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A TECHNIQUE FOR ESTIMATING YIELD IN BLACK PEPPER (*PIPER NIGRUM* L.)*

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ABSTRACT

A technique for visually scoring for yield of pepper plants was standardised. It was found that yield of pepper plants could be estimated with a high R^2 value ($R^2 = 0.81$) using visual yield score as a predictor variable. It was established that by using visual yield score as an ancillary variable in a double sampling scheme, the cost of yield estimation could be reduced by half in comparison to that of simple random sampling for estimating the yield of pepper plantations with a given accuracy. The technique for visually scoring for yield of pepper was field tested and it was found that the method could be adopted with very minimum training to the investigators.

INTRODUCTION

The yield of black pepper is widely influenced by various factors like age of the vines, varietal characteristics, the growth habits of the individual plants and the weather parameters at the time of flower initiation. The harvest of the crop is highly labour intensive and harvesting periods vary depending upon factors like altitude of the place and the varieties planted in a field. Consequently, yield estimation in black pepper using conventional crop cutting method involves a lot of manpower for harvesting and supervision. The present investigation aims at identifying a suitable index of yield potential in black pepper that would reduce the manpower requirements for yield estimation in large scale surveys and also in arriving at reasonably accurate estimates of yield without resorting to actual crop cutting.

MATERIALS AND METHODS

The observations pertaining to the present investigation were carried out for two crop seasons, 1982-83 and 1983-84 in a large pepper plantation in Calicut district, Kerala State. During the two years, observations were recorded on 601 and 527 plants respectively and it consisted of a random mixture of three varieties *viz*, Karimunda, Panniyur I and Arakkulam Munda. Each of the plants was categorised visually as poor yielding, moderate yielding and high yielding for each meter of the plant

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from bottom to top depending upon a judgement of spike density in the canopy of the plant. In addition, in each of the plants a length of one metre of the canopy was marked at reachable height and at the time of harvest the yield of pepper from this portion was recorded. All the plants were individually harvested and the yield of green pepper was recorded at harvest. The data were compiled and the yield of pepper from one metre portion for the three categories of visual judgement were tabulated for further analysis. A field experiment was separately conducted to study the variation in visually scoring for yield of pepper plants by different observers. Two sets of three investigators each were engaged for the purpose of visually scoring 70 plants and 50 plants respectively. One investigator was common for both the sets. An analysis of variance was done to test the difference in the mean yield scores as recorded by the investigators. Based on the value of the critical difference to detect the difference between any two observers as significant, a criterion was evaluated to study the frequency pattern of the number of agreements between the investigators in recording the visual yield score of the plants. The i th investigator was said to be in agreement with the mean yield score for the j th plant, if $| xij - x.j | \leq 20$ per cent of x.j, where xij is the record of the i th investigator (i = 1 to 3) and x.j is the mean visual score of the 3 investigators. Thus the observed frequency of 0, 1, 2 and 3 agreements were tabulated for both the set of investigators.

RESULTS AND DISCUSSION

The mean yield of green pepper from one meter of the plant canopy for the three categories of visual classification (Table I) were analysed statistically and it was noted that the mean yields within each category did not differ significantly over the crop seasons. The mean yield per metre in these categories were in a geometric series and hence numerical scores of 1, 2 and 4 were fixed for poor, moderate and high yielding portions respectively. Based on the corresponding numerical score for each metre of the plants, the visual classifications were converted to numerical grades, hereafter referred to as 'visual yield score'. For example, a plant classified as poor, poor, moderate and high yielding from bottom to top for successive metres would get a visual yield score of $1+1+2+4=8$.

Singh (1968) lists good examples where visual estimates had been successfully implemented as ancillary variates in double sampling schemes. Accordingly, in the present study the relationship between the visual yield score and the actual yield of green pepper was evaluated and the regression coefficients were tested for their homogeniety. It was noted that the regression coefficients were uniform for the varieties over the crop seasons and that the R^2 values were high (Table II). Following Sukhatme and Sukhatme (1978), the costs of yield estimation using double sampling and simple random sampling were evaluated and the results are presented in Table III. While evaluating the costs of yield estimation the cost of recording the actual yield was taken as

Table I. *Mean yield in gms of green pepper per metre under three visual yield classifications*

Year	Variety	High yielding	Moderate yielding	Poor yielding
1982–83	Karimunda	1087.4	512.3	293.3
	Arakkulam Munda	1035.0	500.0	227.0
	Panniyur I	1305.0	692 0	384.0
1983–84	Karimunda	985.0	571.0	278.0
	Arakkulam Munda	936.0	539.5	246.0
	Panniyur I	1262.0	675.0	293.0
Pooled	Overall	1103.0	579.3	292.0

Table II. *Regression of green pepper yield Y (in kgs) on visual yield score X**

Year	Karimunda	Arakkulam Munda	Panniyur I	Overall	R^2 %
1982–83	0.320	0.310	0.400	0.355	81.2
1983–84	0.295	0.305	0.345	0.310	78.9
Pooled	0.305	0.305	0.360	0.320	80.3

* The regression equations are of the form: $Y=b\,X$, b the regr. coeff.
The regression coefficients and R^2 values are significant at 1% level.

Table III. *Sample sizes and cost of evaluation to estimate the plantation yield with given accuracy**

Method of sampling	C. V. in yield %	Accuracy required $\lvert \bar{y} - \bar{Y} \rvert \leq e\bar{Y}$, e = .10			Accuracy required $\lvert \bar{y} - \bar{Y} \rvert \leq e\bar{Y}$, e = .20		
		n	n'	cost (Rs)	n	n'	cost (Rs)
Double	30	11	67	35.40	3	7	9.40
Sampling	40	19	119	61.80	5	30	16.00
	50	30	186	97.20	7	47	23.00
Simple	30	35		70.00	9		18.00
Random	40	60		120.00	16		32.00
Sampling	50	92		184.00	24		48.00

* n is the number of plants which are harvested for recording total yield; n' is the number of plants on which visual yield score is alone recorded, in double sampling n is a subsample from n' plants. The figures are for estimating yield for 1 ha. pepper plantation.

Rs. 2/– per plant and the cost of recording the visual score was taken to be 1/10 th of the former. A perusal of Table III indicates that only half the cost is required in case of double sampling as against the simple random sampling. This was found to be true for varying levels of C. V. of yield and the accuracy coefficients chosen.

An analysis of variance of the visual yield scores as recorded by the three investigators indicated that the mean yield scores did not differ

significantly. The frequencies of the number of agreements among the investigators in recording the visual yield scores for a plant are presented in Table IV. For both the set of experiments the mean number of agreements were nearly equal and high; their variances were uniform. Alternatively the number of disagreements followed a poisson distribution and the mean number of disagreements was low. It was estimated that the probability of 2 or more disagreements was about 0.12. The pooled estimate of the correlation coefficient between the scores of any two observers was estimated to be 0.81.

The above study indicated that visual scoring of yield potential of black pepper is a simple technique that can be quite useful in improving the efficiency of yield estimation procedures and reduce the cost of estimation in comparison to simple random sampling. Also where quick but fairly reliable estimates are required, the visual yield score can be used as a predictor variable.

Table IV. *Frequency distribution of number of agreements in visually scoring for yield of pepper by 3 investigators*

No. of agreements	Observed frequency Set I	Set II	No. of disagreements	Expected frequency Set I	Set II
0	0	0	3	1	1
1	12	7	2	7	5
2	15	15	1	23	16
3	43	28	0	39	28
Total	70	50	Total	70	50
Mean	2.44	2.42	Mean	0.56	0.58
Variance	0.59	0.52	Variance	0.59	0.52

* Expected frequencies under poisson model: $\frac{N.\ e^{-\mu}\ \mu^x}{x!}$ $x = 0, 1, 2,$

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