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Potential yield indices and economic estimation of some newer insecticides against pod borer complex of pigeonpea

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Abstract
The present study was conducted at the Research cum Instructional Farm, IGKV, Raipur, Chhattisgarh during Kharif season 2013-2014. Economics of eight newer insecticidal molecules, acetamiprid 20SP @ 20g a.i/ha, indoxacarb 14.5SC @ 50g a.i/ha, acephate 75SP @ 750g a.i/ha, spinosad 45SC @ 73g a.i/ha, emamectin benzoate 5WSG @ 9.5g a.i/ha, flubendiamide 20WG @ 50g a.i/ha, rynaxipyr 18.5SC @ 30g a.i/ha and thiamethoxam 25WG @ 75g a.i/ha against pod borer complexof pigeonpeawere evaluatedincluding control as check. Spinosad maintained its lethal effect with least pod damage of 6.00% which was at par with indoxacarb (6.14%), whereas maximum pod damage of 10.03% was recorded with flubendiamide. Pod damage in untreated control was 11.30%.The minimum grain damageof 2.10% was recorded with spinosad and indoxacarb, which were at par with emamectin benzoate (2.63%), whereas the maximum grain damage of 4.26% was recorded in flubendiamide. Grain damage in untreated control was 5.40%.
The highest grain yield (1360.54 Kg/ ha) was recorded in spinosad which was at par with indoxacarb (1207.48 kg/ha) emamectin benzoate (1139.44 kg/ha) and acetamiprid (1122.44 kg/ha), while the lowest grain yield (1037.41 Kg /ha) was recorded in flubendiamide, and the untreated control resulted least (816.32 kg /ha) grain yield.The highest incremental cost-benefit ratio was with spinosad (1:9.48) followed by indoxacarb (1:6.26), emamectin benzoate (1:5.43), acetamiprid (1:5.20), acephate(1:3.18), thiamethoxam (1:3.54) and rynaxipyr (1:2.75) while the lowest incremental cost-benefit ratio was with flubendiamide (1:1.89). Thus application of spinosad, indoxacarb, emamectin benzoate and acetamiprid proved to be the best regarding economic management of pod borers in pigeonpea.

Keywords: Pod borer complex, cost: benefit, newer insecticides, pegionpea, potential yield

Introduction

Our country has the distinction of being the largest producer of legumes with over a dozen of pulse crops, grown on about 25.43 million hectares of land and 18.24 million tonnes of production with the average productivity of 679 kg/ha (Anonymous 2011-12) [1, 2]. Among the important pulses grown in India, pigeonpea belongs to family Leguminosae, is a multipurpose grain legume crop. The green pods of pigeonpea are used as vegetables, grains used as split dal and are rich in protein, averaging a protein digestibility of 70% when cooked (Singh, 1991) [10].

Pigeonpea is cultivated in more than 25 countries of the world. As compared to the other pulses produced in the world, pigeonpea holds the sixth rank in production. It covers 6.5 percent of the world's total pulses area and contributes 5.7 percent to the total pulses production (Rao *et al.*, 2010) [9] and is grown in an area of 4.7 million ha with a production of 3.69 million tonnes in the world with the productivity of 784 kg/ha (FAOSTAT, 2010) [4]. Among the pulses, pigeonpea is the second major pulse crop grown in India after chickpea (*Cicer aritinum* L.), accounting for 15.8% of total pulse production (Anonymous, 2012) [2], is an important drought tolerant pulse crop, grown mainly in the semi-arid tropics though it is well adopted to several environments (Treason *et al.*, 1990) [14], lying between 30°S and 30°N of the world. In Indian subcontinent, pigeonpea accounts for almost 90% of the world's crop and Kenya is the second largest pigeonpea producer.

In India, pigeonpea is grown in 3.86 million hectares with an annual production of 2.65 million tonnes and 741 kg $ha^{-1}$of productivity (FAOSTAT, 2012) [5], which is 4/5th share in the world total pigeonpea produced. About 90% of the global pigeonpea area falls in India (Anonymous, 2012) [2]. In Chhattisgarh, acreage under pigeonpea is 51.9 thousand hectares with a total production and productivity of 31 thousand tonnes and 597 kg/ha, respectively (Anonymous, 2013) [3].

Insect pests are major biological constraints to production of pigeonpea crop. It is attacked by several insect pests from seedling stage till harvesting. Worldwide, over 30 species of Lepidoptera feed on pods and seeds of pigeonpea (Shanower *et al.*, 1999) [11], among these only few are economically important as pests *viz*., Tur plume moth, *Exelastis atomosa* (Walsh), Tur pod borer, *Helicoverpa armigera* (Hubner) and Tur Pod fly, *Melanagromyza obtusa* (Mall) collectively referred as "Pod borer complex" (Lal, 1998; Patil *et al*., 1990) [6, 8]. This pod borer complex recorded economic damage at various places ranging 30 to 100 percent, as a result we had to import pulses from other countries by investing a huge amount, in addition direct loss to cultivators in the past years.

Management of pigeonpea pest is complicated as crop is affected by three groups of insects with different biology and variable population dynamics occurring throughout the year across wider geographical areas. After introduction of the new molecules, which were tested and found effective against the key polyphagous pests there is every need to study their effect on these species. Hence, the present study was mainly focused on the effective management strategies on the pod borer complex of pigeonpea at Chhattisgarh, and keeping the above points in view, the present study was formulated.

Materials and Methods

The Present study entitled "Economic estimation of some newer insecticides against pod borer complex of pigeonpea"was conducted during July 2013 to February 2014, at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).A field experiment was laid in randomized block design (RBD) with nine treatments including untreated control, replicated three times for the assessment of their comparative performance against pod borer complex of pigeonpea. The crop was sown on 30th June 2013 in plot size of 19.6 m^2.

Insecticides tested against pod borer complex in pigeonpea

Treatments	Insecticides	Trade name	Doses(ai/ha)
T_1	Acetamiprid 20SP	Pride	20g
T_2	Indoxacarb 14.5 SC	Avanut	50g
T_3	Acephate 75SP	Lancer	750g
T_4	Spinosad 45SC	Tracer	73g
T_5	Emamectin benzoate 5WSG	Safari	9.5g
T_6	Flubendiamide 20WG	Takumi	50g
T_7	Rynaxipyr 18.5SC	Coragen	30g
T_8	Thiamethoxam 25WG	Actara	75g
T_9	Control		-

The data on pod and grain damage were first recorded from the plants and then converted into percent. The percent pod and grain damage were subjected to angular transformation $X=\sqrt{\sin^{-1}}$ P, where X= transformed value and P= Percent data. These transformed values and data on grain yield were analyzed statistically by using the techniques of analysis of variance for randomized block design and significance was tested by "F" test (Cochran and Cox, 1957).

Percent pod and grain damage was recorded with the help of following formula:

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods(healthy + damage)}} \times 100$$

$$\text{Grain damage (\%)} = \frac{\text{Number of damaged grains}}{\text{Total number of grains(healthy + damage)}} \times 100$$

Grain yield

To assess the losses caused by gram pod borer, five random plants from each plot were selected at the time of maturity. There after total number of pods and grains damaged by gram pod borer were counted separately and the percent losses were counted.

The weight of healthy and damaged grains were recorded from each plot and converted in to kg / ha with the help of following formula

$$\text{Grain yield (kg/ha)} = \frac{\text{weight of grains in Kg/plot}}{\text{plot area in m}^2} \times 10000$$

Economics for different insecticides against pod borers of pigeonpea

Economics of different insecticides were worked out as per the market price of the commodities and wages prevailing during the course of studies. For economic analysis, the factors considered were cost of different insecticides and other additional cost involved. Gross and net returns and benefit cost ratio were worked out.

Value of increased yield over untreated control was calculated by multiplying the increased yield over control by prevailing market price of pigeonpea (Rs 3000 per quintal). The net profit over untreated control was worked out by deducting cost of insecticides and labour charges from price of increased yield over control. The incremental cost:benefit ratio was also calculated by dividing net profit over control by the total cost (insecticides and labour charges).

$$\text{Incremental Benefit:Cost Ratio} = \frac{\text{Net Returns}}{\text{Total Cost (Insecticides + Labour Charges)}}$$

Results and Discussion

Percent pod damage by pod borer complex

The data presented in Table 1 reflects that the percent pod damage was also significantly influenced by the insecticidal treatments. All the treatments showed lower percent of pod damage overuntreated control. The minimum percent pod damage was recorded with spinosad 45SC17.77% (14.05%) which was at par with indoxacarb 14.5SC 18.96% (14.52%), emamectin benzoate5WSG19.54% (14.78%) and acetamiprid 20SP19.14% (14.61%) followed by acephate 75SP 22.04% (15.71%), rynaxipyr 18.5SC 23.40% (16.20%) and thiamethoxam 25WG 22.29% (15.80%) treated plots. The highest percent pod damage was recorded 25.03% (16.77%) with flubendiamide 20WG. The percent pod damage recordedin untreated control was 34.35% (19.79%).

Table 1: Percent pod damage by pod borer complex and grain yield in different treatments of pigeonpea

Treatments	Percent Pod damage by pod borer complex	Percent pod damage due to				Yield (Kg/ha)
		H. armigera	*M. vitrata*	*E. atomosa*	*M. obtusa*	
Acetamiprid 20SP	19.14 (14.61)	7.78 (16.16)	6.13 (14.36)	6.16 (14.36)	5.43 (13.47)	1122.44
Indoxacarb 14.5 SC	18.96 (14.52)	6.14 (14.30)	5.50 (14.17)	6.04 (14.17)	7.59 (15.93)	1207.482
Acephate 75SP	22.04 (15.71)	8.29 (16.72)	7.30 (15.13)	6.83 (15.13)	6.96 (15.29)	1088.43
Spinosad 45SC	17.77 (14.05)	6.00 (14.16)	5.13 (12.98)	5.06 (12.98)	7.50 (15.79)	1360.54
Emamectin benzoate 5WSG	19.54 (14.78)	7.43 (15.81)	5.66 (14.18)	6.02 (14.18)	6.93 (15.25)	1139.45
Flubendiamide 20WG	25.03 (16.77)	10.03 (18.45)	8.53 (16.81)	8.37 (16.81)	6.43 (14.68)	1037.41
Rynaxipyr 18.5SC	23.40 (16.20)	9.44 (17.86)	7.39 (15.75)	7.39 (15.75)	6.96 (15.29)	1071.42
Thiamethoxam 25WG	22.29 (15.80)	8.36 (16.80)	7.61 (15.92)	7.54 (15.92)	6.20 (14.40)	1062.92
Control	34.35 (19.79)	11.30 (19.62)	11.10 (19.75)	11.40 (19.72)	12.00 (20.25)	816.32
SE (m) ±	0.30	0.53	0.42	0.42	0.59	86.90
C.D (5%)	0.92	1.61	1.27	1.27	1.78	260.53

Figures in Parentheses are angular transformed values

The present findings are in agreementwith Narasimhamurthy and Ram (2013) [7] that recorded the lowest pod damage in case of spinosad 45SC @73g a.i./ha (8.30%) which was at par with indoxacarb 14.5SC (8.96%) @60g a.i./ha, monocrotophos 36SL @1.2lt/ha (10.10%), endosulfan 35EC @ 0.07% (10.60%) and dimethoate 30EC @1.8lt/ha (12.14%).

Percent grain damage by pod borer complex

The data presented in Table 2 reflects that the grain damage was also significantly influenced by the insecticidal treatments. All the treatments showed least percent of grain damage than control. The minimum percent grain damage was recorded with spinosad 45SC 6.30% (8.31%) which was at par with indoxacarb 14.5SC 7.22% (8.91%) followed by emamectin benzoate 5WSG7.80% (9.26%), acetamiprid 20SP7.85% (9.30%), acephate 75SP9.40% (10.18%) rynaxipyr 18.5SC 9.75% (10.38%) and thiamethoxam 25WG10.45% (10.74%) treated plots. The highest percent grain damage was recorded with flubendiamide 20WG10.97% (11.02%). The grain damage recordedin untreated control was 16.20% (13.43%).

Table 2: Percent grain damage by pod borer complex and grain yield in different treatmentsof pigeonpea

Treatments	Percent grain damage by pod borer complex	Percent grain damage due to				Grain Yield (Kg/ha)
		H. armigera	*M. vitrata*	*E. atomosa*	*M. obtusa*	
Acetamiprid 20SP	7.85 (9.30)	2.83 (9.68)	1.53 (7.10)	3.26 (10.40)	2.83 (9.66)	1122.44
Indoxacarb 14.5 SC	7.22 (8.91)	2.10 (8.29)	1.40 (6.78)	2.30 (8.70	3.83 (11.28)	1207.482
Acephate 75SP	9.40 (10.18)	3.20 (10.29)	1.66 (7.40)	3.60 (10.93)	4.06 (11.61)	1088.43
Spinosad 45SC	6.30 (8.31)	2.10 (8.32)	1.00 (5.65)	1.56 (7.11)	3.73 (11.11)	1360.54
Emamectin benzoate 5WSG	7.80 (9.26)	2.63 (9.28)	1.56 (7.11)	2.93 (9.85)	3.26 (10.40)	1139.45
Flubendiamide 20WG	10.97 (11.02)	4.26 (11.90)	3.20 (10.29)	4.03 (11.58)	3.13 (10.18)	1037.41
Rynaxipyr 18.5SC	9.75 (10.38)	3.33 (10.49)	2.43 (8.95)	3.76 (11.16)	3.46 (10.71)	1071.42
Thiamethoxam 25WG	10.45 (10.74)	4.00 (11.53)	3.06 (10.06)	3.96 (11.46)	2.90 (9.79)	1062.92
Control	16.20 (13.43)	5.40 (13.42)	5.33 (13.34)	5.46 (13.51)	5.40 (13.42)	816.32
SE (m) ±	0.20	0.42	0.36	0.40	0.33	86.90
C.D (5%)	0.28	0.59	0.51	0.56	0.47	260.53

Figures in Parentheses are angular transformed values

Based on percent grain damage by pod borers in the present findings, spinosad 45SC @ 73g a.i./ha and indoxacarb 14.5SC @ 50g a.i./ha proved to be the best among tested insecticides and the present results are in accordance with Yogyata Singh (2012) who also stated that indoxacarb 14.5SC @ 50g a.i./ha to be best insecticide in managing grain damage.

Present findings are also in confirmation with Narasimhamurthy and Ram (2013) [7] as they also recorded significant differences in the percent grain damage in pigeonpea over control plot, and least percent grain damage of 2.36% was observed in spinosad 45SC @ 73g a.i./ha during 2009-2010 while percent grain damage of 2.58% was recorded in indoxacarb 14.5SC @ 60g a.i./ha during 2010-2011.

Grain yield (Kg/ha)

The highest grain yield 1360.54 Kg /ha was recorded in spinosad 45SC which was at par with indoxacarb 14.5SC (1207.48 kg/ha) emamectin benzoate 5WSG (1139.44 kg/ha) and acetamiprid 20SP (1122.44 kg/ha), while the lowest grain yield of 1037.41 Kg /ha was recorded in flubendiamide 20WG treated plots, and the untreated control resulted least (816.32 kg /ha) grain yield in comparison to newer insecticides treated plots). Fig.1: represents Percent pod and grain damage versus yield in each plot treated with newer insecticides.

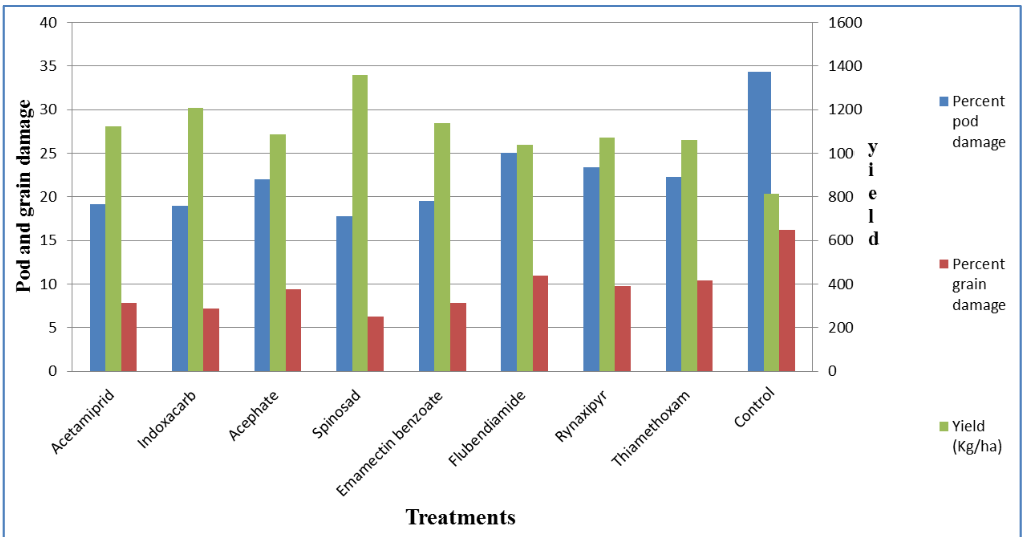

Fig 1: Percent pod and grain damage versus yield in each plot treated with newerinsecticides

Present findings are in agreement with Srinivasan and Durairaj (2007) [12] as they also recorded highest grain yield in indoxacarb 14.5SC @ 50g a.i./ha (864.0 kg/ha) and spinosad 45SC @ 73g a.i./ha (841.1 kg/ha) as against the minimum yield of 432.7 kg/ha in the untreated control plot.
Tamboli and Lolage (2008) [13] who working on newer insecticides in testing the efficacy of newer insecticides also recorded highest grain yield in spinosad 45SC @ 90g a.i./ha (1681 Kg/ha

Net returns
The results of the present findings states that all the treatments showed best in yield over control. The highest yield over control was obtained under treatment spinosad 45SC (1360.54 Kg/ha) which was at par with indoxacarb 14.5SC (1207.48 Kg/ha) emamectin benzoate 5WSG (1139.45 Kg/ha) and acetamiprid 20SP (1122.44 Kg/ha). Price of increased yield over control was calculated and highest price was withspinosad 45SC (Rs.16326.6) lowest was with flubendiamide 20WG (Rs.6632.7).

Cost benefit ratio
Among different newer insecticides tested, the highest net return was found in spinosad45SC (Rs.14769.70) followed by indoxacarb 14.5SC (Rs.10119.86)**,** emamectin benzoate 5WSG (Rs.8187.40), acetamiprid 20SP (7703.60), acephate 75SP (Rs.6213.00), thiamethoxam 25WG (Rs.5770.50) and rynaxipyr 18.5SC (Rs.5613.00) while the lowest net return was with flubendiamide 20WG (Rs.4342.70). The economic analysis is based on the prevailing market rates of insecticides, labour wages and pigeonpea grain cost.
The highest incrementalcost-benefit ratio was with spinosad 45SC @ 73g a.i./ha (1:9.48) followed by indoxacarb 14.5SC @ 50g a.i./ha(1:6.26), emamectin benzoate 5WSG @ 9.5g a.i./ha(1:5.43), acetamiprid 20SP @ 20g a.i./ha (1:5.20), acephate 75SP @ 750g a.i./ha(1:3.18), thiamethoxam 25WG @ 75g a.i./ha (1:3.54) and rynaxipyr (1:2.75) while the lowest incremental cost-benefit ratio was with flubendiamide 20WG @ 50g a.i/a (1:1.89).
Thus application of spinosad 45SC, indoxacarb14.5SC, emamectin benzoate 5WSG and acetamiprid 20SP proved to be the best regarding economic management of pod borers in pigeonpea. The details of the incrementalcost: benefit estimates are presented in the table 3.

Table 3: Cost economics of different insecticides againstpod borer complex in pigeonpea

Notation	Insecticide	Yield (Kg/ha)	Increased yield over control (Kg/ha)	Price of Increased yield over control (Rs./ha)	Cost of chemicals & labour (Rs./ha)	Net profit over control	Incremental Benefit: Cost Ratio
T_1	Acetamiprid 20SP	1122.40	306.12	9183.60	1480.00	7703.60	5.20
T^2	Indoxacarb 14.5 SC	1207.40	391.10	11734.86	1615.00	10119.80	6.26
T_3	Acephate 75SP	1088.40	272.10	8163.30	1950.00	6213.30	3.18
T_4	Spinosad 45SC	1360.50	544.20	16326.60	1556.90	14769.70	9.48
T_5	Emamectin benzoate 5WSG	1139.40	323.10	9693.90	1506.50	8187.40	5.43
T_6	Flubendiamide 20WG	1037.40	221.10	6631.70	2290.00	4342.70	1.89
T_7	Rynaxipyr 18.5SC	1071.40	255.10	7653.00	2040.00	5613.00	2.75
T_8	Thiamethoxam 25WG	1062.90	246.60	7398.00	1627.50	5770.50	3.54
T_9	Control	816.32					

Cost of chemicals: Acetamiprid (20SP) 1 Kg- Rs 2000, Indoxacarb (14.5SC) 1 Lit- Rs 3500, Acephate (75SP) 1 Kg- Rs 680, Spinosad (45SC) 1 Lit- Rs 15333, Emamectin benzoate (5WSG) 1 Kg- Rs 7000, Flubendiamide (20WG) 1 Lit- Rs 1700, Rynaxipyr (18.5SC) 1 Lit- Rs 20000, Thiamethoxam (25WG) 1 Kg- Rs 2500.
Labour cost = 4 Labour day /ha @ Rs 180.00per day
Total labour cost / ha (Two sprays) = Rs. 1440
Price of Pigeonpea = Rs 3,000 per quintal.

Present findings are in agreement with Narasimhamurthy and Ram (2013) [7] who also recorded highest incremental benefit: cost ratio of 13.23 in case of spinosad 45SC @ 73g a.i./ha followed by NSKE-5% (9.99:1) and indoxacarb 14.5 SC @ 60g a.i/ha (9.48:1) in the field evaluation of some insecticides in pigeonpea.

References

1. Anonymous. Annual Progress Report of All India Coordinated Research Project on Pigeonpea, Indian Institute of Pulses Research, Kanpur, 2011.
2. Anonymous. Agricultural production and Programmes, 2012, 83p. pib.nic.in/achieve/others/2012/mar/d2012031305.pdf.
3. Anonymous. Directorate of economics and statistics. Economic survey report, Government of Chhattisgarh, Raipur, 2013, 60-62p.
4. FAOSTAT. Food and Agriculture Organization of United Nation, 2010. [web page] http://faostat.fao.org/
5. FAOSTAT. Food and Agriculture Organization of United Nation, 2012. [web page] http://faostat.fao.org/
6. Lal SS, Katti G. IPM of pod borer complex infesting pigeonpea (In) IPM system in Agriculture, Aditya books Pvt. Ltd., New Delhi. 1998; IV:79-128.
7. Narasimhamurthy GM, Ram K. Field evaluation of some insecticides and bio-pesticide against tur pod bug, *Clavigralla gibbosa* (Spinola) in long duration pigeonpea. African Journal of Agricultural Research. 2013; 8(38):4876-4881.
8. Patil CS, Khaire VM, Mole UN. Comparative performance of different insecticides against pigeonpea pod borer complex on short duration pigeonpea. Journal of Maharashtra Agril. Uni. 1990; 15(30):337-339.
9. Rao PP, Birthal PS, Bhagavatula, Bantilan MCS. Chickpea and Pigeonpea economics in Asia, facts, trends and outlook. International crops research institute for the semi-arid tropics, Patancheru (A.P.) India, 2010.
10. Singh U. The role of pigeonpea in human nutrition.*In:* Uses of tropical grain legumes: Proceedings of consultants meeting. Patancheru, Andhra Pradesh, India, 1991, 129-144p.
11. Shanower TG, Romeis J, Minja EM. Insect pests of pigeonpea (*Cajanus cajan*) and their management. Annual Review of Entomology. 1999; 44(5):77-96.
12. Srinivasan T, Durairaj C. Newer insecticides against pod borer complex of pigeonpea with special reference to *Helicoverpa armigera* and *Melanagromyza obtusa.* Indian J. Pt. Prot. 2007; 35(1):47-49.
13. Tamboli ND, Lolage GR. Bio-efficacy of newer insecticides against pod borer, Helicoverpa armigera Hub (Noctuidae: Lepidoptera) on pigeonpea. Pestology. 2008; 32(10):29-32.
14. Treason RJ, Wallis ES, Singh L. Pigeonpea: Adaptation. *In*: Nene, Y., Hall, S.D., Sheila, V.K. (Eds.), The Pigeonpea. CABI, Wallingford, 1990, 159-177p.