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Effect of NPK (23-10-5) on Nodulation in Two Cowpea Varieties (Asontem and Asetenapa)

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Abstract
Effect of NPK fertilizer on nodulation at flowering / podding and at harvesting, was investigated in two early maturing cowpea varieties (*Asontem* and *Asetenapa*) in the major cropping seasons (March to August) of 2009 and 2013. In Trial 1 (2009), three levels of NPK fertilizer, comprising (i) no fertilizer, (ii) starter fertilizer only, using 23-10-05 at 125 kg/ha applied 9 days after sowing, and (iii) starter fertilizer plus a top-dress of 50 kg/ha sulphate of ammonia 21 days after sowing were tested in . 2 x 3 factorial in a randomized complete block design with four replications. In Trial 2, a blanket dressing of 40 kg/ha triple super phosphate was combined with four rates of 23-10-05 NPK at 0, 30, 60 and 120 kg/ha, in a 2x4 factorial randomized complete block design with eight replications. In Trial 1, total nodule count per plant was higher than active nodules ($p<0.05$) at early flowering (12.66 & 2.24, respectively) and at harvest (10.49 & 0.23, respectively) in both varieties. However, in Trial 2, total and active nodules were not significantly different at the same stage of development: 6.1 & 5.9, respectively, at podding and 2.3 & 1.9, respectively, at harvest. In the two trials, variety and fertilizer significantly affected nodulation but the trends were not consistent. In Trial 1, neither fertilizer nor variety was significant in total or active nodule count at early flowering or at harvest ($p>0.05$). On the other hand, in Trial 2, *Asontem* bore significantly more nodules at podding (8.4 per plant) than *Asetenapa* (3.7 per plant), though fertilizer was not significant. By harvesting time, the total number of nodules per plant had reduced to a mean of 2.2. In this, *Asontem* had 2.5 at harvesting, while *Asetenapa* had 1.9 nodules per plant.
Keywords: cowpea, nodulation, NPK, *Asontem*, *Asetenapa*
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INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp) contains about 23-25% protein in the grain and serves as an inexpensive source of dietary protein for both rural and urban consumers, while livestock also benefit from the protein content of the haulms (Fatokun, 2002). It is well adapted to the hot and erratic rainfall areas of the savannah ecologies of sub-Saharan Africa where about 80% of the world's cowpea is produced (Huesing *et al*, 2011). In Ghana, cowpea is the second most important legume crop after groundnut, yielding about 143,000 MT annually from an estimated 156,000 hectares of land, making Ghana the fifth highest producer in Africa (MOFA, 2010). It is mainly grown in the interior savannah zones of Ghana (Derived Savannah, Southern and Northern Guinea Savannah areas), which constitute about 41% of Ghana's landmass.

The grains are a source of income to smallholder farmers and the crop contributes to sustainable soil fertility improvement in marginal lands through the provision of ground cover, weed suppression and fixation of nitrogen. The traditional system of soil fertility maintenance in West Africa has been through bush fallowing which is currently unsustainable. Today, some farmers use chemical fertilizer which, although this is not widespread because of the expense involved. The use of organic manure has been proposed (Parr *et al*, 1990) to avoid the long-term negative effects of chemical fertilizers on the soil. However, because organic manure is required in large quantities to sustain crop production and may not be available to the small scale farmer (Nyathi and Campbell, 1995), the need for inorganic fertilizers remains relevant.

Prior to the onset of symbiotic nitrogen fixation in cowpea, cotyledonary nitrogen reserves are mobilized during hypocotyl elongation and the cotyledons are shed one or two days after emergence. Thus seedlings dependent upon symbiotically fixed nitrogen may well suffer from temporary nitrogen deficiency during the seedling growth stage once the cotyledonary reserves have been exhausted. It has therefore been recognized and demonstrated that the application of a small amount of nitrogen fertilizer as starter fertilizer, enhances early vegetative growth (Dart et al, 1997). Burries (1959) reported that nitrogen has a stimulating effect on root activity and rooting pattern of the crop, and that available nitrogenous compounds allowed seedlings to make a good start before nitrogen fixation has a chance to occur. Sarr *et al.,* (2015) have shown that plants given inorganic nitrogen during early vegetative growth were much larger by the onset of flowering than those dependent on symbiotic nitrogen fixation alone and such plants also produced more branches and peduncles resulting in greater number of pods, seeds and significantly higher yields.

MATERIALS AND METHODS

The Teaching and Research Farm of the Faculty of Applied Sciences of the Methodist University College Ghana

(MUCG) located at Wenchi in the Brong Ahafo Region (latitude 7° 45' N, longitude 2° 6' W and an altitude of about 338 metres above sea level), was the test site. The vegetation is a forest - savannah transitional ecology with an erratic bimodal rainfall regime. The major cropping season starts from February/March to July and the minor season, from August/September to early December. The mean annual rainfall for Wenchi for a period of ten years (2006 – 2016) was 1,212.9 mm (Anon, 1916). The soils found in this area are largely sandy-loams, high in lateritic concretions and are underlain by a hard pan. Two early maturing cowpea varieties: *Asontem* (reddish coloration) and *Asetenapa* (white with black eye) were used for the study. Cowpeas have been grown in these soils for several years, so the rhizobia present were appropriate for effective inoculation.

The trials were carried out in the 2009 and 2013 major cropping seasons, i.e, March-August. In the first trial, the fertilizer treatments were: (i) no fertilizer, (ii) at 125 kg/ha of 23-10-05 NPK applied as starter fertilizer 9 days after planting, and (iii) starter fertilizer plus a top-dress of 50 kg sulphate of ammonia applied 21 days after sowing, and the experimental design was a 2 x 3 factorial in a randomized complete block design with four replications. The second trial comprised 23-10-05 NPK at 0, 30, 60 and 120 kg/ha and the experimental design was a 2 x 4 factorial in a randomized complete block design (RCBD) with eight replications.

The land was ploughed and harrowed before planting. In the first trial, each block was divided into six plots while in the second trial, each block was divided into 8 plots and the treatment combinations randomly assigned to them. Each plot measured 3 m x 5 m and was separated by paths 1 m wide on all sides. At planting, a blanket application of triple super phosphate (TSP) was made at the rate of 40 kg/ha at planting, followed by the NPK treatments. Three seeds were sown per hill at a spacing of 60 cm between rows and 20 cm within rows and these were thinned to two plants per hill after emergence. Lamda-cyhalothrin 2.5% EC was applied to control pre-flowering insects, while Cymethoate Super EC was also applied to control flowering and post-flowering insect pests. Kocide 2000 fungicide was used to control fungal diseases on the cowpea plants. Nodule count was carried out at early pod setting and at harvesting. Four plants were sampled randomly on each count from two border rows of each plot. The plants were carefully dug out with the help of a mattock, and a razor blade was used to split the nodules to determine active (pink coloration) nodules. Harvesting was done twice, at 70 and 77 days after planting. The data gathered were subjected to the analysis of variance (ANOVA) and the t-Test, using procedures described by Le-Clerg (1966). Mean values for the treatments were separated at the 5% probability level.

RESULTS

Nodule count per plant declined from flowering / pod setting to harvesting: 12.66 to 2.24 in Trial 1 and from 6.1 to 2.3 in Trial 2 (Tables 1a & 2a, and 1b & 2b; also Tables 7a, 7b. 8a & 8b). As expected, total nodule count was significantly higher than active nodule count at the same stage of development i.e. both at flowering / podding and at harvesting (1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b). Between the two varieties, total nodule count per plant was not significantly different ($p<0.05$) at flowering / podding (11.33 & 14.00) and at harvesting (2.16 & 2.33) in Trial 1 (Tables 1a & 2a). However, in Trial 2, *Asontem* had more nodules (8.4 at podding and 2.73 at harvesting) than *Asetenapa* (3.7 & 1.9) (Tables 1b & 2b). There were no significant fertilizer effects ($p>0.01$) in nodule counts in Trial 1 (Tables 1a, 1b and 2a). Fertilizer was, however, significant ($p < 0.01$) in total nodule count at harvesting, with 120 & 60 kg/ha NPK scoring the lowest mean counts of 1.75 & 1.65, respectively, while 30 & 0 kg/ha NPK scored a mean of 2.95 each.(Tables 2b). Similar trends were shown in active nodule count in Trial 2 (Table 4b).

Table 1a: Total nodule count per plant at early flowering ((Trial 1))

NPK→	S&T	S	0	μ
Asontem Means	10.50	11.50	12.00	11.33A
Asetenapa Means	13.25	17.00	11.75	14.00A
Fertilizer Means	11.87a	14.25a	11.87a	12.66

Legend: S&T = Starter & Top-dress
S = Starter fertilizer only
0 = No NPK fertilizer

Table 1b: Total nodule count per plant at early podding (Trial 2)

NPK→	120	60	30	0	Σ	μ
***Asontem* means**	7.3	9.9	7.1	9.3	33.5	8.4B
***Asetenapa* means**	3.6	3.9	3.5	3.8	14.8	3.7A
Fertilizer means	5.5a	6.9a	5.3a	6.6a		**6.1**

Table2a:. Total nodule count per plant at harvest (Trial 1)

NPK→	S&T	S	0	Σ	μ
Asontem means	2.75	1.50	2.25		2.16A
Asetenapa means	2.25	2.25	2.50		2.33A
Fertilizer means	2.50a	1.87a	2.37a		2.24

Legend: S&T = Starter & Top-dress
S = Starter fertilizer only
0 = No NPK fertilizer

Table 2b: Total nodule count per plant at harvest (Trial 2)

NPK→	120	60	30	0	μ
Asontem means	1.5	2.0	4.1	3.3	2.73B
Asetenapa means	2.0	1.3	1.8	2.6	1.9A
Fertilizer means	1.75a	1.65a	2.95b	2.95b	**2.3**

Table 3a: Active nodule count per plant at early flowering (Trial 1)

NPK→	S&T	S	0		μ
Asontem Means	8.50	10.00	12.00		10.16A
Asetenapa Means	12.00	15.00	8.50		11.83A
Fertilizer Means	10.25a	12.50a	10.25a		11.0

Legend: S&T = Starter & Top-dress
S = Starter fertilizer only
0 = No NPK fertilizer

Table 3b: Active nodule count per plant at podding (Trial 2)

NPK→	120	60	30	0	Σ	μ
Asontem Means	7.4	9.8	7.1	8.5	32.8	8.2B
Asetenapa Means	2.9	3.1	3.3	5.1	14.4	3.6A
Fertilizer Means	5.2a	6.5a	5.2a	6.8a		5.9

Table 4a: Active nodule count per plant at harvest (Trial 1)

NPK→	S&T	S	0	Σ	μ
Asontem Means	**0.25**	**0.0**	**0.0**		**0.08**
Asetenapa Means	**0.75**	**0.0**	**0.43**		**0.39**
Fertilizer Means	**0.50**	**0.0**	**0.22**		**0.24**

Legend: S&T = Starter & Top-dress
S = Starter fertilizer only
0 = No NPK fertilizer

Table 4b: Active nodule count per plant at harvest (Trial 2)

NPK→	120	60	30	0	Σ	μ
Asontem Means	0.9	0.5	3.8	3.0	8.2	2.1B
Asetenapa Means	1.9	1.3	1.3	2.5	7.0	1.8A
Fertilizer Means	1.4b	0.9a	2.6c	2.8c		**1.95**

DISCUSSION

Nodulation in cowpeas grown in Kumasi ranged from 12 to 20 per plant with an average of 14.2 to 16.9 per plant (Agyeman *et al.,* 2014*)*. These counts were much higher than the average of 6.9 nodules per plant in the current study at Wenchi. As in this study, Agyeman *et al.*, (2014) did not find any consistent relationship between nodule count and grain yield. However, high fertilizer levels scored low nodulation: both active and total. This might have been due to a depression of nitrogen-fixation by the nitrogen component of the compound fertilizer, because nitrogen is widely reported to depress nodulation and nitrogen fixation (e.g. Stamford *et al.,* 2013; Sarr, Fujimoto & Yamakawa, 2015). In the study by Sarr *et al.* (2015) in which cowpeas were inoculated with three strains of rhizobia and exposed to various levels of mineral nitrogen, it was found that in some strains nodulation continued to increase from 2 weeks to 6 weeks after transplanting, while others declined from 4 weeks. Still others, when exposed to high levels of mineral nitrogen, scored poor nodulation at the early stages and shot up at 6 weeks. In Sarr *et al* (2015), at 4 weeks, one strain gave increased nodulation at intermediate levels of mineral nitrogen before declining as nitrogen increased, but at 6 weeks, two strains showed this trend. Thus the report by

Sarr etal (2015) seem to agree with the findings in the present Wenchi study and it would seem that the specific strain of rhizobia would determine the specific nodulation response to fertilizer nitrogen.

CONCLUSION

The study showed that high NPK levels produced low nodule counts, both active and total, at podding and harvesting. This indicates cowpea di-nitrogen fixation can be enhanced or maintained by low rates of external nitrogen supply e.g. at 30 kg/ha.

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APPENDICES

APPENDIX 1

Table 5a: t-Test on total & active nodule count at flowering (Trial 1)

	All nodules at flowering	Active nodules at flowering	Difference between means (d)	d^2
Xxxxxxx				
Asontem S&T	10.5	8.5	2	**4**
Asontem S	11.5	10	1.5	2.25
Asontem 0	12.0	12	0	0
xxxxxxxxx				
Asetena S&T	13.25	12	1.25	1.56
Asetena S	17	15	2	4
Asetena 0	11.75	8.5	3.25	10.56
Σ			**S(d)= 10**	**S (d^2)=22.37**

n = 6 μ_d =10÷6=1.67 $S(d^2)$= 22.37 $S(d)^2$=100

$s^2 = \{S(d^2) - [S(d)]^2/6\}/\{5\} = \{22.37-100/6\}/\{5\} = 5.703/5=1.141$

$t = \{\mu_d\} \div \sqrt{(1.141/6)} = 1.67 \div 0.436 = \mathbf{3.83}$

At 5 df, t values are 2.571 for 0.05% & 4.032 for 1%. We reject the null H_o at 5% i.e.

Total & active nodule counts were significantly different at flowering (p>0.05) i.e. total nodules were more numerous than active nodules.

Table 6a: t-Test on total & active nodulation at harvest (Trial 1)

	All Nodules Harvest	Active at Harvest	Difference between means (d)	d^2
Asontem S&T	11	0.25	10.75	115.56
Asetena S	6	0	6	36
Asontem 0	9	0	9	81
Asetena S&T	9	0.75	8.25	68.1
Asetena S	9	0	9	81
Asetena 0	10	0.43	9.57	91.6
			S(d)= 52.57	**S (d^2)=473.26**

n = 6 μ_d =52.57÷6=8.76 S(d^2)= 473.26 $S(d)^2=(52.57)^2=2763.6$

$s^2 = \{S(d^2) – [S(d)]^2/6\}/\{5\} = \{473.26 - 460.6\}/\{5\} = 12.66/5=2.532$

$t = \{\mu_d\}÷ \sqrt{(2.532/6)} =$ 8.76÷0.61=**14.36**

At 5 df, t values are 2.571 for 0.05% & 4.032 for 1%. We reject the null H_o i.e. Total nodule count was significantly more than active nodule count at harvest (p>0.01)

Table 7a: t-Test on total nodulation at flowering & harvesting (Trial 1)

	All Nodules flowering	All Nodules Harvest	Difference between means (d)	d^2
Asontem S&T	10.5	11	0.5	0.25
Asontem S	11.5	6	5.5	30.3
Asontem 0	12.0	9	3	9
Asetena S&T	13.25	9	4.25	18.1
Asetena S	17	9	8	64
Asetena 0	11.75	10	1.75	3.1
			S(d)= 23	**S (d^2)=124.75**

n = 6 μ_d=3.833 $s^2= \{S(d^2) – [S(d)]^2/6\}/\{5\} = \{124.75 – 23^2/6\}/\{5\}$ = {124.75-88.17}/5= 7.316 t = $\mu_d \div \sqrt{(S^2/n)}$ = 3.833÷√7.316/6 = **2.73. At 5 df, t values are 2.571 for 0.05% & 4.032 for 1%.** We reject the null H_o i.e. nodulation at flowering is significantly more than at harvest time (p<0.05).

Table 8a: t-Test on active nodules at flowering & harvesting (Trial 1)

	Active at podding	Active at harvesting	Difference between means (d)	d^2
Asontem S&T	8.5	0.25	8.25	68.06
Asontem S	10	0	10	100
Asontem 0	12	0	12	144
Asetena S&T	12	0.75	11.25	126.56
Asetena S	15	0	15	225
Asetena 0	8.5	0.43	8.17	66.75
			Sd= 54.67	**S (d^2)=730.37**

n = 6 μ_d=9.11 S(d^2)=730.37 $(Sd)^2$ = 54.67^2 $S^2= \{S(d^2) – [(Sd)^2÷6]\}/\{5\}$ ={730.37 - 2988.81/6}/{5}S^2= {730.37 – 498.14}/{5}= {730.37-99.62}/{5} = 126.15

$t = \mu_d \div \{\sqrt{s^2/6}\}$ = 9.11÷4.59 = **4.52 At 5 df, t values are 2.571 for 0.05% & 4.032 for 1%.** We reject the null H_o i.e. active at flowering is greater than active nodules at harvest.

Table 7b: t-Test on total nodulation at podding & harvesting (Trial 2)

	All Nodules Poddingp4	All Nodules Harvest P5	Difference between means (d)	d^2
Asontem 120	7.3	1.5	5.8	33.64
Asontem 60	9.9	2.0	7.9	62.41
Asontem 30	7.1	4.1	3.0	9.0
Asontem 0	9.3	3.3	6.0	36.0
Asetena 120	3.6	2.0	1.6	2.56
Asetena 60	3.9	1.3	2.6	6.76
Asetena 30	3.5	1.8	1.7	2.89
Asetena 0	3.8	2.6	1.2	1.44
	48.4	**18.6**	**(Σd) =29.8**	**Σ(d^2)=154.7**

n = 8 μ_d=29.8÷8=3.725 S^2= 6.2421 t = $\mu_d \div \sqrt{(S^2/n)}$ = 4.2176

At 7 df, t values are 2.365 for 0.05% & 3.499 for 1%. We reject the null hypothesis at $p < 0.01$ i.e. Nodulation at podding is significantly more than at harvest time ($p<0.01$).

Table 8b: t-Test on active nodules at podding & harvesting (Trial 2)

	Active at podding p6	Active at harvesting P7	Difference between means (d)	d^2
Asontem 120	7.4	0.9	6.5	42.25
Asontem 60	9.8	0.5	9.3	86.49
Asontem 30	7.1	3.8	3.3	10.89
Asontem 0	8.5	3.0	5.5	30.25
Asetena 120	2.9	1.9	1.0	1.0
Asetena 60	3.1	1.3	1.8	3.24
Asetena 30	3.3	1.3	2.0	4.0
Asetena 0	5.1	2.5	2.6	6.76
	47.2	**15.2**	**(Σd) = 32**	**Σ(d^2)=184.88**

n = 8 μ_d=32÷8=4.0 S^2= 8.1257 t = 3.97

At 7 df, t values are 2.365 for 0.05% & 3.499 for 1%. We reject the null hypothesis at $p<0.01$ i.e. active nodulation at podding is significantly more than at harvesting ($p<0.01$).

Table 5b: t-Test on total & active nodulation at podding (Trial 2)

	All nodules at poddingp4	Active nodules at podding p6	Difference between means (d)	d^2
Asontem 120	7.3	7.4	0.1	0.01
Asontem 60	9.9	9.8	0.1	0.01
Asontem 30	7.1	7.1	0	0
Asontem 0	9.3	8.5	0.8	0.64
Asetena 120	3.6	2.9	0.7	0.49
Asetena 60	3.9	3.1	0.8	0.64
Asetena 30	3.5	3.3	0.2	0.04
Asetena 0	3.8	5.1	1.3	1.69
Σ	48.4	47.2	(Σd) =4.0	Σ(d^2)=**3.52**

n = 8 μ_d = 4÷8=0.5 S^2= 1.52 t = $\mu_d \div \sqrt{(1.52/8)}$ = 0.31

At 7 df, t values are 2.365 for 0.05% & 3.499 for 1%. We accept the null H_o i.e. Total & active nodule counts were not significantly different at podding ($p>0.05$)

Table 6b: t-Test on total & active nodulation at harvest (Trial 2)

	All Nodules Harvest P5	Active at Harvest P7	Difference between means (d)	d^2
Asontem 120	1.5	0.9	0.6	0.36
Asontem 60	2.0	0.5	1.5	2.25
Asontem 30	4.1	3.8	0.3	0.09
Asontem 0	3.3	3.0	0.3	0.09
Asetena 120	2.0	1.9	0.1	0.01
Asetena 60	1.3	1.3	0	0
Asetena 30	1.8	1.3	0.5	0.25
Asetena 0	2.6	2.5	0.1	0.01
	18.6	**15.2**	(Σd) =**3.4**	$\Sigma(d^2)$=**3.06**

n = 8 μ_d=0.425 S^2= 1.615 $t = \mu_d \div \sqrt{(S^2 \div n)} = 0.945$

At 7 df, t values are 2.365 for 0.05% & 3.499 for 1%

We accept the null H_o i.e. at harvest total nodule count is not different from active nodule count.

APPENDIX 2

Table 7a: ANOVA on total nodulation at early flowering (Trial 1)

Source	D F	SS	MS	F	Prob
Replication	3	111.458	37.153	2.4043ns	0.1081
Variety	1	5.042	5.042	0.3263ns	
Fertilizer	2	75.000	37.500	2.4267ns	0.1222
Interaction	2	74.333	37.167	2.4052ns	0.1242

Table 7b: ANOVA on total nodule count at podding (Trial 2)

Source	D F	SS	MS	F	$F_{0.05}$	$F_{0.01}$
Blocks	7	243	34.7	3.5**	2.21	3.04
Variety	1	351.6	351.6	35.5**	4.04	7.19
Fertilizer	3	28.9	9.6	0.97ns	2.80	4.22
Fertilizer x Variety	3	745.5	248.5	25.1**	2.80	4.22

APPENDIX 3

Table 8a: ANOVA on total nodule count at harvest (Trial 1)

Source	D F	SS	MS	F	$F_{0.05}$	$F_{0.01}$
Blocks	3	72.83	24.28	2.8ns	3.29	5.22
Variety	1	0.2	0.2	0.02ns	4.54	8.68
Fertilizer	2	1.41	0.71	0.08ns	3.68	6.36
Fertilizer x Variety	2	204.39	102.2	11.77**	3.68	6.36

Table 8b: ANOVA on total nodulation at harvest (Trial 2)

Source	D F	SS	MS	F	$F_{0.05}$	$F_{0.01}$
Blocks	7	1.00	0.14	0.56 ns	2.21	3.04
Variety	1	5.06	5.06	20.2 **	4.04	7.19
Fertilizer	3	39.13	13.0	52.8**	2.80	4.22
Fertilizer x Variety	3	33.56	11.2	44.8**	2.80	4.22

APPENDIX 4

Table 9a: ANOVA on active nodule count per plant at early flowering (Trial 1)

Source	**D F**	**SS**	**MS**	**F**	$F_{0.05}$	$F_{0.01}$
Blocks	3	11.79	3.93	1.82ns	3.29	5.42
Variety	1	3.38	3.38	1.56ns	4.54	8.68
Fertilizer	2	3.09	1.545	0.71ns	3.68	6.36
Fertilizer x Variety	2	47.46	23.73	10.97**	3.68	6.36

Table 9b: ANOVA table on active nodulation at podding (Trial 2)

Source	D F	SS	MS	F	$F_{0.05}$	$F_{0.01}$
Blocks	7	197.32	28.19	2.61*	2.21	3.04
Variety	1	337.6	337.6	31.2**	4.04	7.19
Fertilizer	3	35.63	11.88	1.1 ns	2.80	4.22
Fertilizer x Variety	3	750.97	250.3	23.1**	2.80	4.22

APPENDIX 5

Table 10a: ANOVA ON ACTIVE NODULE COUNT PER PLANT AT HARVEST (Trial 1)

Source	D F	SS	MS	F	$F_{0.05}$	$F_{0.01}$
Blocks	3	11.79	3.93	1.82ns	3.29	5.42
Variety	1	3.38	3.38	1.56ns	4.54	8.68
Fertilizer	2	3.09	1.545	0.71ns	3.68	6.36
Fertilizer x Variety	2	47.46	23.76	10.97**	3.68	6.36

Table 10b: ANOVA on active nodulation at harvest (Trial 2)

Source	D F	SS	MS	F	$F_{0.05}$	$F_{0.01}$
Blocks	7	34	4.85	19.4**	2.21	3.04
Variety	1	1.56	1.56	6.24*	4.04	7.19
Fertilizer	3	38.5	12.83	51.3**	2.80	4.22
Fertilizer x Variety	3	76.94	25.64	102.56**	2.80	4.22