net returns (` ha^{-1})	B:C
M_1N_1	38428	92669	54240	2.41	42711	124689	81978	2.92
M_1N_2	38542	97442	58900	2.53	42881	122864	79983	2.87
M_1N_3	39242	106628	67386	2.72	43622	152757	109135	3.50
M_2N_1	39947	77923	37976	1.95	44571	112269	67698	2.52
M_2N_2	40061	91540	51479	2.29	44741	111904	67163	2.50
M_2N_3	40761	90263	49502	2.21	45482	120228	74745	2.64
M_3N_1	39359	94396	55037	2.40	43982	121007	77024	2.75
M_3N_2	39472	99908	60436	2.53	44153	136665	92512	3.10
M_3N_3	40172	110462	70290	2.75	44894	159074	114180	3.54
M_4N_1	37365	78767	41402	2.11	41619	100012	58393	2.40
M_4N_2	37478	83825	46346	2.24	41789	113838	72048	2.72
M_4N_3	38178	93640	55462	2.45	42530	129006	86476	3.03
M_5N_1	35437	76011	40574	2.14	39265	102941	63675	2.62
M_5N_2	35551	65603	30052	1.85	39436	102833	63397	2.61
M_5N_3	36251	77863	41612	2.15	40177	112375	72198	2.80
M_6N_1	34190	60133	25942	1.76	37740	91579	53839	2.43
M_6N_2	34304	60963	26659	1.78	37911	98520	60609	2.60
M_6N_3	35004	71151	36147	2.03	38651	106843	68191	2.76

Data not statistically analyzed

TVC- Total Variable Cost; B:C- Benefit Cost

Table 2: Effect of Spatial Pattern and Nitrogen Scheduling on Partial Budgeting (` ha^{-1})

Treatments	2011			2012		
	Added cost	Added return	Net gain	Added cost	Added return	Net gain
M_1N_1	-	-	-	-	-	-
M_1N_2	114	4773	4659	170	-1825	-1995
M_1N_3	814	13959	13145	911	28068	27157
M_2N_1	1519	-14746	-16265	1860	-12420	-14280
M_2N_2	1633	-1129	-2762	2030	-12785	-14815
M_2N_3	2333	-2406	-4739	2771	-4462	-7233
M_3N_1	930	1727	797	1271	-3683	-4954
M_3N_2	1044	7239	6195	1442	11976	10534
M_3N_3	1744	17793	16049	2183	34385	32202
M_4N_1	-1063	-13902	-12839	-1092	-24677	-23585
M_4N_2	-950	-8844	-7894	-921	-10851	-9930
M_4N_3	-250	971	1221	-181	4317	4498
M_5N_1	-2991	-16658	-13667	-3445	-21748	-18303
M_5N_2	-2877	-27066	-24189	-3275	-21856	-18581
M_5N_3	-2177	-14806	-12629	-2534	-12314	-9780
M_6N_1	-4238	-32536	-28298	-4971	-33110	-28139
M_6N_2	-4124	-31706	-27582	-4800	-26169	-21369
M_6N_3	-3424	-21518	-18094	-4059	-17846	-13787

Data not statistically analyzed