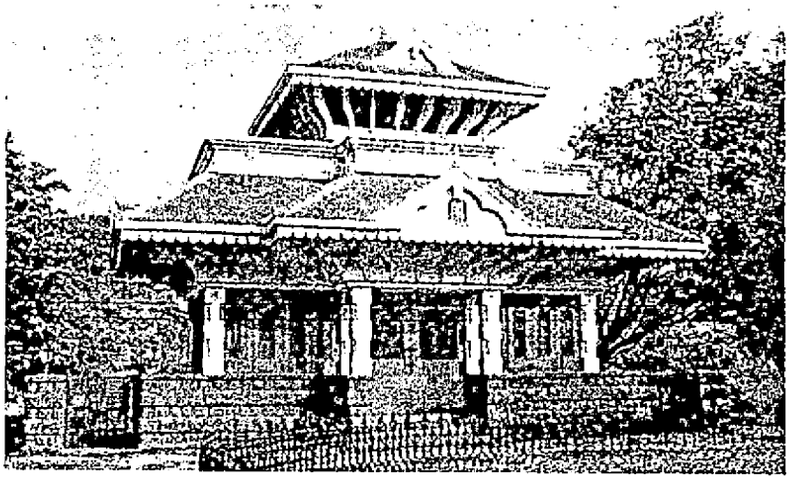
COLLABORATIVE RESEARCH PROJECT

EVALUATION OF SLOW RELEASE FERTILIZERS FOR IMPORTANT CROPS IN KERALA

FINAL REPORT



KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF HORTICULTURE, TRICHUR 680 656

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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, NEW DELHI

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COLLABORATIVE RESEARCH PROJECT ON THE EVALUATION OF SLOW RELEASE FERTILIZERS FOR IMPORTANT CROPS IN KERALA

SPONSORED BY DSIR, NEW DELHI
EXECUTING AGENCY : FACT UDYOGAMANDAL COCHIN

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1999

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The members of the Project Review Committee, viz., Shri. K.V. Srinivasan (Chairman, DSIR), Dr. Prem Sagar (Director, DSIR), Dr. N. N. Goswami (Ex-Vice Chancellor CAUAST), Dr. S. Nand (Fertilizer Association of India), Dr. B. C. Biswas (Chief Agromomist, Fertilizer Association of India) and Dr.(Mrs) Chandrika Varadachari (Secretary RCFAIS, Calcutta) need to be appreciated for their critical review of the project and suggestions from time to time. We remain grateful to them for making their field visits to our experimental plots at various locations and recording their appreciation.

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The finacial assistance from DSIR for the operation of this project is greatly acknowledged.

CO- PRINCIPAL INVESTIGATOR

EVALUATION OF SLOW RELEASE FERTILIZERS FOR THE IMPORTANT CROPS OF KERALA

OBJECTIVES

*To evaluate the efficiency of slow release fertilizers developed by the FACT

*To modify the release pattern of nutrients from slow release fertilizers depending on the crop and soil requirements

*To evolve suitable agronomic or soil management practices for the efficient use of slow release fertilizers

CONTENTS

TABLE 1. EVALUATION OF SLOW RELEASE FERTILIZERS
INITIAL TECHNICAL PROGRAMME FOR PADDY

Tr.	Formulation	Treatment particulars
1	Spike	Urea formaldehyde, Factomphos, Urea & MOP (Gypsum & wax binder)
2	Spike	Phosphogypsum urea adduct, single super phosphate & MOP (Gypsum & Neem cake)
3	Spike	Phosphogypsum urea adduct, single super phosphate & MOP (Gypsum and wax)
4	Mixture	Physical barrier & nitrification inhibitor
5	Mixture	Factomphos coated with coaltar, Urea & MOP
6	Spike	Factomphos, Ammonium sulphate & MOP (Gypsum & neemcake)
7	Mixture	Single application of straight fertilizers at the full recommended dose
8	Mixture	Split application of the recommended dose as per the POP of KAU
9-16	Similar to Tr.1-8 except that the total NPK supplied will be at 75% of the recommended doses	
17	Absolute control with out any NPK fertilizers	

TABLE 2. GENERAL DETAILS OF THE FIRST CROP OF PADDY

Crop	Rice (Transplanted)
Variety	Jaya
Recommendation	90 : 45 : 45 kg ha^{-1}
Duration	120 - 125 days
Type of nursery	Dry
Date of sowing	8 June 1995
Plot size	5.6m x 3.6 m (20.16 m^2)
Spacing	20 x 15 cm
Date of transplanting	14 & 15 July 1995
No. of treatments	17
Replication	3
Design	RBD
Date of harvest	3 November 1995

TABLE 3. INITIAL SOIL FERTILITY STATUS BEFORE THE FIRST CROP OF PADDY

Tr.	Organic carbon (%)	pH	EC dS m^{-1}
1	1.07	4.37	0.10
2	1.09	4.43	0.10
3	1.10	4.33	0.12
4	0.71	4.33	0.11
5	0.74	4.27	0.11
6	1.06	4.13	0.07
7	0.67	4.77	0.07
8	0.80	4.37	0.08
9	0.71	4.50	0.10
10	0.70	4.63	0.11
11	0.79	4.83	0.10
12	0.76	4.93	0.10
13	0.77	4.58	0.11
14	0.70	4.67	0.08
15	0.70	4.87	0.08
16	0.71	4.67	0.08
17	0.69	5.00	0.10
CD	0.07	0.21	0.01

TABLE 4. MEAN BIOMETRIC OBSERVATIONS ON THE FIRST CROP OF PADDY

Treatment	No. of productive tillers / hill	1000 grain wt (g)	Height of the plant cm
1	5.28	24.85	82.00
2	4.05	23.88	81.00
3	4.30	22.98	81.50
4	6.21	26.39	83.13
5	4.00	22.95	82.00
6	6.25	25.88	83.28
7	5.15	24.68	82.70
8	5.50	25.03	83.10
9	3.92	22.70	80.19
10	3.78	22.65	82.78
11	3.95	21.05	82.70
12	4.45	23.21	83.16
13	3.73	22.25	81.38
14	4.38	23.25	82.88
15	4.23	22.68	81.99
16	4.43	23.18	82.00
17	3.61	20.00	79.78

MEAN GRAIN AND STRAW YIELD OF THE FIRST CROP OF PADDY

The grain and straw yield of the first crop of paddy is presented in table 5. It is seen that the maximum yield of grains was recorded from treatment 4 where single application of slow release fertilizer formulation (mixture) was applied at full recommended dose. Treatments 6, 2, 4 & 8 though recorded lower yields than treatment 4, were considered to be on par with one another sine there was no statistical difference between them. From this it is clear that the efficiency of slow release fertilizers were not over the normal package of practices of the Kerala Agricultural University in terms of grain yield.

However, the cost of application of slow release fertilizer formulation especially the mixtures can be considered as an advantage over the normal and conventional practice of split application, since in the former case only one time application is expected. The available details on the composition of these materials are provided in table 1 along with the technical programme. Incorporation of urea formaldehyde in the fertilizer formulation (treatment 1) could ensure only comparable yield to that obtained from the mixture formulations. Formulations envisaging 75% of the recommended doses provided only lower yields in all treatments when compared to its full dose. The control plot recorded the lowest yield. The straw yields were generally higher than the grain yield in all the treatments. The highest straw yield of 3704 kg/ha, was recorded from the same treatment which provided the maximum yield (Tr.4). However there had been comparable straw yields from treatments 6, 1, 2, & 8. Single application of the full dose of the package of practices (Tr.7) could neither sustain higher yields of grain or straw.

Summary

Many slow release fertilizer formulations were found to be on par with the package of practices of KAU (treatment 8). Considerable savings in labour cost can be made from the application of slow release fertilizers especially the mixture formulations, where one time application is necessitated. Placement of spike form of fertilizers in the root zone of paddy is time consuming and labour intensive. Treatment 4 was found to be the best treatment which provided the maximum grain and straw yield in the first crop of paddy and was comparable with many other formulations. Straw yields from treatments were generally higher than that of the grain yield from treatments. Control plot recorded the lowest grain and straw yields. 75% of the fertilizer recommendation was observed to be inferior in producing both grain and straw yields.

FIG.1 MEAN GRAIN YIELD OF PADDY (FIRST CROP), kg/ha

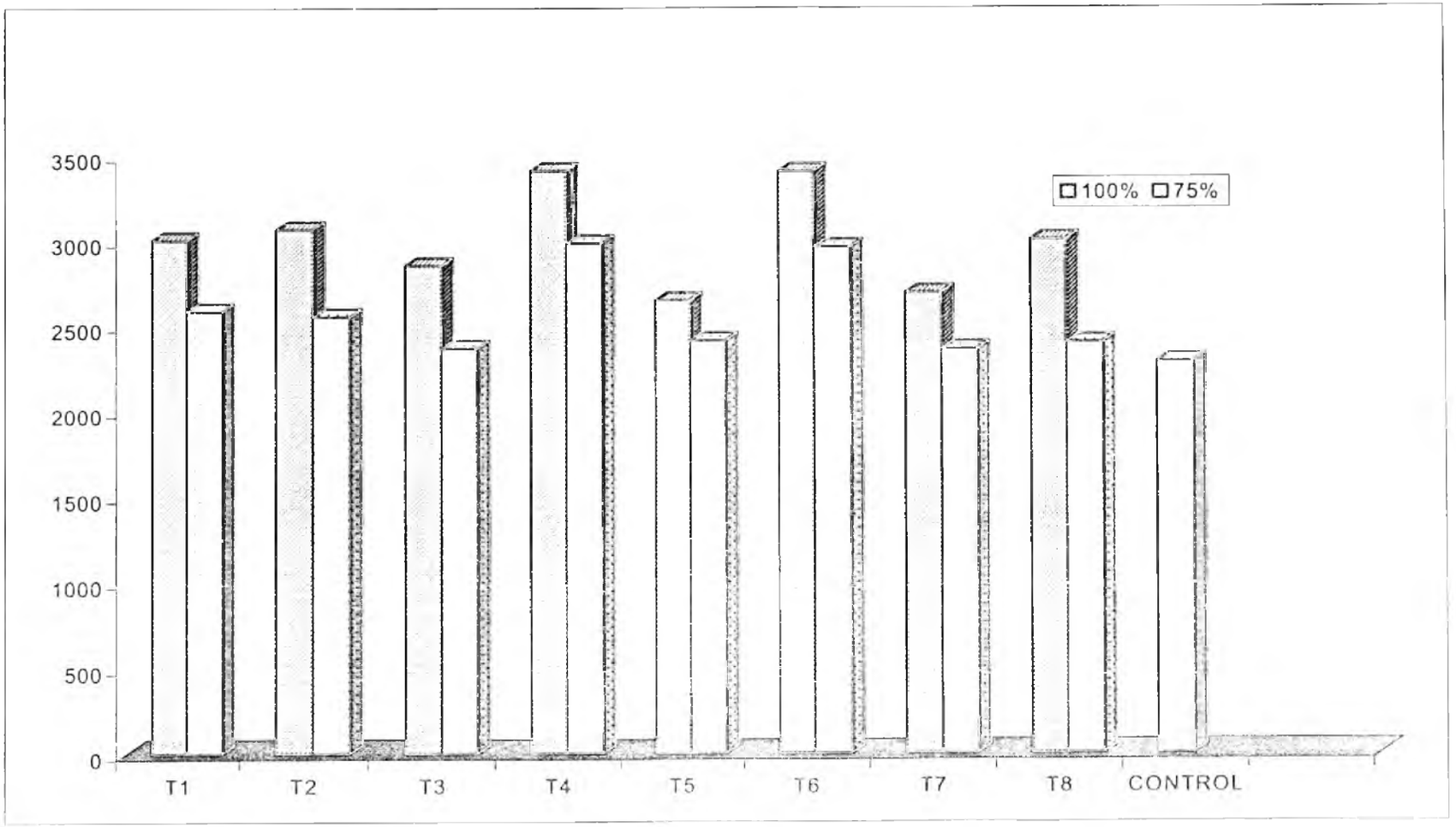


FIG. 2 MEAN STRAW YIELD OF PADDY (FIRST CROP), kg/ha

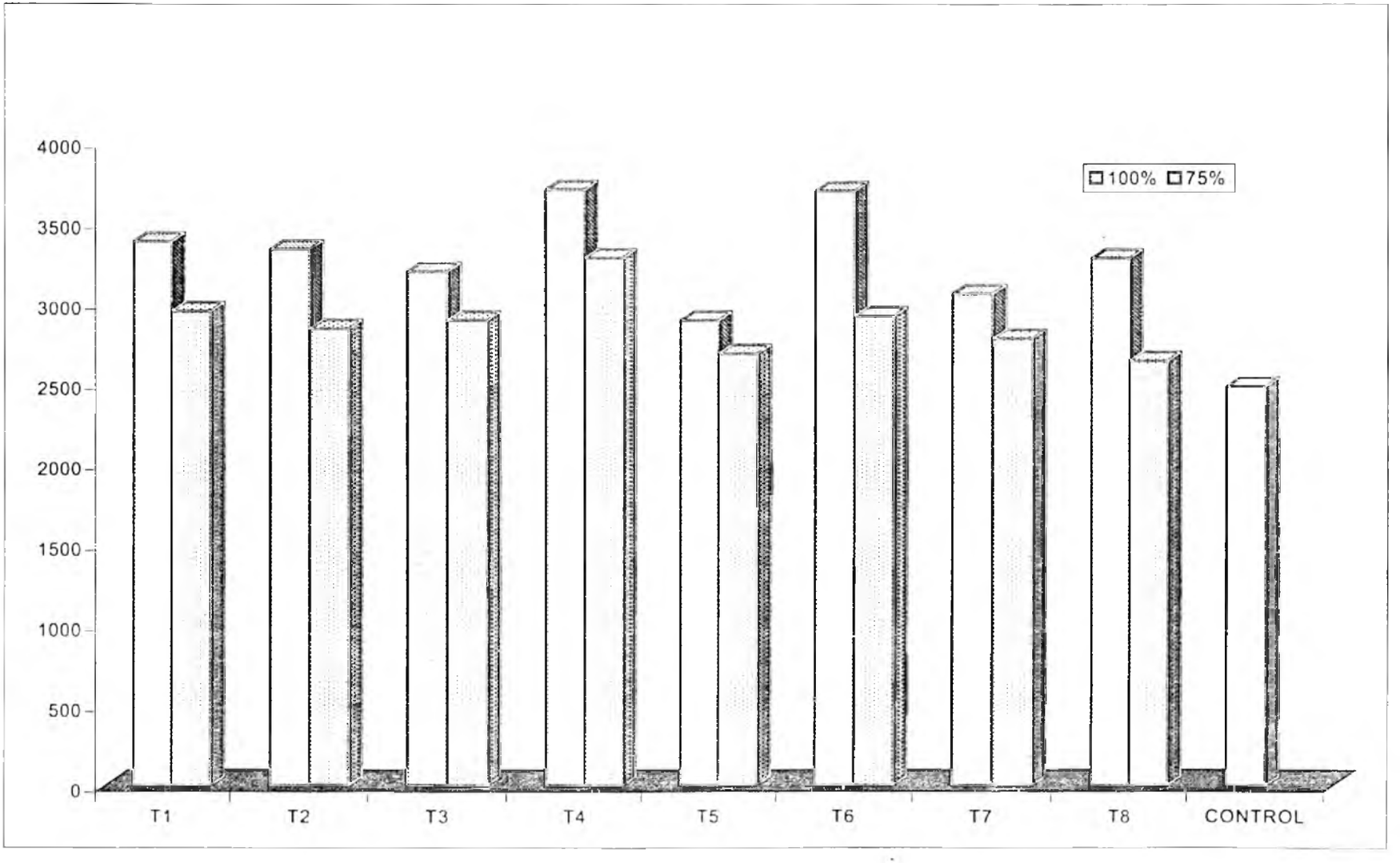


TABLE 5. MEAN GRAIN AND STRAW YIELD OF PADDY (FIRST CROP), kg ha^{-1}

Treatment	Grain yield	Rank	Straw yield	Rank
1	3000	4	3380	3
2	3063	3	3333	4
3	2850	7	3194	6
4	3406	1	3704	1
5	2644	9	2889	10
6	3400	2	3694	2
7	2688	8	3056	7
8	3000	4	3278	5
9	2581	10	2947	9
10	2550	11	2838	11
11	2363	14	2831	12
12	2981	5	3278	5
13	2406	12	2681	15
14	2956	6	2972	8
15	2356	15	2778	13
16	2394	13	2639	14
17	2281	16	2478	16
CD	614		1229	

TABLE 6. POST HARVEST SOIL FERTILITY STATUS IN EXPERIMENTAL PLOTS (FIRST CROP)

Tr.	Av. N mg kg^{-1}	Av. P mg kg^{-1}	Av. K mg kg^{-1}
1	256.7	18.1	94.00
2	272.5	17.3	90.0
3	260.4	16.9	89.3
4	273.5	18.8	87.3
5	245.3	17.6	86.7
6	254.8	18.6	85.0
7	238.0	17.5	87.3
8	241.0	17.3	88.3
9	199.7	15.1	87.7
10	201.6	14.4	85.3
11	215.6	13.7	84.0
12	234.3	16.2	80.7
13	233.4	14.1	83.3
14	232.4	16.8	81.0
15	214.7	14.0	84.0
16	219.3	14.4	84.7
17	161.5	12.9	76.0
CD	12.1	1.2	3.3

TABLE 7. MEAN PER CENT NUTRIENT CONTENT IN PADDY GRAINS (FIRST CROP)

TREATMENT	N	P	K
1	1.70	0.257	0.43
2	1.60	0.300	0.50
3	1.58	0.250	0.45
4	1.74	0.307	0.51
5	1.55	0.233	0.49
6	1.71	0.267	0.49
7	1.53	0.293	0.48
8	1.64	0.300	0.50
9	1.36	0.210	0.41
10	1.37	0.243	0.41
11	1.35	0.247	0.40
12	1.51	0.290	0.46
13	1.43	0.215	0.46
14	1.51	0.240	0.45
15	1.34	0.263	0.40
16	1.42	0.263	0.41
17	1.30	0.185	0.35
CD	0.05	0.183	0.08

TABLE 8. MEAN PER CENT NUTRIENT CONTENT IN PADDY STRAW (FIRST CROP)

Treatment	N	P	K
1	1.2	0.184	2.32
2	1.1	0.218	2.30
3	1.1	0.183	2.06
4	1.3	0.223	2.50
5	1.1	0.174	2.24
6	1.3	0.204	2.13
7	1.0	0.233	2.20
8	1.1	0.244	2.35
9	1.0	0.159	1.97
10	0.99	0.186	2.19
11	0.97	0.159	1.97
12	1.09	0.204	2.22
13	0.98	0.161	2.09
14	1.08	0.182	2.17
15	0.97	0.176	2.03
16	1.03	0.181	2.21
17	0.86	0.156	1.90
CD	0.06	0.083	0.17

TABLE 9. MEAN UPTAKE OF NUTRIENTS IN PADDY GRAINS (FIRST CROP), kg ha^{-1}

Treatment	N	P	K
1	51.0	7.7	13.0
2	49.0	9.2	15.3
3	45.1	7.1	12.7
4	59.2	10.4	17.3
5	41.0	6.2	13.0
6	58.0	9.1	16.7
7	41.1	7.9	12.9
8	49.2	9.0	15.1
9	35.1	5.4	10.6
10	34.9	6.2	10.4
11	31.9	5.8	9.5
12	45.0	8.6	13.7
13	34.5	5.2	11.1
14	44.7	7.1	13.4
15	31.6	6.2	9.4
16	34.1	6.3	9.9
17	29.7	4.2	8.0
CD	8.6	1.4	2.2

FIG. 3 MEAN UPTAKE OF NITROGEN IN PADDY GRAINS (FIRST CROP), kg/ha

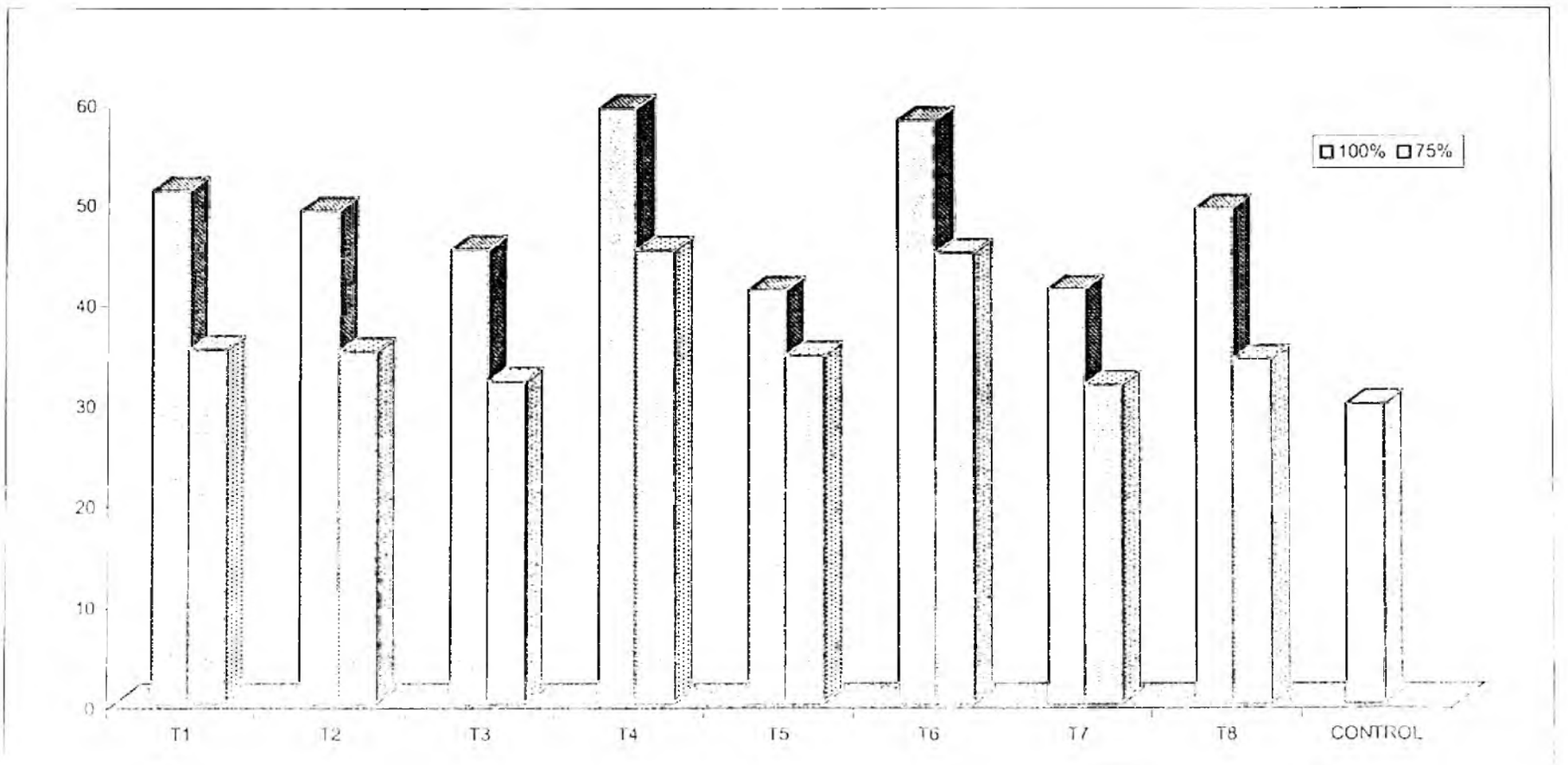


FIG.4 MEAN UPTAKE OF PHOSPHORUS IN PADDY GRAINS (FIRST CROP), kg/ha

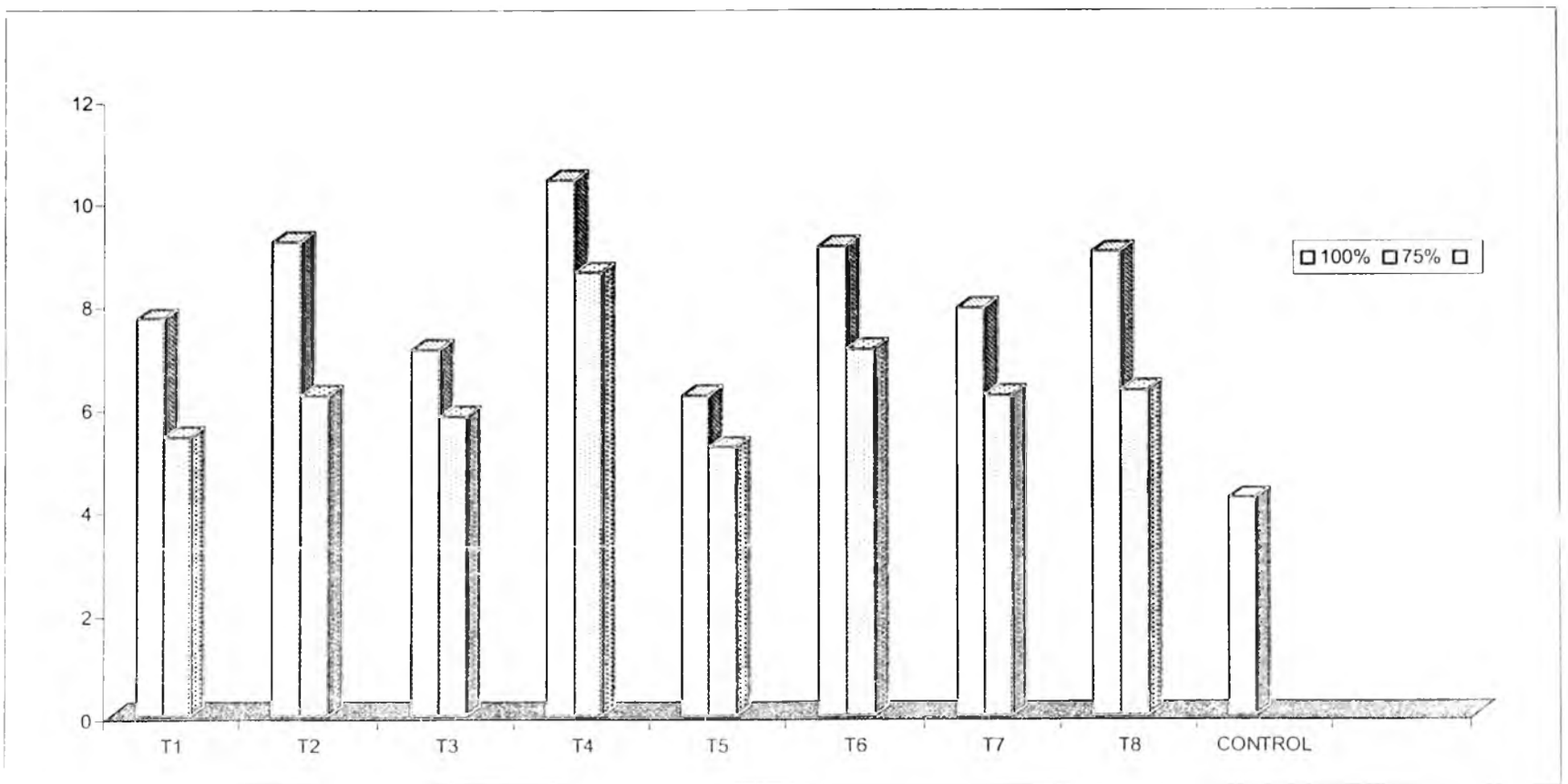


FIG. 5 MEAN UPTAKE OF POTASSIUM IN PADDY GRAIN (FIRST CROP), kg/ha

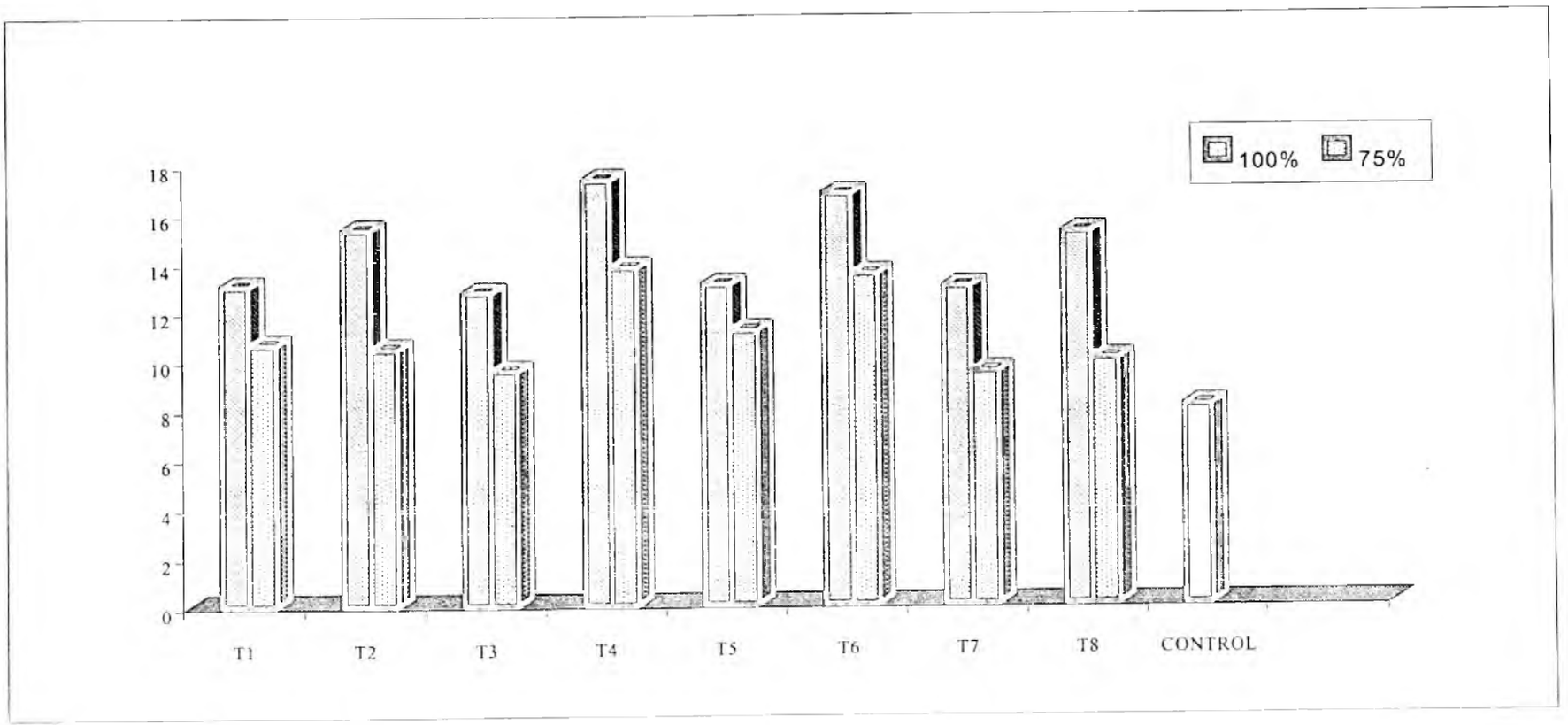


TABLE 10. MEAN UPTAKE OF NUTRIENTS IN PADDY STRAW (FIRST CROP), kg ha^{-1}

Treatment	N	P	K
1	41.57	6.21	70.31
2	36.33	7.27	76.56
3	33.76	5.85	65.89
4	48.04	8.24	92.41
5	31.98	5.03	64.71
6	46.54	7.55	78.57
7	31.69	7.12	66.92
8	36.48	8.00	77.03
9	29.97	4.69	57.97
10	28.25	5.27	62.04
11	27.46	4.50	55.77
12	35.73	6.68	72.77
13	25.78	4.24	55.77
14	32.01	5.41	64.40
15	27.03	4.89	55.50
16	27.10	4.78	58.32
17	21.31	3.86	47.08
CD	8.30	1.25	10.52

FIG. 6 MEAN UPTAKE OF NITROGEN IN PADDY STRAW (FIRST CROP), kg/ha

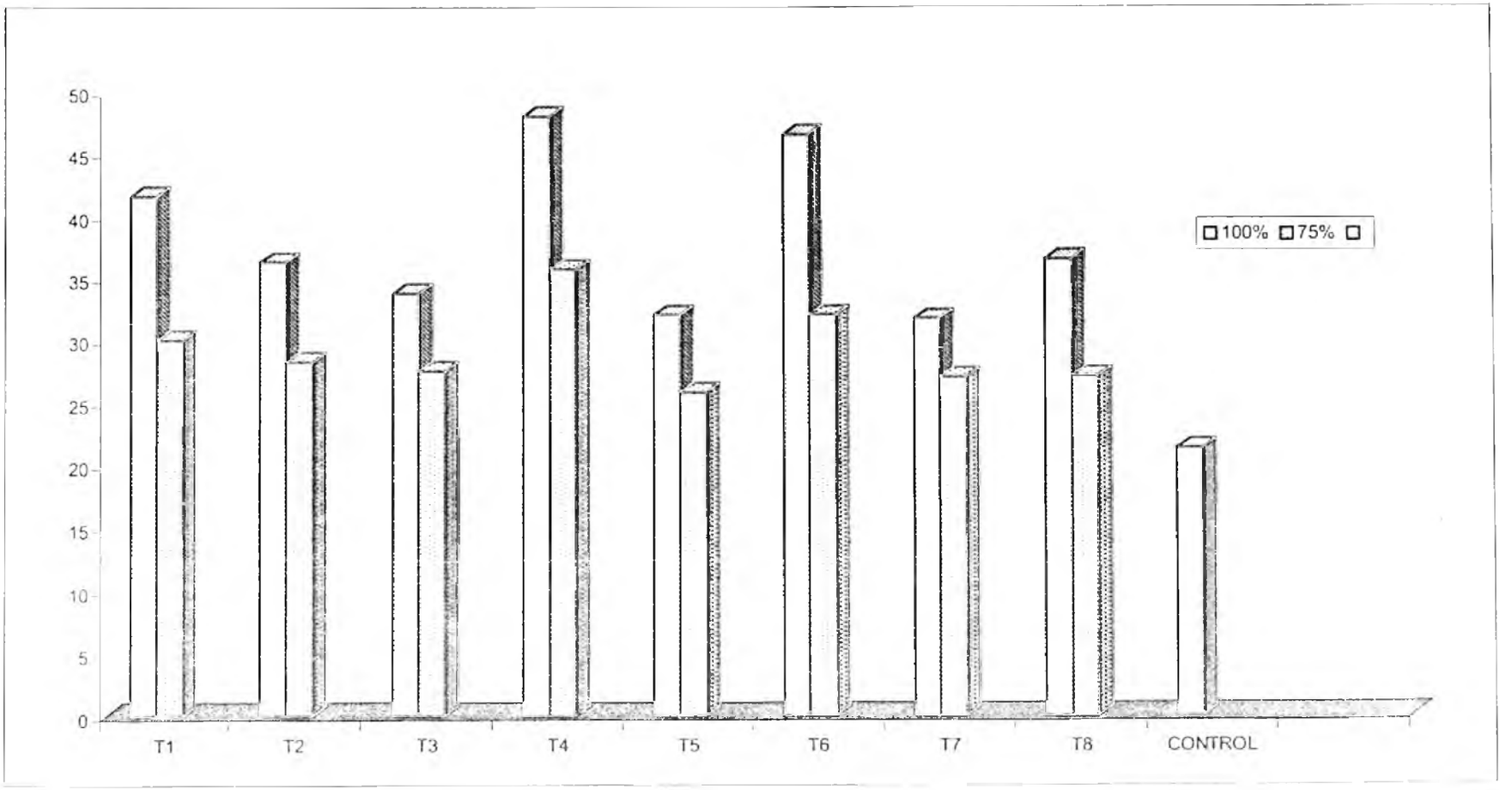


FIG.7 MEAN UPTAKE OF PHOSPHORUS IN PADDY STRAW (FIRST CROP), kg/ha

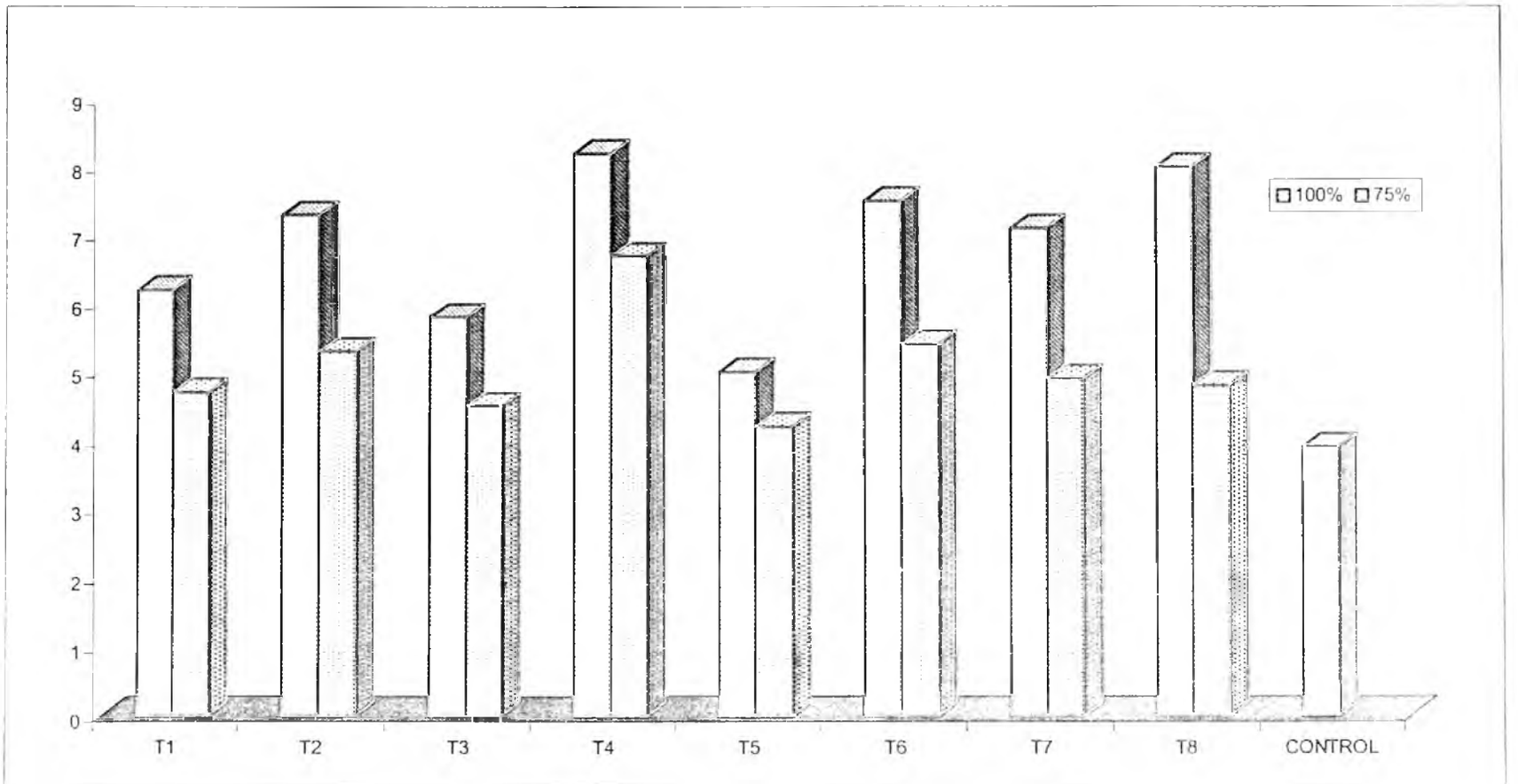


FIG. 8 MEAN UPTAKE OF POTASSIUM IN PADDY STRAW (FIRST CROP), kg/ha

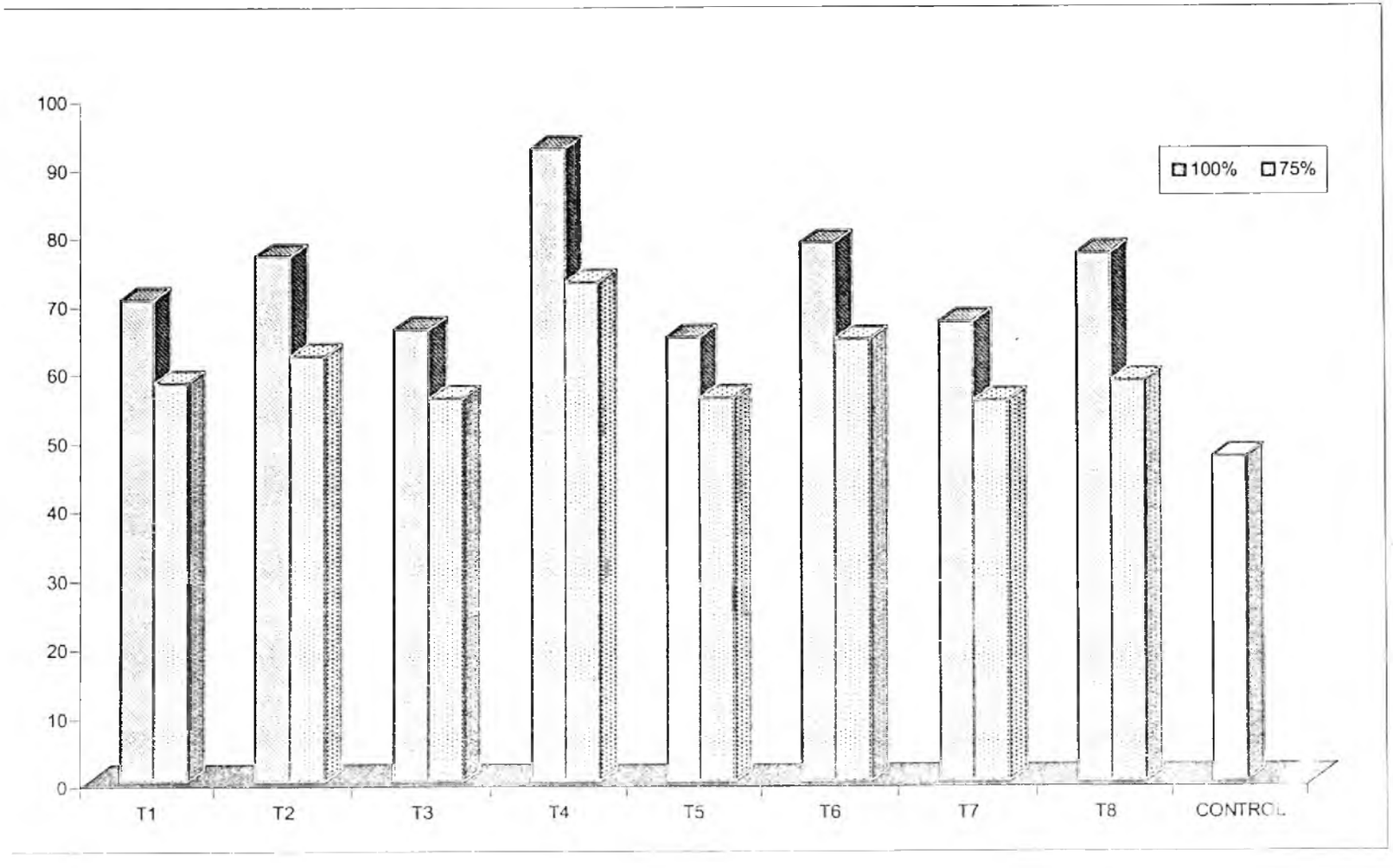


TABLE 11. GENERAL DETAILS OF THE SECOND CROP OF PADDY

Crop	Rice (Transplanted)
Variety	Jaya
Recommendation	90 : 45 : 45 kg ha^{-1}
Duration	120 - 125 days
Type of nursery	Dry
Date of sowing	28 October 1995
Plot size	5.6m x 3.6 m (20.16 m^2)
Spacing	20 x 10 cm
Date of transplanting	28 November 1995
No. of treatments	17
Replications	3
Design	RBD

TABLE 12. INITIAL SOIL FERTILITY STATUS IN EXPERIMENTAL PLOTS BEFORE THE SECOND CROP OF PADDY

Tr.	Av. N mg kg^{-1}	Av. P mg kg^{-1}	Av. K mg kg^{-1}
1	256.7	18.1	94.00
2	272.5	17.3	90.0
3	260.4	16.9	89.3
4	273.5	18.8	87.3
5	245.3	17.6	86.7
6	254.8	18.6	85.0
7	238.0	17.5	87.3
8	241.0	17.3	88.3
9	199.7	15.1	87.7
10	201.6	14.4	85.3
11	215.6	13.7	84.0
12	234.3	16.2	80.7
13	233.4	14.1	83.3
14	232.4	16.8	81.0
15	214.7	14.0	84.0
16	219.3	14.4	84.7
17	161.5	12.9	76.0
CD	12.1	1.2	3.3

TABLE 13. MEAN BIOMETRIC OBSERVATIONS ON THE SECOND CROP OF PADDY

Treatment	No. of productive tillers / hill	1000 grain wt (g)	Height of the plant cm
1	5.20	23.78	61.00
2	4.89	24.52	61.30
3	4.30	23.57	59.66
4	5.76	24.09	65.25
5	5.05	24.77	62.32
6	5.95	25.96	66.62
7	4.65	24.70	63.12
8	6.35	26.42	66.33
9	3.95	22.95	60.19
10	3.75	23.15	61.33
11	3.60	23.38	62.00
12	4.25	24.00	60.66
13	4.10	23.78	60.00
14	4.60	24.59	61.25
15	4.05	24.15	61.33
16	5.00	25.38	62.10
17	3.45	22.70	52.66

GRAIN AND STRAW YIELD OF SECOND CROP OF RICE

The mean grain and straw yield of the second crop of paddy is presented in table 14. It is seen that the maximum yield of 3793 kg/ha grains was recorded from treatment 8 where split application of straight fertilizers were applied as per the package of practices of the Kerala Agricultural University, followed by treatment 6 where spike form of straight fertilizers were used using neem cake as binder. Treatment 4 ranked as third in providing grain yield where spike form of fertilizers were applied. The composition of these material are given in table 1. Incorporation of urea formaldehyde in the fertilizer formulation(treatment 1) could ensure only a significantly lower yield when compared to these treatments probably due to its low efficiency under waterlogged condition. As observed in the first experiment 75% of the recommendation gave consistently lower yields in all treatments when compared to its corresponding full doses. The control plot recorded the lowest yield, emphasizing the need for balanced nutrition.

The straw yield were generally higher than the grain yield in all the treatments. The highest straw yield of 4829 Kg/ha. was recorded from treatment 8. However the straw yield obtained in treatment 1 is comparable with that of treatment 8. The pattern of yield obtained for straw and grain were entirely different in treatments, except in treatments 8 and 17. Single application of the full dose of the package of practices could not sustain higher yields of grain and straw possibly on account of higher losses of nutrients from soil.

summary

Package of practices of KAU(treatment 8) recorded the highest significant grain yield and straw yield in the experiment. Different treatments provided different yields. Straw yields from all treatments were higher than the corresponding grain yield. Control plot recorded the lowest grain and straw yields. 75% of the fertilizer recommendation was proved to be inferior in producing both grain and straw yields.

TABLE 14. MEAN GRAIN AND STRAW YIELD OF PADDY (SECOND CROP), kg ha^{-1}

Treatment	Grain	Rank	Straw	Rank
1	3140	4	4645	2
2	3030	7	4280	3
3	2940	10	3725	5
4	3383	3	3958	4
5	3078	5	3412	7
6	3416	2	3678	6
7	2959	9	3342	10
8	3793	1	4829	1
9	2640	13	3344	9
10	2627	14	3119	13
11	2393	16	3270	11
12	2577	15	3049	15
13	2787	11	3361	8
14	2967	8	3058	14
15	2646	12	2930	16
16	3056	6	3213	12
17	2353	17	2752	17
CD	205		283	

FIG. 9 MEAN GRAIN YIELD OF PADDY (SECOND CROP), kg/ha

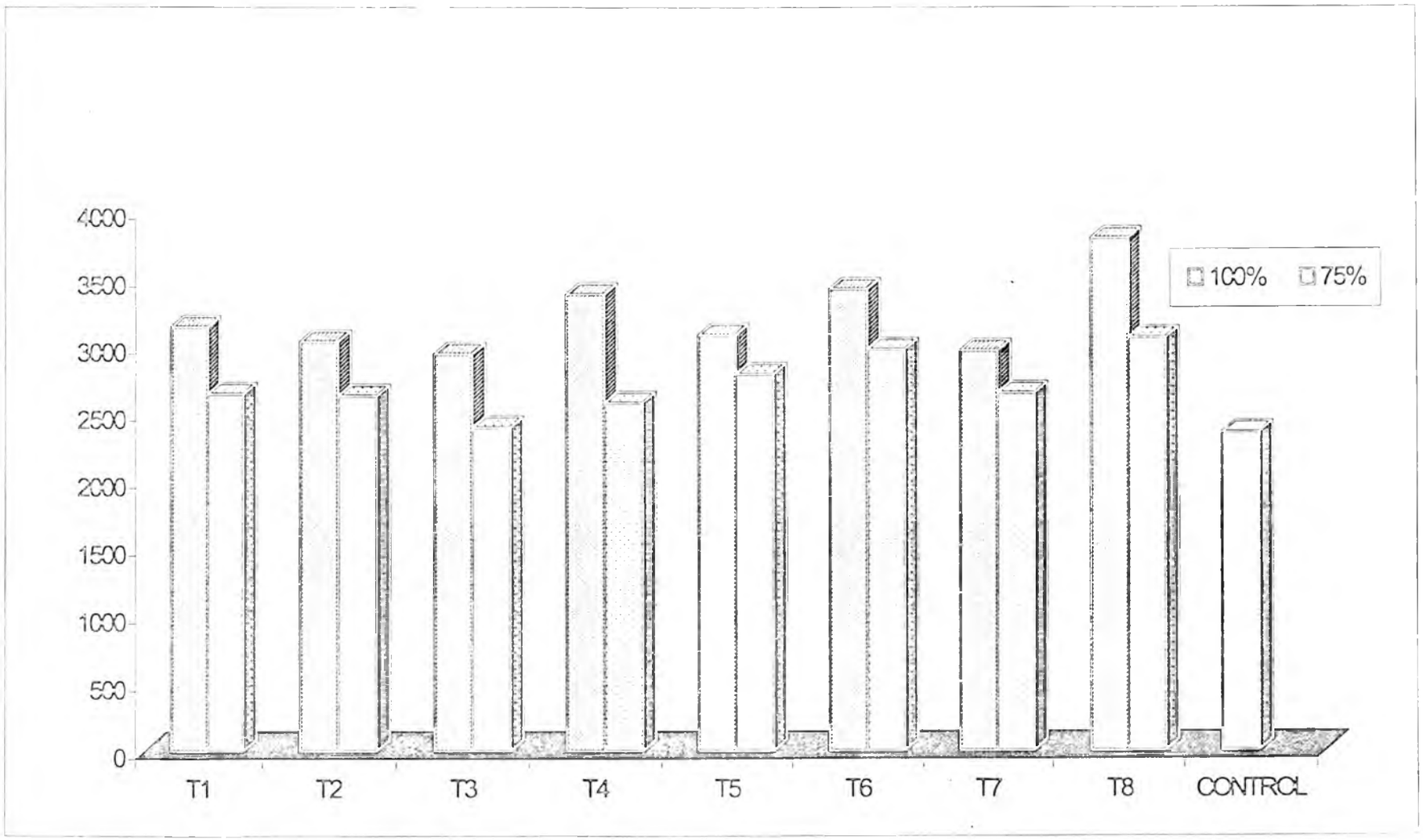


FIG. 10 MEAN STRAW YIELD OF PADDY (SECOND CROP), kg/ha

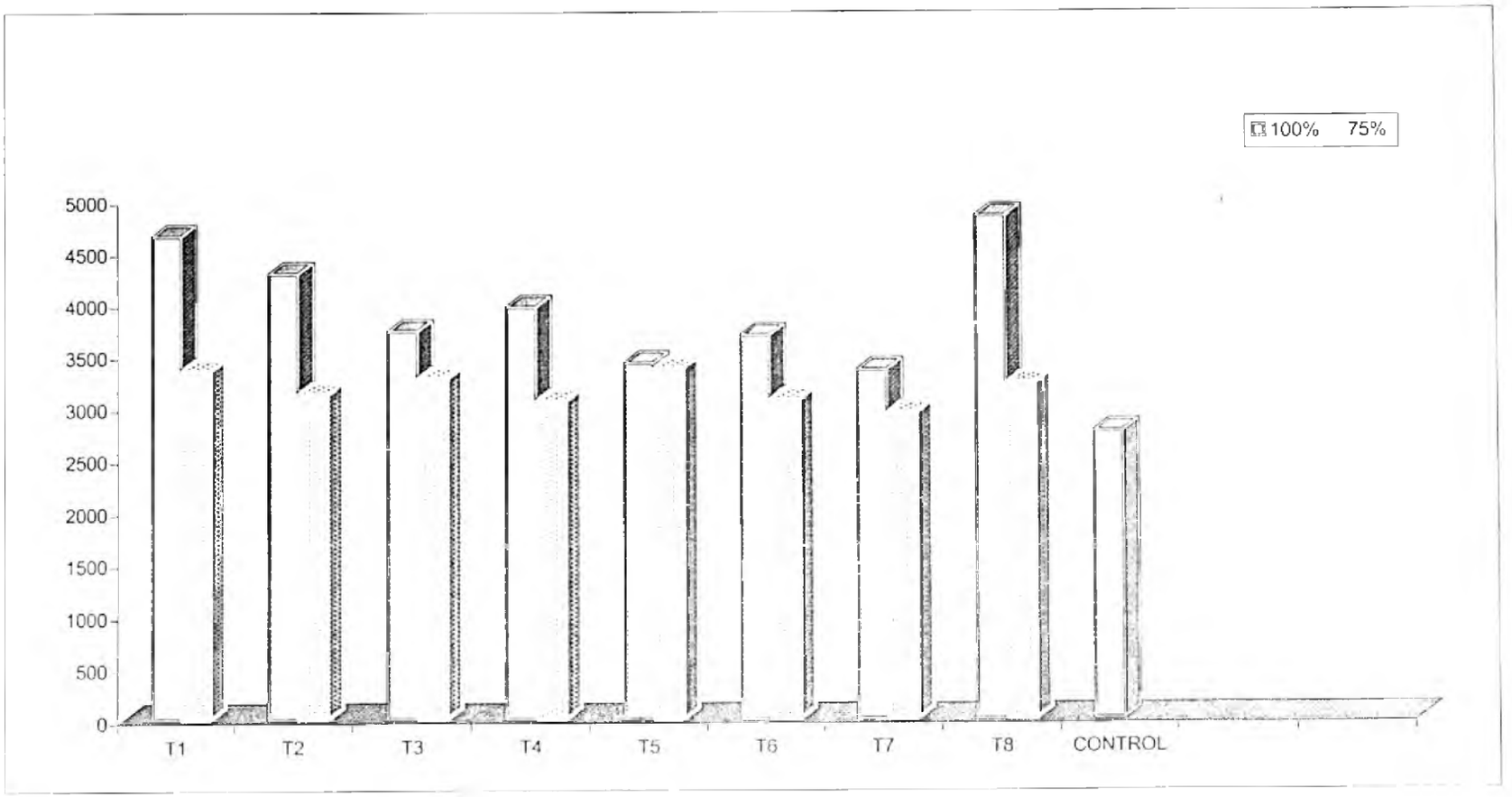


TABLE 15. POST HARVEST SOIL FERTILITY STATUS IN EXPERIMENTAL PLOTS (SECOND CROP)

Tr.	Organic carbon (%)	pH	EC dS m^{-1}
1	0:66	4.98	0.11
2	0.63	5.15	0.12
3	0.67	5.05	0.12
4	0.67	5.08	0.10
5	0.62	4.78	0.09
6	0.62	4.75	0.11
7	0.61	4.78	0.12
8	0.61	4.72	0.12
9	0.63	5.00	0.11
10	0.64	4.65	0.10
11	0.64	4.86	0.12
12	0.66	4.78	0.09
13	0.62	4.71	0.10
14	0.61	4.86	0.09
15	0.64	4.88	0.10
16	0.62	5.02	0.07
17	0.60	4.93	0.10
CD	0.03	0.15	0.03

TABLE 16. MEAN PER CENT NUTRIENT CONTENT IN SECOND CROP IN PADDY GRAINS

Treatment	N	P	K
1	1.68	0.270	0.55
2	1.66	0.275	0.50
3	1.64	0.267	0.50
4	1.68	0.288	0.47
5	1.68	0.268	0.50
6	1.68	0.294	0.49
7	1.67	0.279	0.51
8	1.72	0.298	0.49
9	1.65	0.261	0.44
10	1.65	0.271	0.46
11	1.63	0.267	0.45
12	1.68	0.290	0.50
13	1.64	0.268	0.47
14	1.65	0.279	0.47
15	1.65	0.287	0.49
16	1.68	0.291	0.44
17	1.64	0.256	0.45
CD	0.023	0.006	0.037

TABLE 17. MEAN PER CENT NUTRIENT CONTENT IN PADDY STRAW (SECOND CROP)

Treatment	N	P	K
1	1.3	0.199	2.22
2	1.2	0.203	2.16
3	1.5	0.182	2.19
4	1.2	0.185	2.16
5	1.3	0.180	2.14
6	1.3	0.184	2.20
7	1.3	0.193	2.19
8	1.3	0.213	2.21
9	1.3	0.186	2.18
10	1.1	0.178	2.05
11	1.2	0.179	2.11
12	1.2	0.179	2.10
13	1.3	0.175	2.13
14	1.3	0.183	2.16
15	1.3	0.197	2.15
16	1.2	0.196	2.14
17	1.2	0.174	1.93
CD	0.205	0.008	0.234

TABLE 18. MEAN UPTAKE OF NUTRIENTS IN PADDY GRAINS (SECOND CROP), kg ha^{-1}

Treatment	N	P	K
1	52.7	8.5	17.1
2	50.4	8.3	15.1
3	48.2	7.8	14.7
4	57.1	9.7	15.7
5	51.9	8.3	15.3
6	57.5	10.0	16.8
7	49.5	8.2	15.2
8	65.4	11.3	18.5
9	43.6	6.9	11.7
10	43.3	7.1	12.0
11	39.0	6.3	10.7
12	43.3	7.4	12.9
13	45.9	7.5	13.1
14	49.2	8.2	13.9
15	43.7	7.6	13.1
16	51.4	8.9	13.6
17	38.6	6.0	10.5
CD	3.51	0.55	1.29

FIG. 11 MEAN UPTAKE OF NITROGEN IN PADDY GRAINS (SECOND CROP), kg/ha

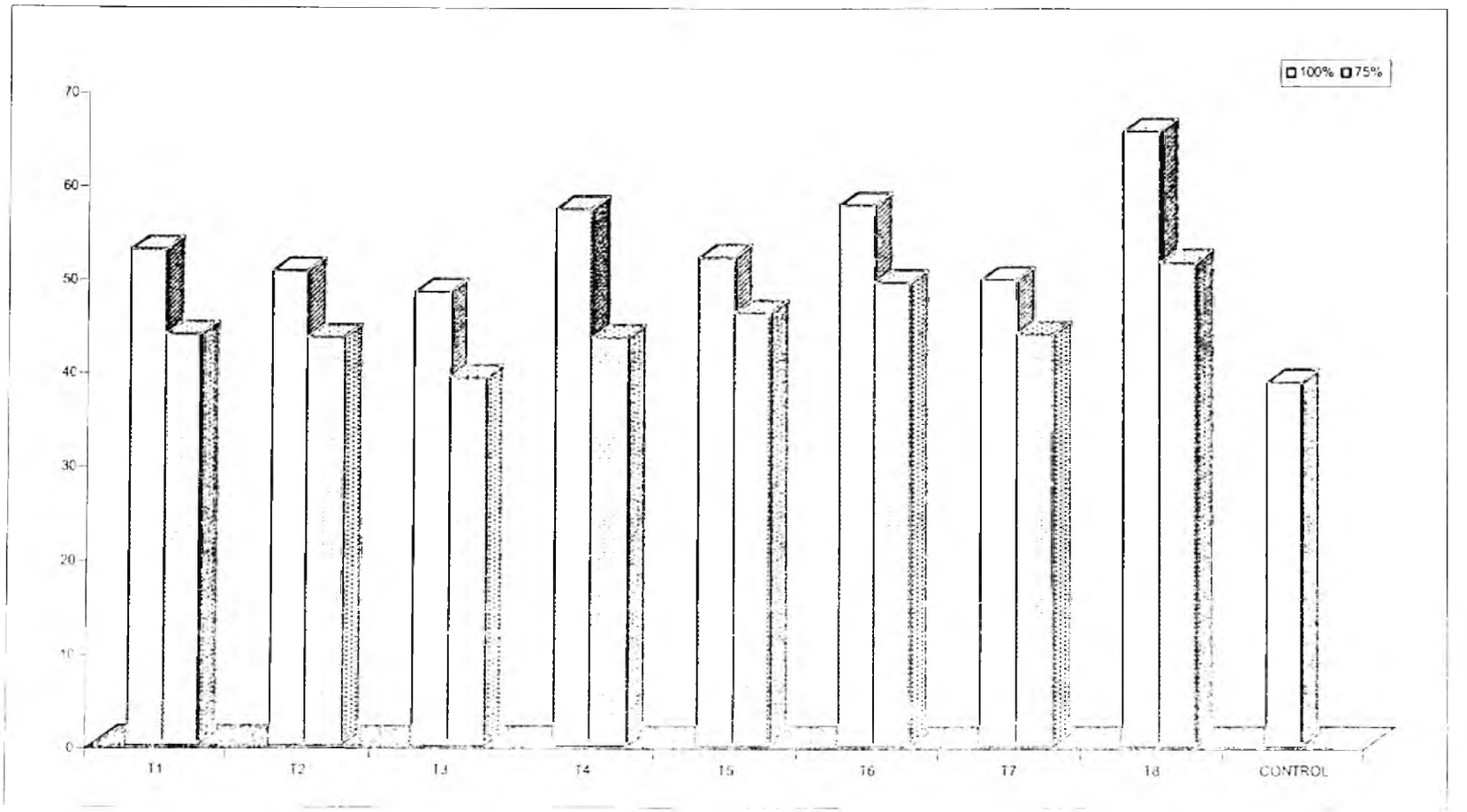


FIG. 12 MEAN UPTAKE OF PHOSPHORUS IN PADDY GRAINS (SECOND CROP), kg/ha

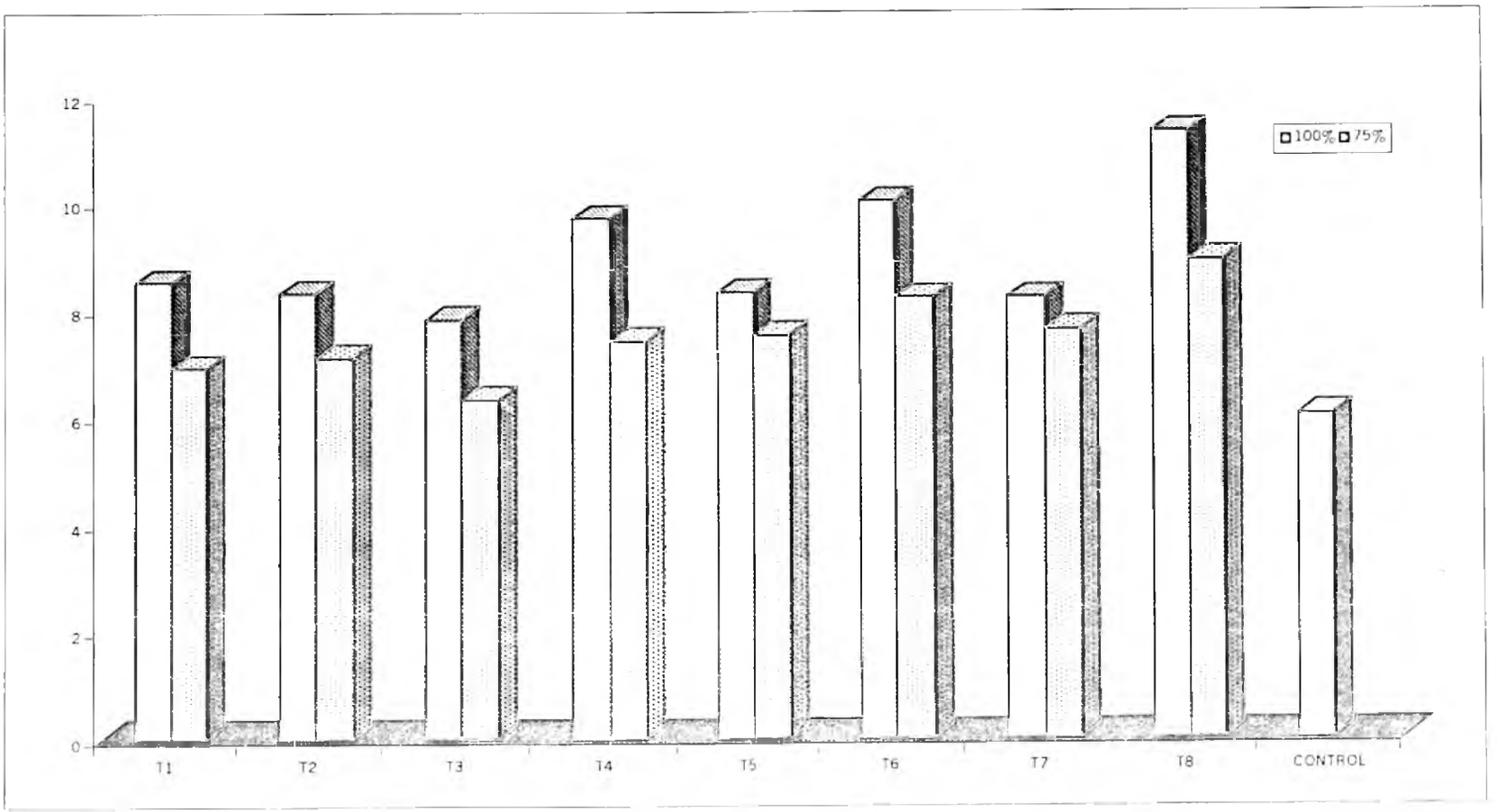


FIG. 13 MEAN UPTAKE OF POTASSIUM IN PADDY GRAINS (SECOND CROP), kg/ha

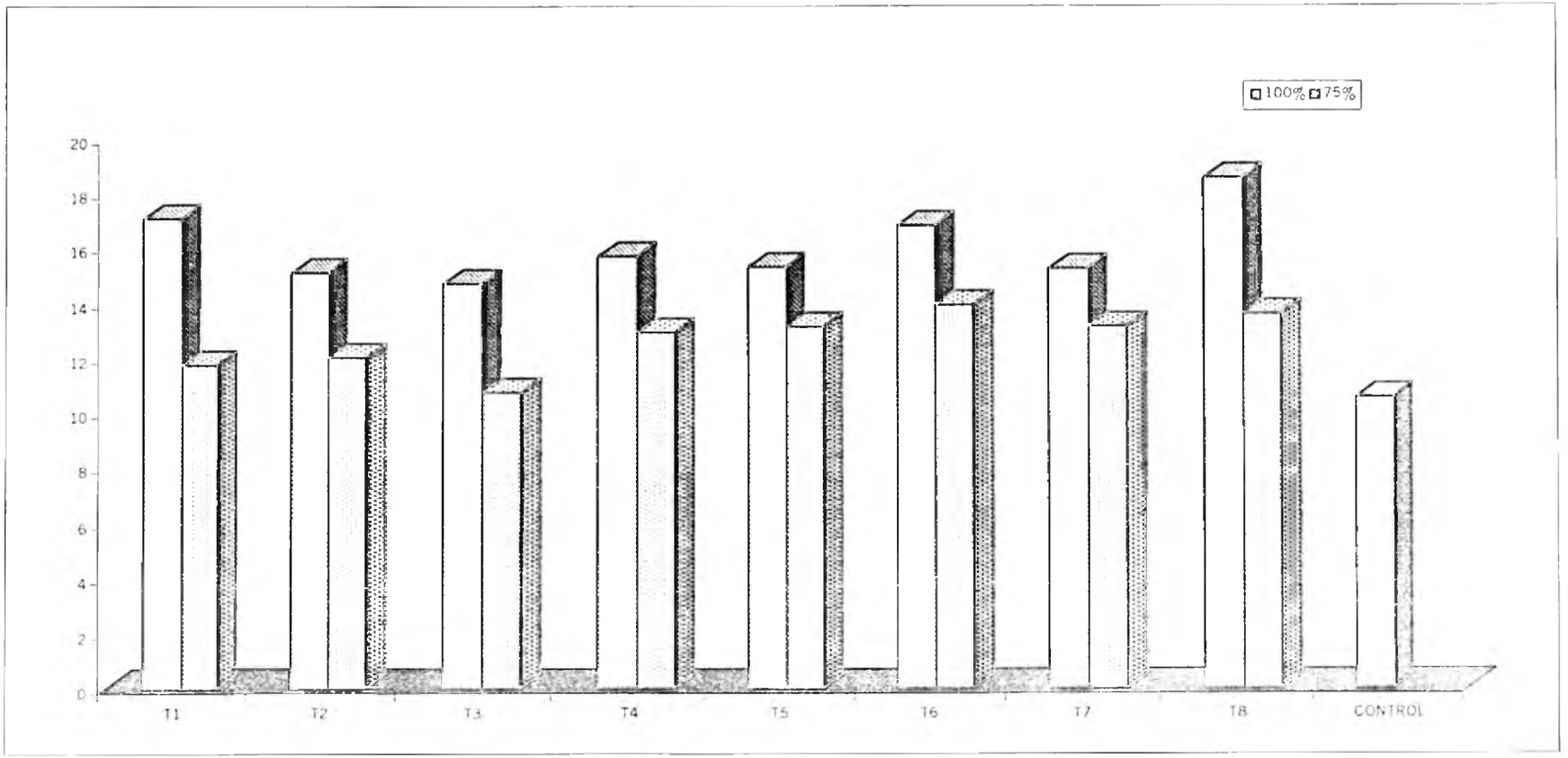


TABLE 19. MEAN UPTAKE OF NUTRIENTS IN PADDY STRAW (SECOND CROP), kg ha^{-1}

Treatment	N	P	K
1	58.98	9.24	102.94
2	51.06	8.69	92.45
3	54.30	6.78	81.49
4	48.94	7.34	85.64
5	44.67	6.13	72.88
6	47.70	7.67	80.92
7	42.68	6.45	73.20
8	62.12	10.28	106.53
9	42.87	6.21	72.93
10	33.89	5.55	64.06
11	37.65	5.85	68.87
12	38.03	5.45	64.13
13	42.31	5.88	71.46
14	38.83	5.61	66.16
15	37.31	5.77	62.99
16	39.61	6.31	75.24
17	33.59	4.79	53.28
CD	8.16	0.59	9.79

FIG.14 MEAN UPTAKE OF NITROGEN IN PADDY STRAW (SECOND CROP) kg/ha

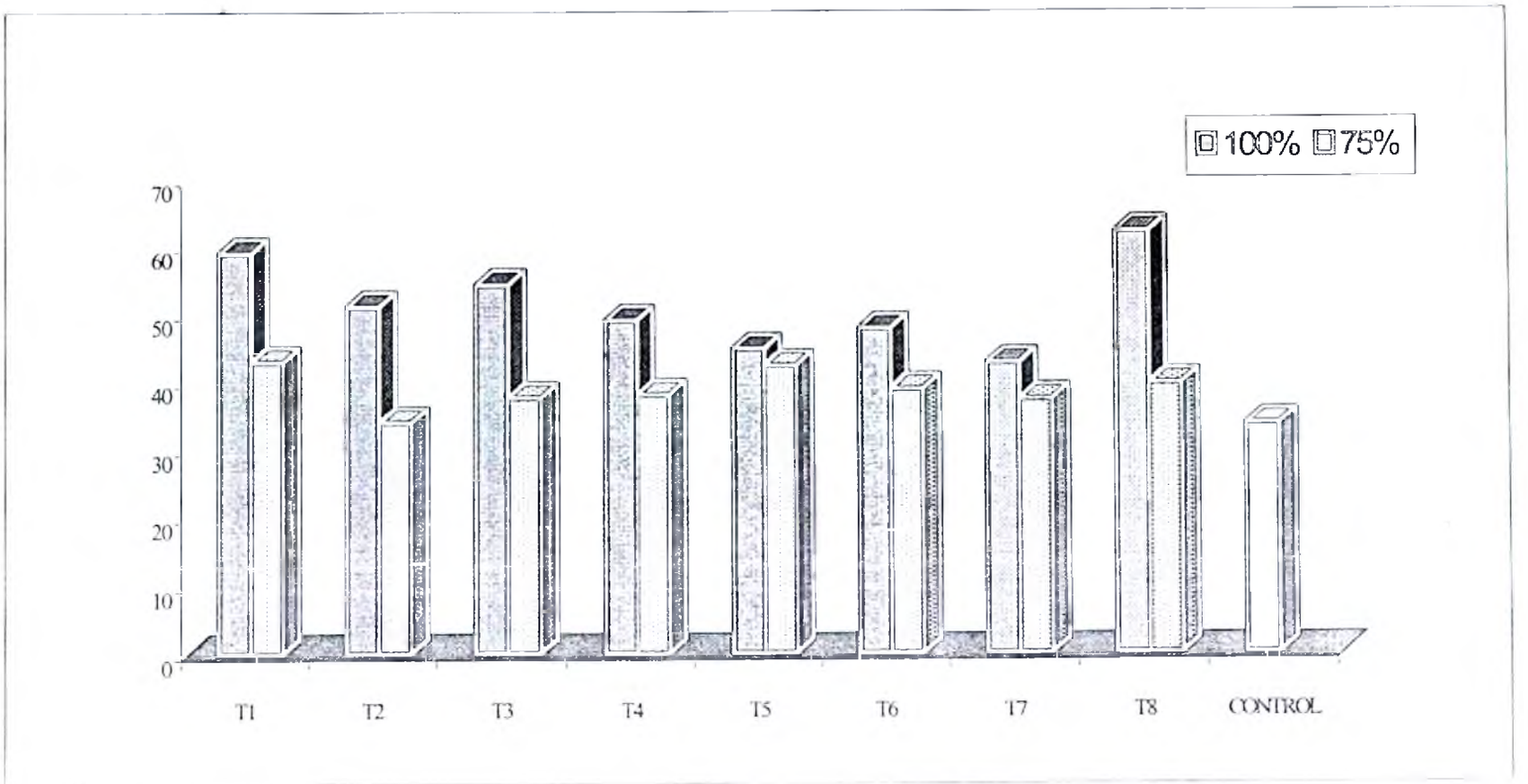


FIG. 15 MEAN UPTAKE OF PHOSPHORUS IN PADDY STRAW (SECOND CROP), kg/ha

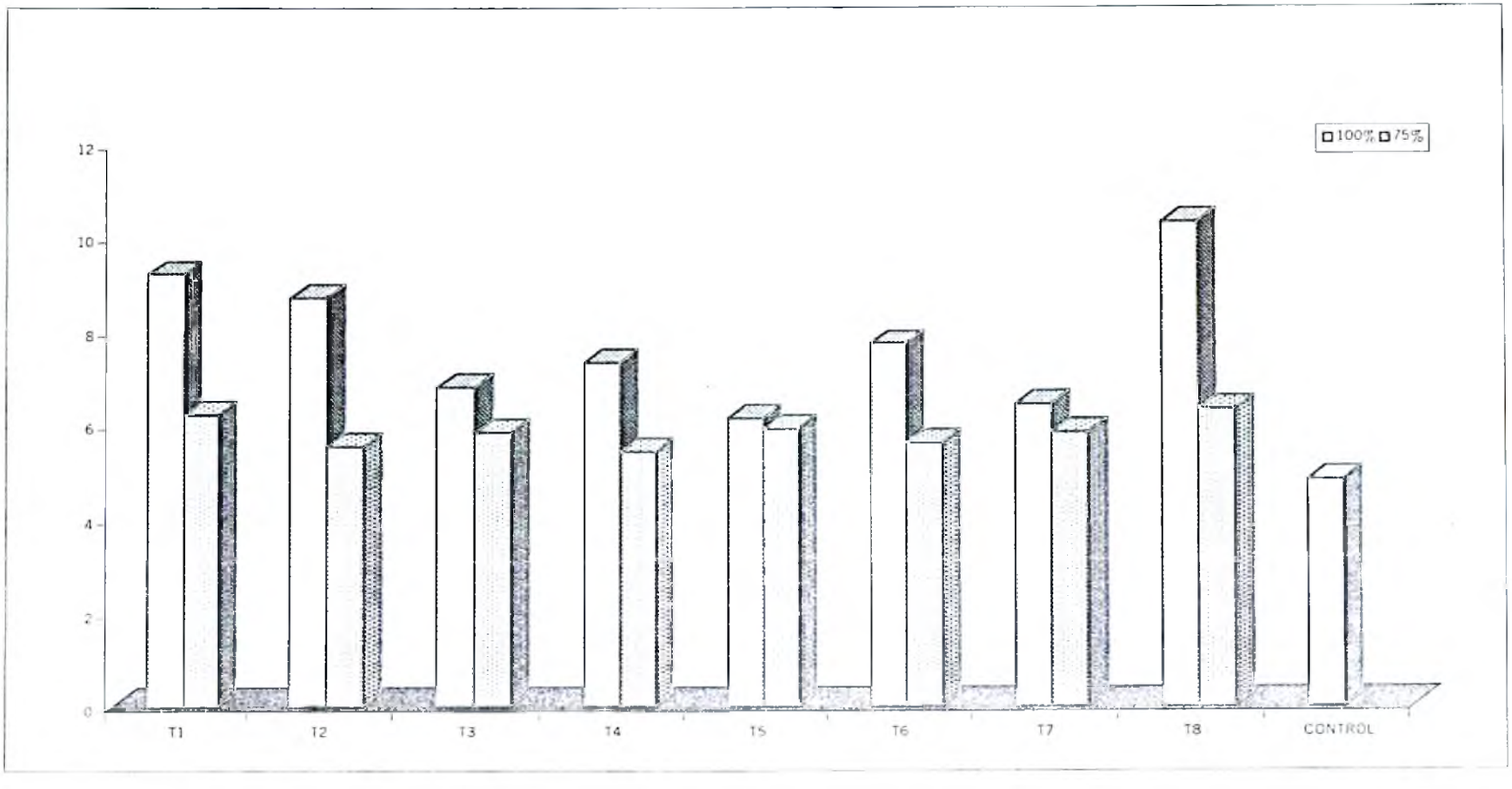


FIG. 16 MEAN UPTAKE OF POTASSIUM IN PADDY STRAW (SECOND CROP), kg/ha

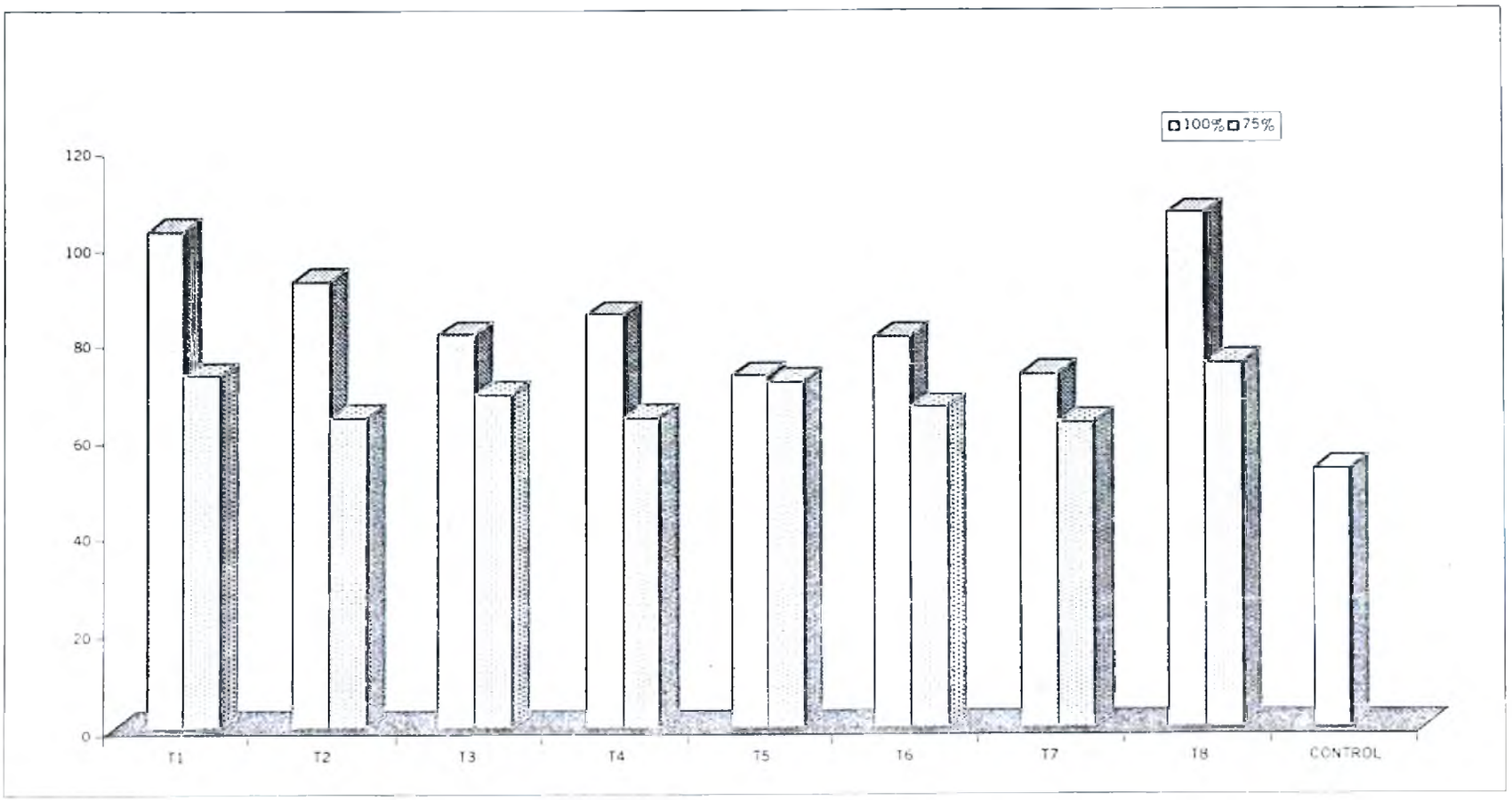


TABLE 20. GENERAL DETAILS OF THE THIRD CROP OF PADDY

Crop	Rice (Transplanted)
Variety	Jaya
Location	ARS, Mannuthy
Recommendation	45 : 22.5 : 22.5 kg ha^{-1} (50 per cent of recommendation)
Duration	120 - 125 days
Type of nursery	Dry
Date of sowing	26 June 1996
Plot size	5.6m x 3.6 m (20.16 m^2)
Spacing	20 x 10 cm
Date of transplanting	27 July 1996
No. of treatments	17
Replications	3
Design	RBD
Date of harvest	15 October 1996

TABLE 21. MEAN BIOMETRIC OBSERVATIONS ON THE THIRD CROP OF PADDY

Treatment	No. of productive tillers/hill	1000 grain wt (g)	Height of the plant cm
1	4.84	22.56	80.00
2	4.86	21.83	78.00
3	4.15	23.56	73.70
4	5.28	24.86	74.80
5	4.15	21.33	78.50
6	5.26	22.76	72.90
7	5.12	23.08	76.90
8	5.36	22.10	77.50
9	4.16	20.55	75.80
10	3.89	20.87	72.80
11	3.36	22.58	69.50
12	4.15	22.51	68.80
13	3.56	20.75	70.80
14	3.71	21.76	71.50
15	3.46	22.76	69.80
16	3.76	21.76	69.60
17	3.14	20.12	67.30

MEAN GRAIN AND STRAW YIELD OF THE THIRD CROP OF PADDY

The yield of the third crop of paddy is presented in table 22. Based on the decision of the second PRC held on 11.2.1996, it was decided to change the location after each experiment and KAU was asked to take a third crop of rice in the same field where the earlier two experiments on rice were conducted with a view to assess the residual effect of fertilizers in soil. Accordingly, it was decided to give 50% of the fertilizer recommendation to all the treatment plots except control. In this study it has been observed that maximum yield of both grain and straw has been recorded from treatment 1 were urea formaldehyde has been incorporated in the formulation. However this observed increase in yield is not significantly higher when compared to the yields from other major treatments. A similar trend has been observed in the straw yield also. Like the earlier experiments the straw yields were generally higher than the grain yields. The residual effect of fertilizers from 75% of the recommended doses were relatively lower than the corresponding full doses. Control plot recorded the lowest yield of both grain and straw.

Summary

The residual effect from formulations containing urea formaldehyde were marginally higher than the other treatments. The residual effect from treatments providing 75% of the doses recorded much lower than the corresponding full doses. Straw yields were generally higher than the grain yields. Single application of the full dose of the POP could not sustain higher yield of grains.

TABLE 22. MEAN GRAIN AND STRAW YIELD OF PADDY (THIRD CROP), kg ha^{-1}

Treatment	Grain	Rank	Straw	Rank
1	1838.5	1	2244.2	1
2	1714.5	5	1963.7	7
3	1643.7	7	2104.0	3
4	1835.0	2	2026.4	5
5	1549.5	10	1894.4	8
6	1821.8	3	2170.0	2
7	1544.6	11	2087.5	4
8	1793.7	4	1988.5	6
9	1608.9	8	1716.2	9
10	1529.7	12	1674.6	10
11	1505.0	14	1575.9	12
12	1493.4	15	1650.2	11
13	1517.5	13	1696.4	9
14	1698.2	6	1575.9	12
15	1341.6	15	1551.2	13
16	1558.4	9	1524.7	14
17	1168.6	17	1336.6	15
CD	226.7		172.2	

FIG.17 MEAN GRAIN YIELD OF PADDY (THIRD CROP), kg/ha

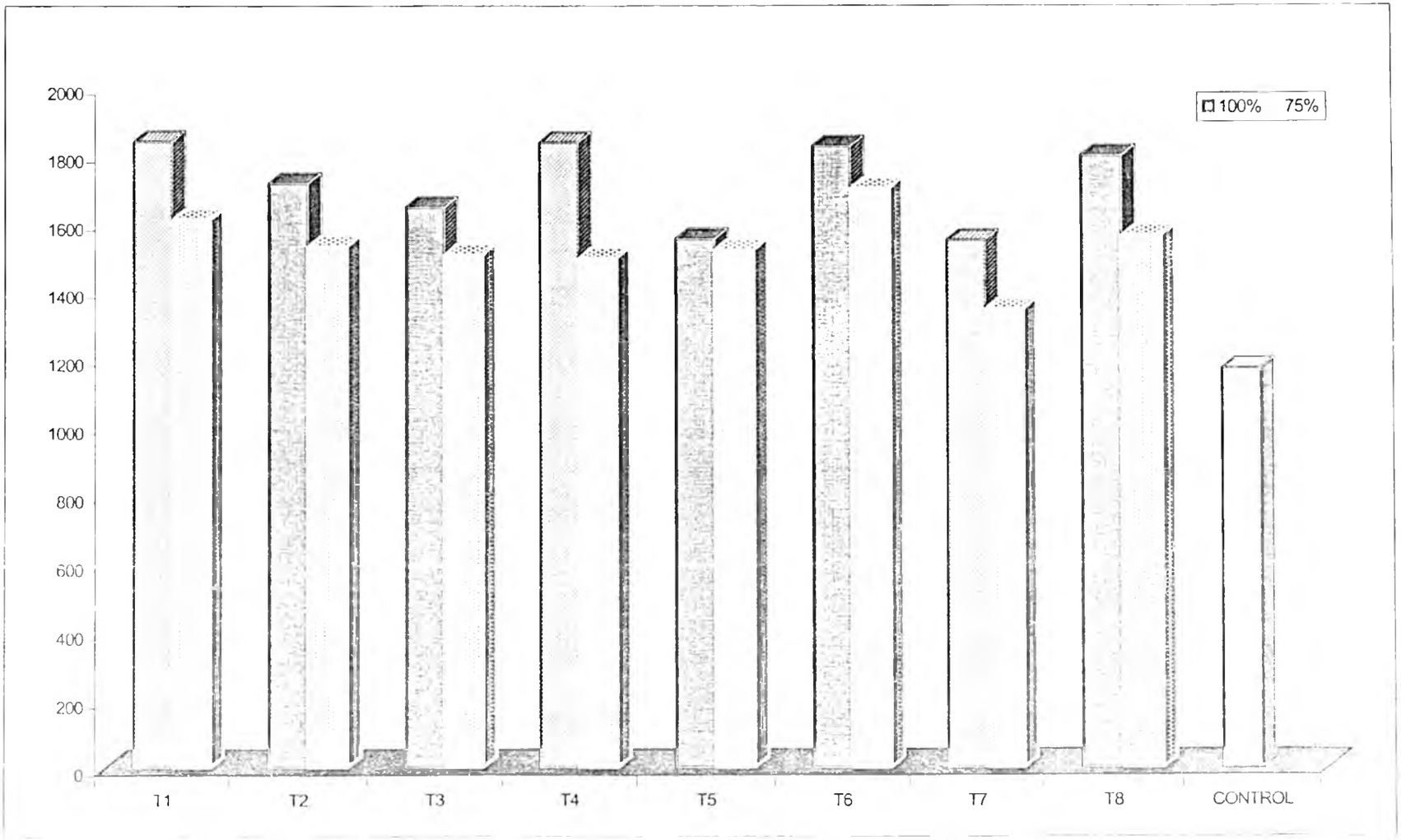


FIG. 18 MEAN STRAW YIELD OF PADDY (THIRD CROP), kg/ha

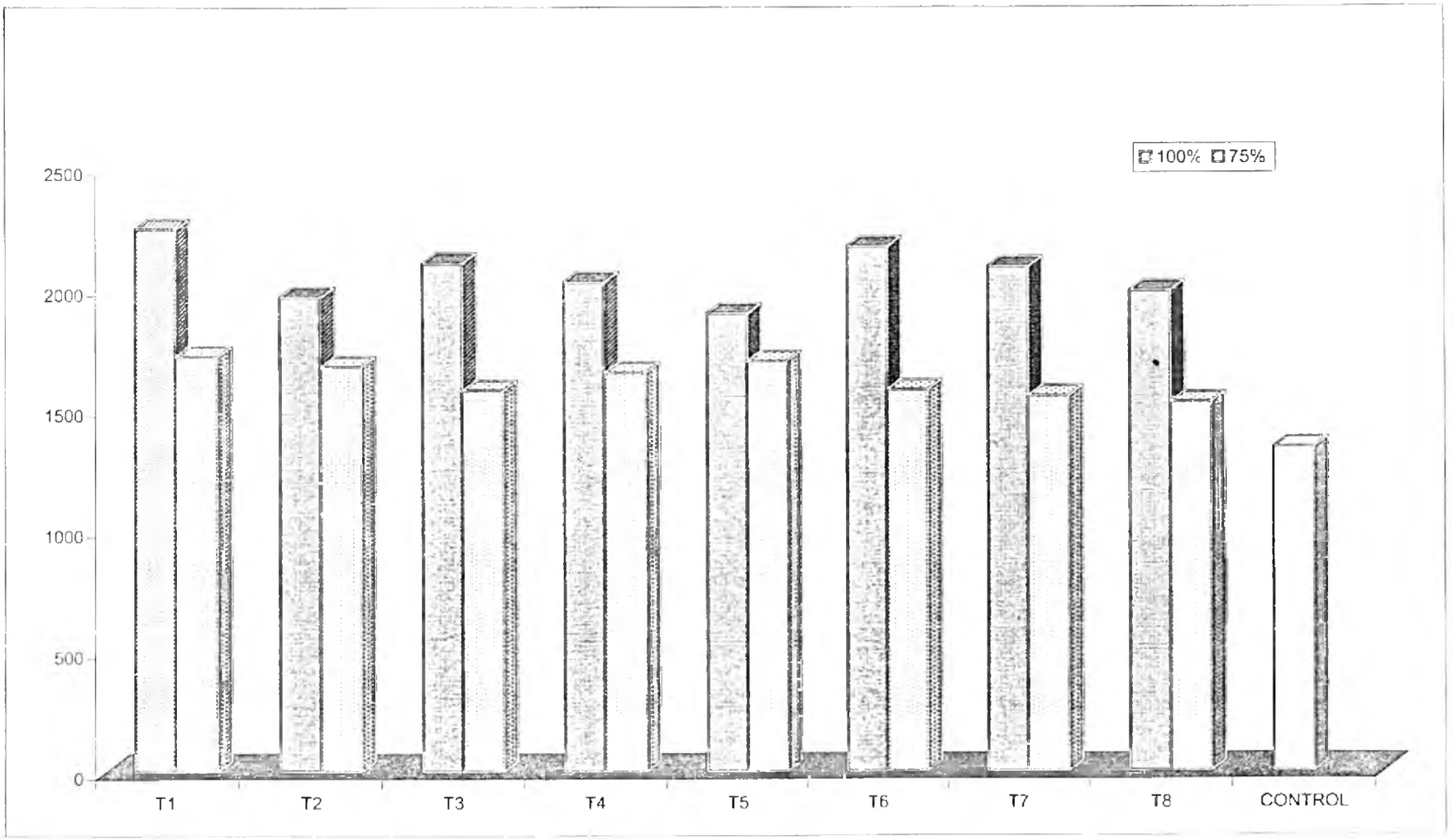


TABLE 23. EVALUATION OF SLOW RELEASE FERTILIZERS MODIFIED TECHNICAL PROGRAMME FOR THE FOURTH CROP OF PADDY

Tr.	Formulation	Treatment particulars
1		
2	Spike	Phosphogypsum urea adduct, single super phosphate & MOP (Gypsum & Neem cake)
3	Spike	Phosphogypsum urea adduct, single super phosphate & MOP (Gypsum and wax)
4	Mixture	Physical barrier & nitrification inhibitor
5	Mixture	Factomphos coated with coaltar, Urea & MOP
6	Spike	Factomphos, Ammonium sulphate & MOP (Gypsum & neemcake)
7		
8	Mixture	Split application of the recommended dose as per the POP of KAU
9-16	Similar to Tr.1-8 except that the total NPK supplied will be at 75% of the recommended doses	
17	Absolute control with out any NPK fertilizers	

TABLE 24. GENERAL DETAILS OF THE FOURTH CROP OF PADDY

Crop	Rice (Transplanted)
Location	Mulayam
Variety	Athira
Recommendation	90 : 45 : 45 kg ha^{-1}
Duration	120 - 125 days
Type of nursery	Dry
Date of sowing	2 September 1996
Plot size	5.3m x 3.8 m (20.14 m^2)
Spacing	20 x 10 cm
Date of transplanting	2 October 1996
No. of treatments	13
Replications	3
Design	RBD
Date of harvest	11 January 1997

TABLE 25. BASIC SOIL FERTILITY STATUS OF THE FOURTH CROP OF PADDY

LOCATION: MUALAYAM	
pH	4.5
EC	0.05 dS m^{-1}
Organic Carbon	0.76 per cent
Available N	189.0 mg kg^{-1}
Available P	12.4 mg kg^{-1}
Available K	84.0 mg kg^{-1}

TABLE 26. MEAN BIOMETRIC OBSERVATIONS ON THE FOURTH CROP OF PADDY

Treatment	No. of productive tillers/hill	1000 grain wt (g)	Height of the plant cm
1			
2	8.17	25.08	94.83
3	8.92	25.57	100.25
4	7.08	24.25	98.92
5	8.83	23.30	96.50
6	7.50	24.57	102.42
7			
8	8.33	24.17	95.50
9			
10	7.17	22.98	94.00
11	7.58	23.88	97.75
12	6.92	23.79	98.17
13	7.92	22.69	96.17
14	7.42	24.41	96.75
15			
16	7.50	23.75	90.92
17	6.25	21.75	85.17

TABLE 27. POST HARVEST SOIL FERTILITY STATUS OF EXPERIMENTAL PLOTS IN THE FOURTH CROP OF PADDY

Treatment	Organic carbon, %	pH	EC dS m^{-1}
1	-	-	-
2	1.09	4.1	0.04
3	1.05	4.1	0.04
4	1.00	4.2	0.05
5	0.97	4.4	0.04
6	0.91	4.0	0.05
7	-	-	-
8	0.95	4.2	0.03
9	-	-	-
10	0.87	4.3	0.04
11	0.89	4.0	0.05
12	0.87	4.0	0.03
13	0.81	4.2	0.05
14	0.71	4.1	0.04
15	-	-	-
16	0.74	4.2	0.03
17	0.69	4.1	0.05
CD	0.20	0.12	0.01

MEAN GRAIN AND STRAW YIELD OF THE FOURTH CROP OF PADDY

The mean grain and straw yield of the fourth crop of medium duration paddy variety Athira is presented in table 28. Based on the recommendations of the PRC, treatments 1 and 7, which included the urea formaldehyde component and the single application of straight fertilizers respectively were deleted together with their 75% doses. The modified technical programme incorporating the correction suggested by the PRC is given in table 23. It is seen that treatment 3 where NPK has been applied in the form of spike (composition of the material refer Table1) had recorded the highest yield for both grain(3428 kg/ha) and straw(6472 kg/ha). Treatment 11 where 75% of the same material has been applied recorded the next highest yield with no significant difference between them. Wide variations in yield between treatments especially between doses were noticed in this crop making it highly difficult to explain within the frame work of the analysis conducted in the experiment. The inconsistent behavior of the formulations under acidic water logged condition together with the low clay content in the soil might have been a possible reason for the observed variation in yield. The straw yields were generally higher than the grain yield. Treatment 8 which advocated the POP recommendation of KAU recorded significantly lower yields compared to many of the slow release formulations. 75% of the recommended doses of fertilizer recorded generally lower yield than the corresponding full doses. The control plot recorded the lowest yield both in terms of grain and straw making all other formulation and treatments significant.

Summary

Treatment 3 recorded the highest yield for both grain and straw. The POP of the KAU (Tr.8) could not sustain significantly higher yield when compared to the application of many other formulations. Treatments receiving 75% of the fertilizer recommendation recorded generally lower yields than the corresponding full doses. The straw yields were higher than the grain yields. Compared to the previous experiments, no definite trend by any treatment in delivering higher yield could be observed and the trend remained highly erratic.

TABLE 28. MEAN GRAIN AND STRAW YIELD OF PADDY (FOURTH CROP), kg ha^{-1}

Treatment	Grain	Rank	Straw	Rank
1	-	-	-	-
2	3099.26	5	4693.84	7
3	3427.62	1	6471.94	1
4	3202.26	4	4845.75	5
5	2603.01	8	4508.45	10
6	3361.44	3	6353.96	2
7	-	-	-	-
8	2752.82	7	4129.23	11
9	-	-	-	-
10	2827.73	6	4525.30	6
11	3390.53	2	5782.42	4
12	2471.92	9	4382.04	9
13	2322.12	10	4281.05	8
14	3202.26	4	6025.30	3
15	-	-	-	-
16	2237.84	11	3943.83	12
17	1690.76	12	2391.58	13
CD	615.91		1385.73	

FIG.19 MEAN GRAIN YIELD OF PADDY (FOURTH CROP), kg/ha

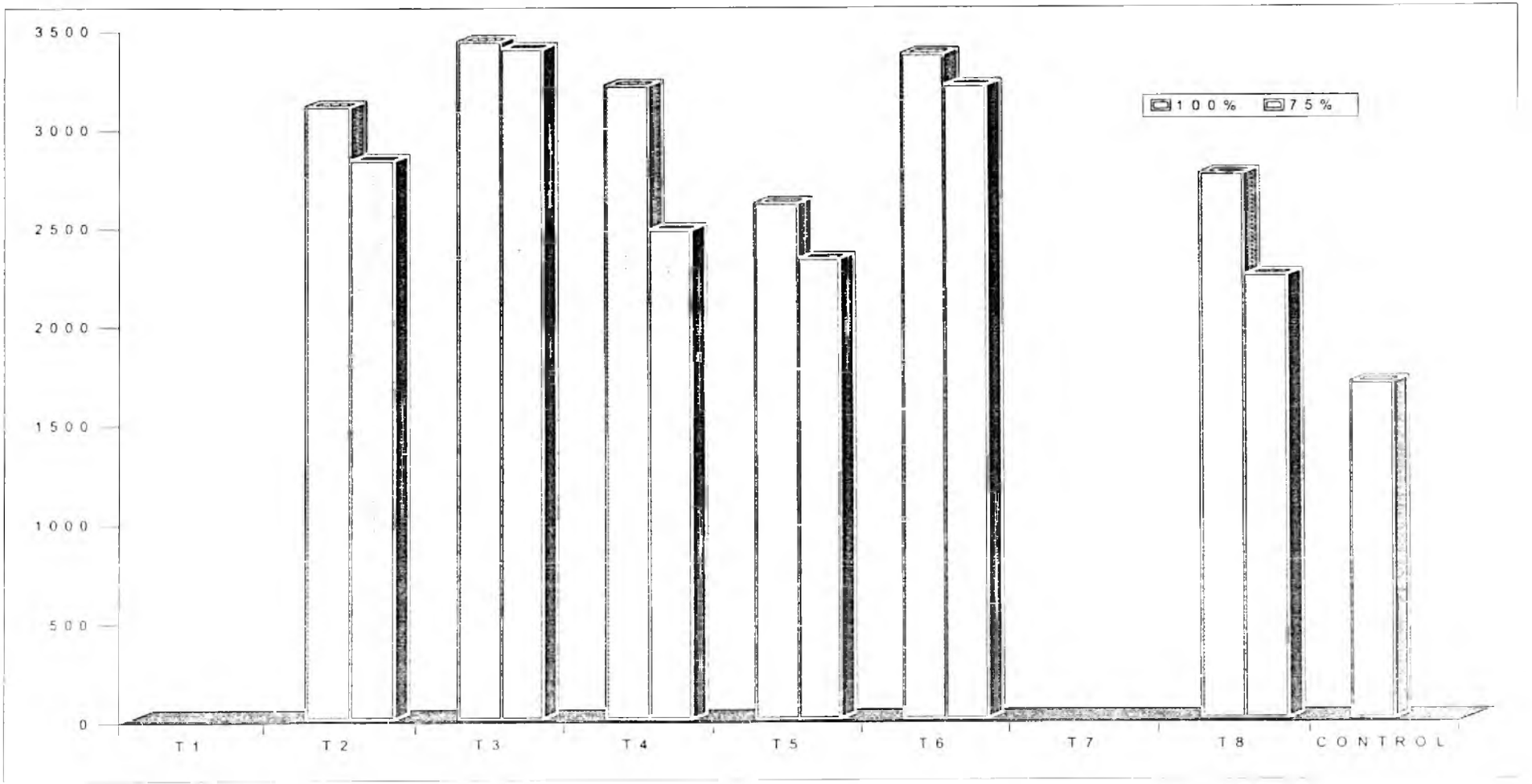


FIG.20 MEAN STRAW YIELD OF PADDY (FOURTH CROP), kg/ha

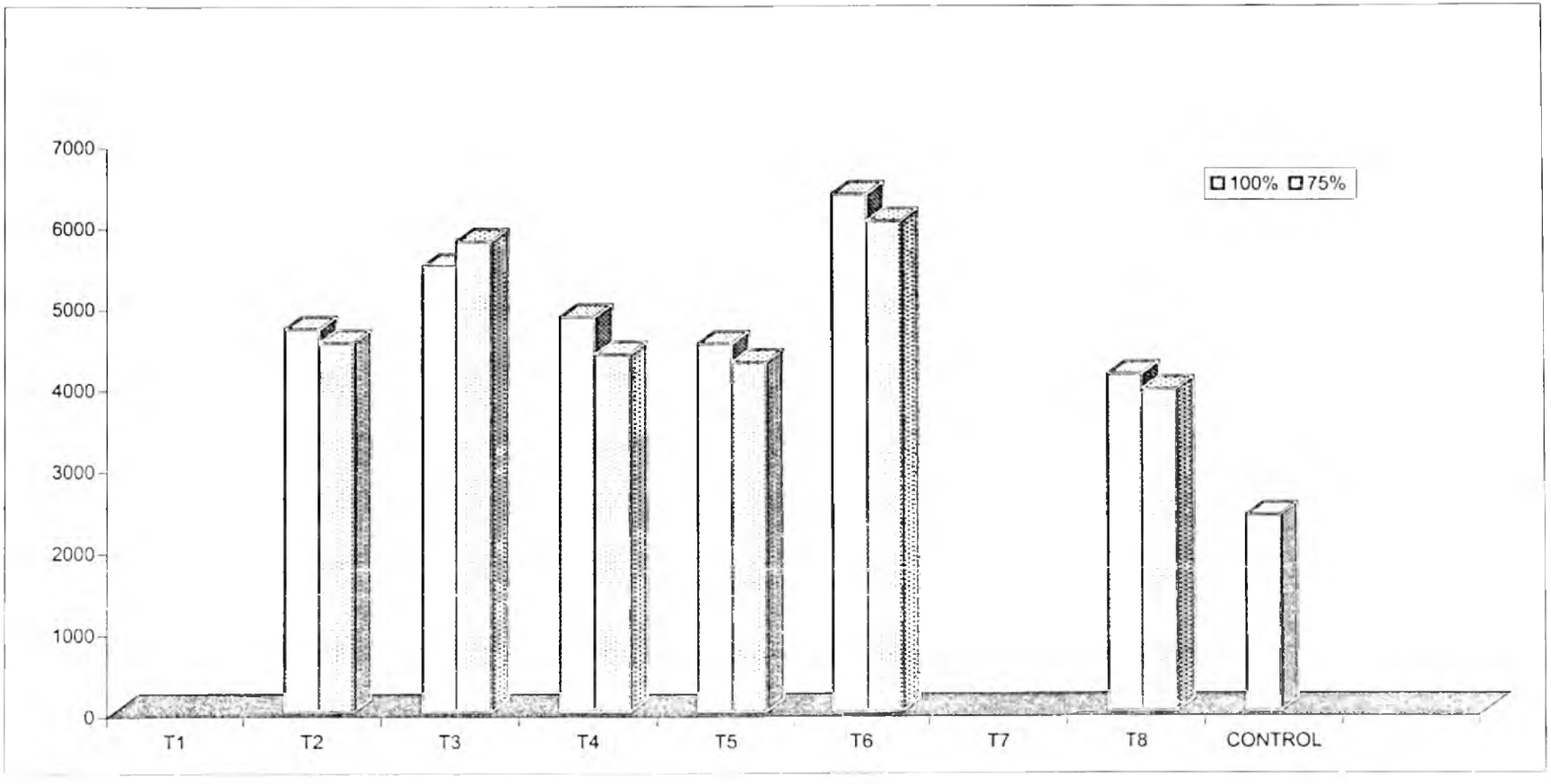


TABLE 29. POST HARVEST SOIL FERTILITY STATUS OF EXPERIMENTAL PLOTS IN THE FOURTH CROP OF PADDY

Treatment	Av. N mg kg $^{-1}$	Av. P mg kg $^{-1}$	Av. K mg kg $^{-1}$
1	-	-	-
2	262.5	14.7	94.0
3	262.1	13.6	90.2
4	288.2	14.2	93.7
5	292.4	13.7	95.7
6	258.4	14.9	97.0
7	-	-	-
8	226.0	14.2	94.2
9	-	-	-
10	255.7	14.0	91.7
11	254.9	12.6	85.7
12	259.0	13.5	92.7
13	278.8	13.1	90.6
14	238.2	13.9	90.7
15	-	-	-
16	216.3	13.2	87.2
17	191.9	12.2	82.0
CD	11.2	1.2	5.3

TABLE 30. MEAN PER CENT NUTRIENT CONTENT IN PADDY GRAINS (FOURTH CROP)

Treatment	N	P	K
1*	-	-	-
2	1.53	0.24	0.45
3	1.43	0.26	0.53
4	1.60	0.23	0.46
5	1.83	0.23	0.43
6	1.36	0.25	0.47
7	-	-	-
8	1.43	0.23	0.44
9	-	-	-
10	1.17	0.22	0.44
11	1.23	0.25	0.48
12	1.37	0.22	0.41
13	1.20	0.22	0.40
14	1.27	0.24	0.46
15	-	-	-
16	1.20	0.22	0.40
17	0.93	0.19	0.33
CD	0.26	0.02	0.06

TABLE 31. MEAN PER CENT NUTRIENT CONTENT IN PADDY STRAW (FOURTH CROP)

Treatment	N	P	K
1	-	-	-
2	0.60	0.14	1.4
3	0.62	0.16	1.53
4	0.65	0.13	1.45
5	0.68	0.12	1.42
6	0.65	0.15	1.5
7	-	-	-
8	0.70	0.12	1.32
9	-	-	-
10	0.58	0.13	1.42
11	0.54	0.14	1.47
12	0.54	0.12	1.38
13	0.52	0.12	1.39
14	0.55	0.14	1.48
15	-	-	-
16	0.56	0.11	1.27
17	0.40	0.09	1.14
CD	0.08	0.03	0.06

TABLE 32. MEAN UPTAKE OF NUTRIENTS IN PADDY GRAINS (FOURTH CROP), kg ha^{-1}

Treatment	N	P	K
1	-	-	-
2	47.6	7.34	13.9
3	49.1	8.92	18.3
4	51.2	7.61	14.6
5	47.9	6.02	11.1
6	49.3	8.27	15.8
7	-	-	-
8	39.5	6.41	12.6
9	-	-	-
10	33.3	6.32	12.5
11	38.2	8.36	16.4
12	33.6	5.39	10.1
13	28.2	5.03	9.4
14	40.7	7.63	14.7
15	-	-	-
16	26.1	4.95	9.2
17	15.5	3.21	5.6
CD	12.9	1.77	3.4

FIG.21 MEAN UPTAKE OF NITROGEN IN PADDY GRAIN (FOURTH CROP), kg/ha

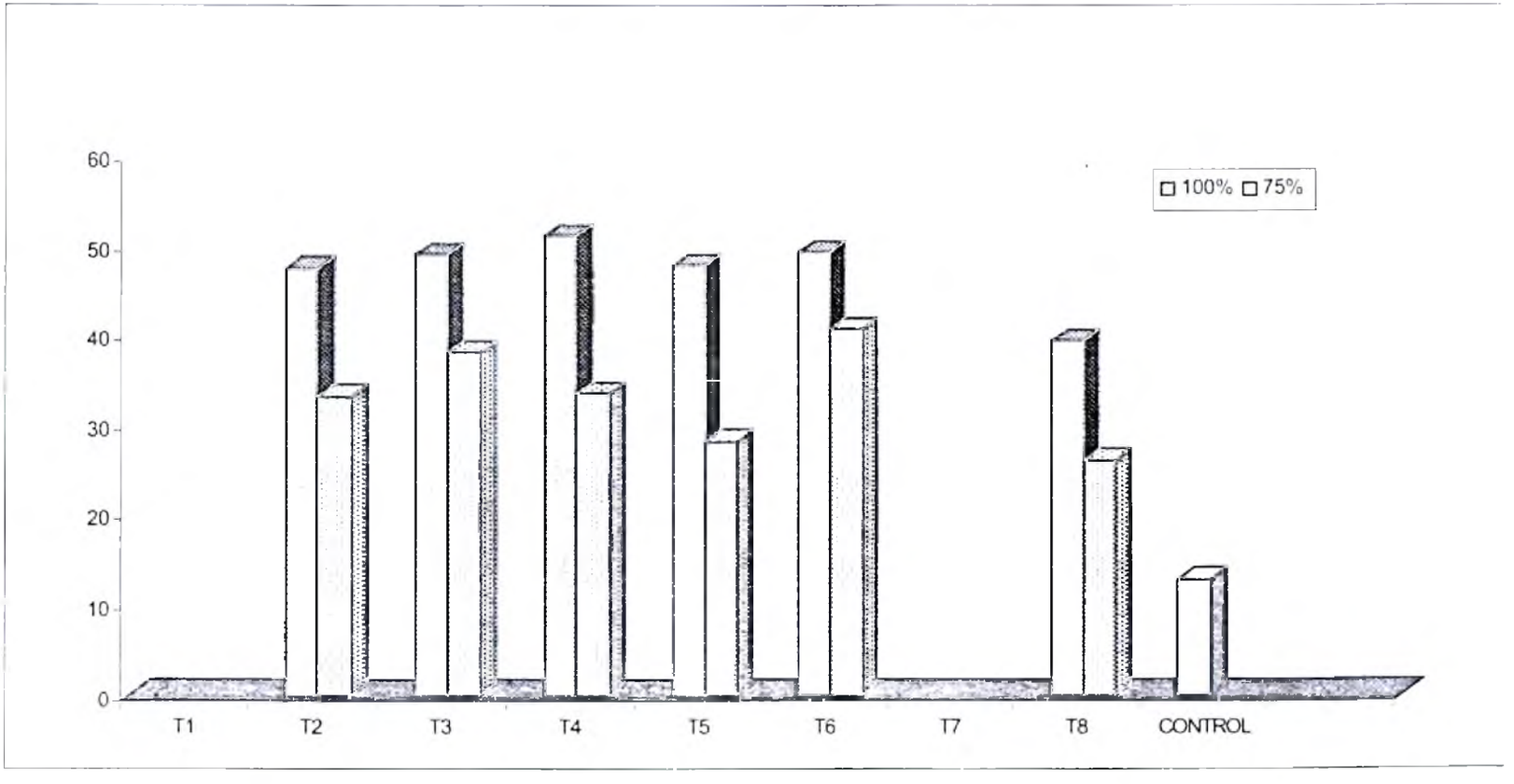


FIG.22 MEAN UPTAKE OF PHOSPHORUS IN PADDY GRAINS (FOURTH CROP), kg/ha

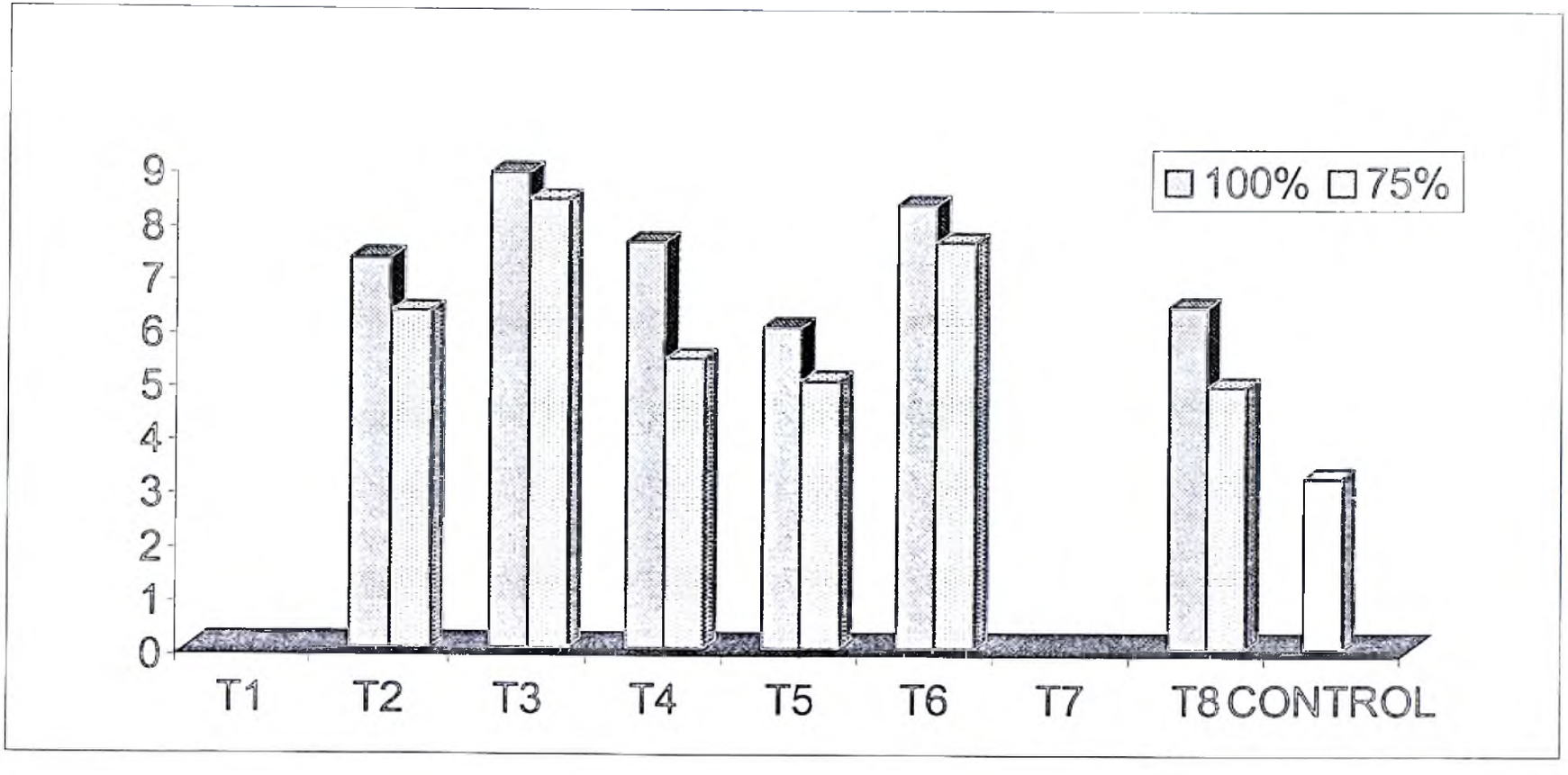


FIG. 23 MEAN UPTAKE OF POTASSIUM IN PADDY GRAINS (FOURTH CROP) , kg/ha

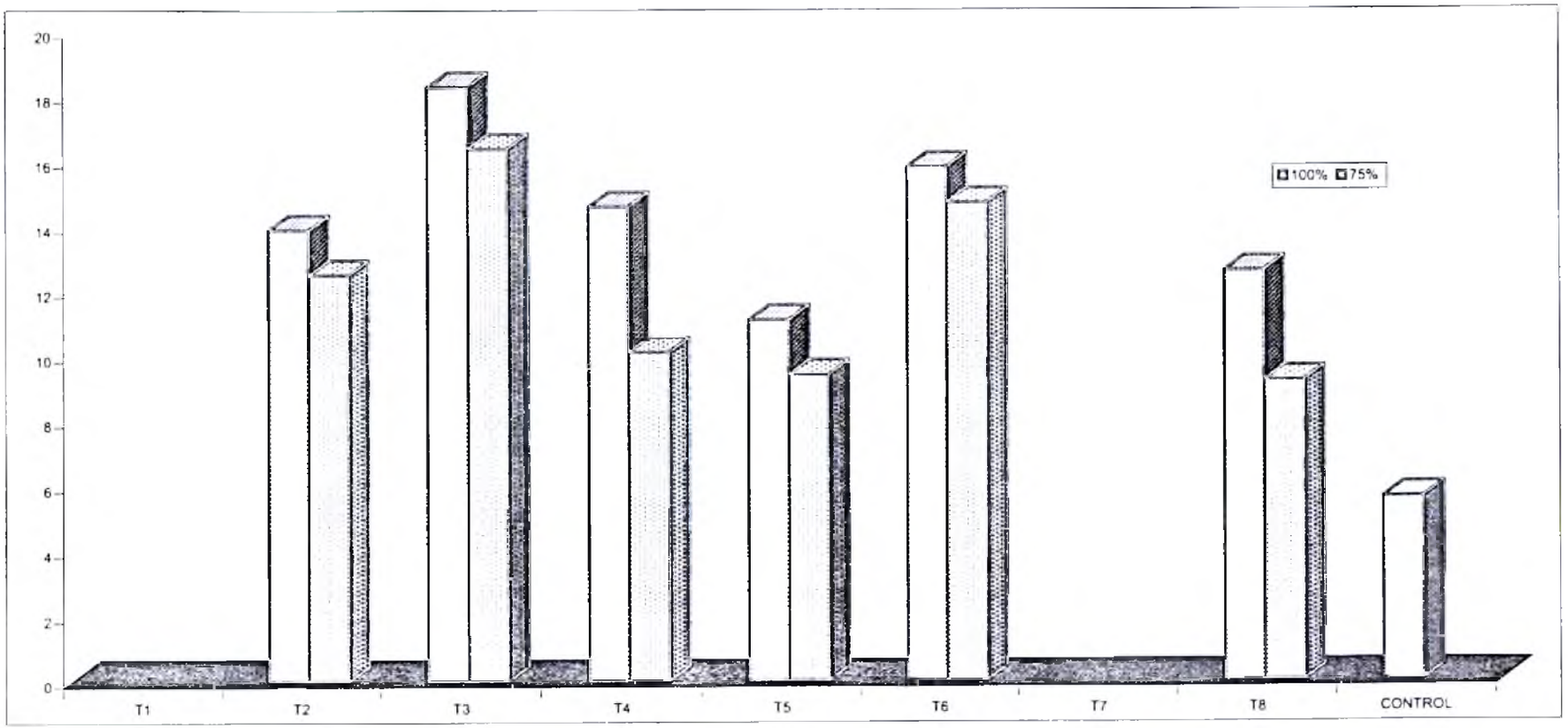


TABLE 33. MEAN UPTAKE OF NUTRIENTS IN PADDY STRAW (FOURTH CROP), kg ha^{-1}

Treatment	N	P	K
1	-	-	-
2	28.4	6.57	67.7
3	40.3	10.39	99.3
4	31.5	6.41	70.8
5	30.9	5.49	64.4
6	41.4	9.55	95.4
7	-	-	-
8	29.0	4.77	54.7
9	-	-	-
10	26.3	6.04	64.6
11	31.1	8.27	85.2
12	23.5	5.41	60.5
13	22.1	5.13	59.4
14	33.2	8.35	88.8
15	-	-	-
16	22.1	4.37	50.5
17	9.6	2.22	27.2
CD	6.66	2.09	20.2

FIG.24 MEAN UPTAKE OF NITROGEN IN PADDY STRAW (FOURTH CROP),kg/ha

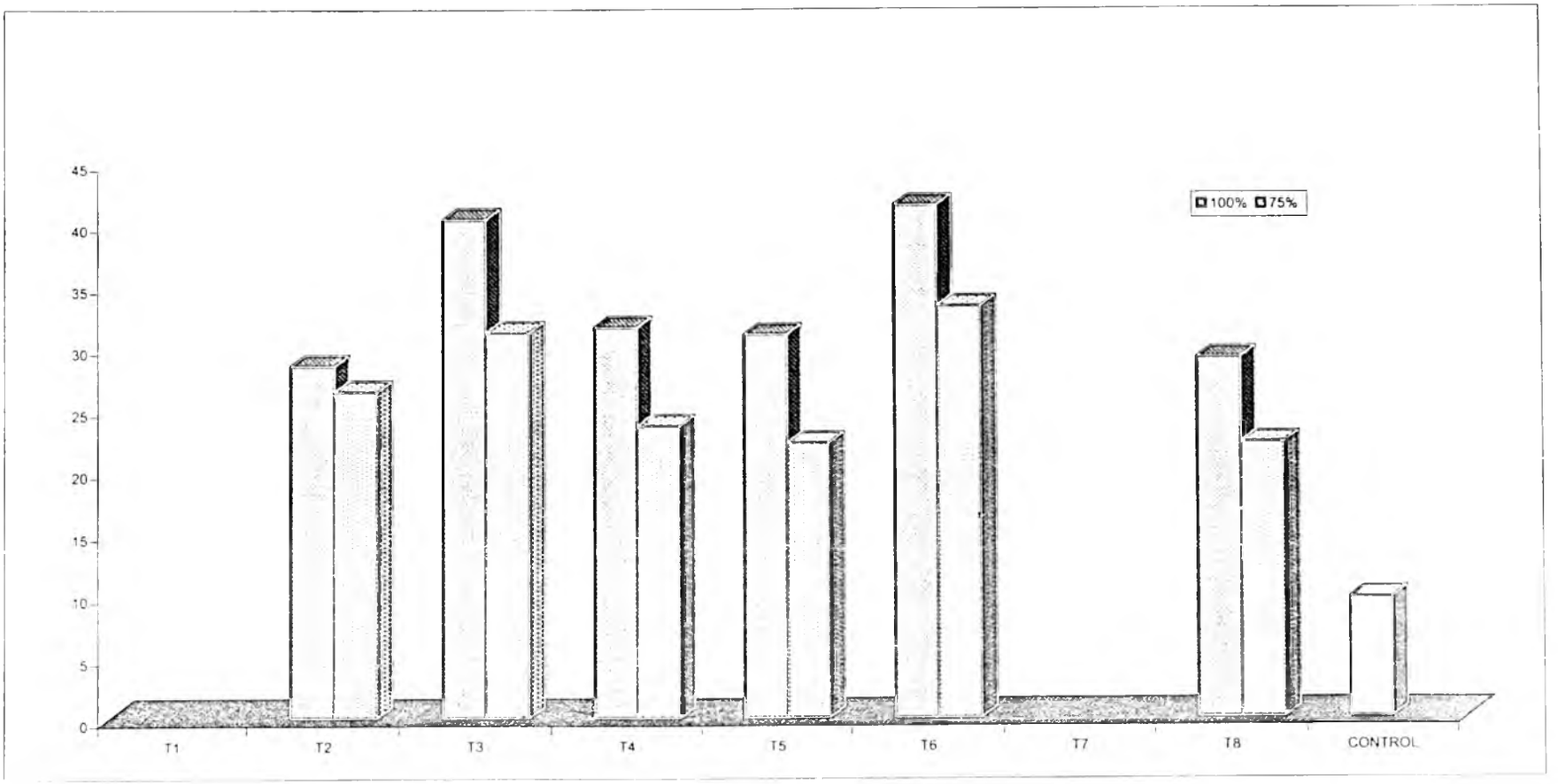


FIG.25 MEAN UPTAKE OF PHOSPHORUS IN PADDY STRAW (FOURTH CROP), kg/ha

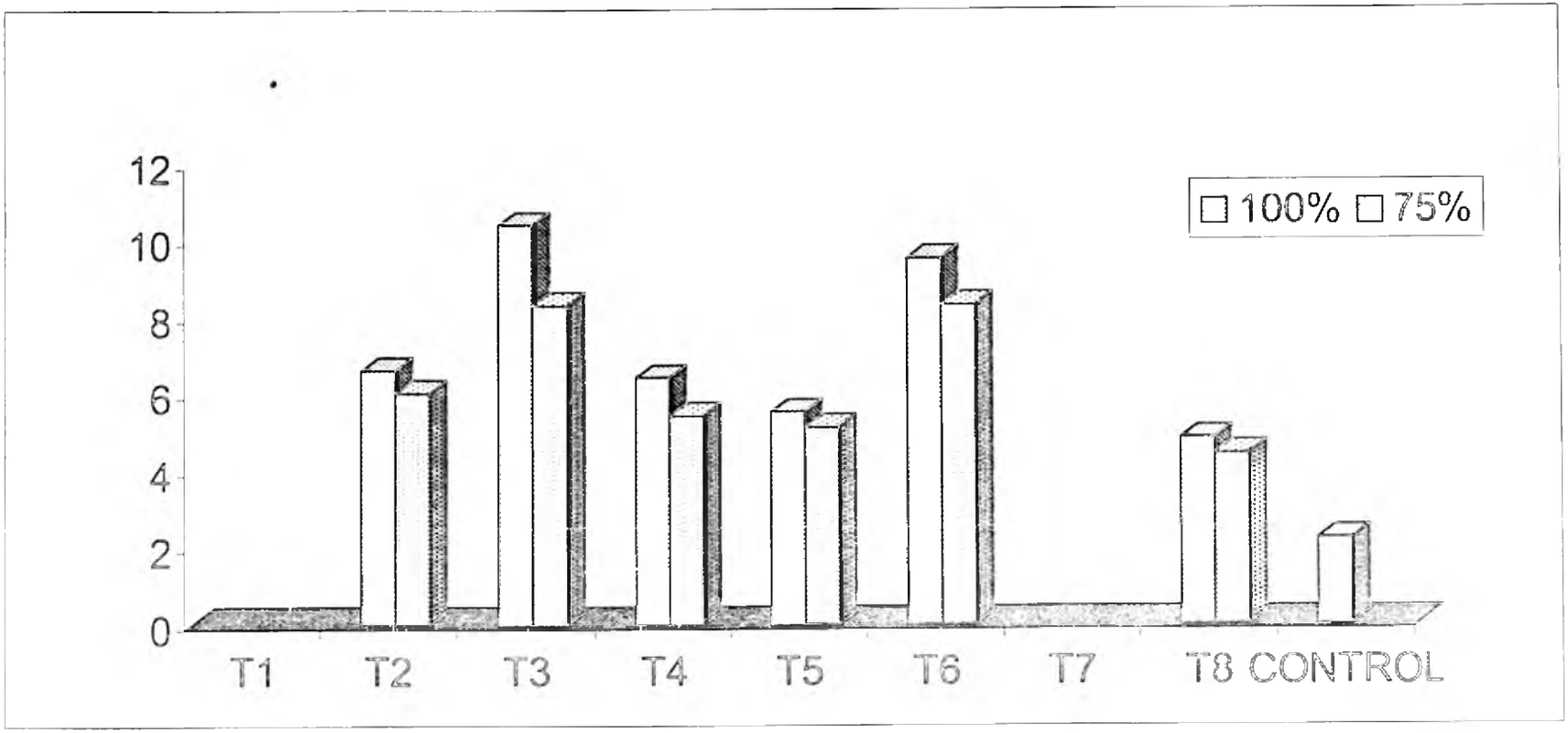


FIG.26 MEAN UPTAKE OF POTASSIUM IN PADDY STRAW (FOURTH CROP), kg/ha

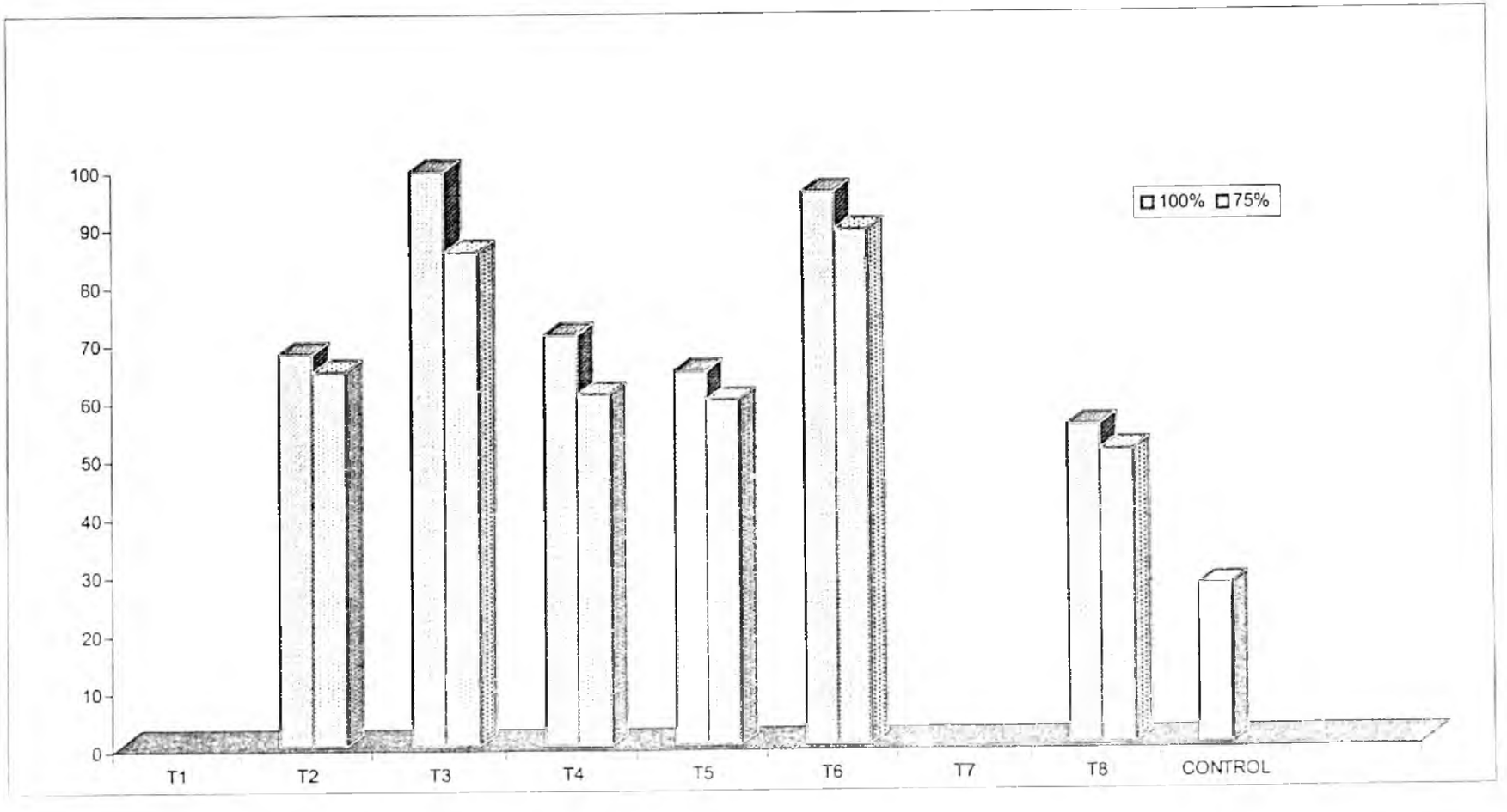


TABLE 33(a). MEAN NITROGEN CONTENT IN FOURTH CROP OF PADDY AT THE DIFFERENT STAGES - (VARIETY ATHIRA)

Tr.	DAP 15	DAP 30	DAP 45	DAP 60	DAP 75	DAP 90	At harvest
1	-	-	-	-	-	-	-
2	2.03	2.69	2.75	1.60	1.42	0.82	0.60
3	2.18	2.57	2.80	1.70	1.25	0.82	0.62
4	2.55	2.65	2.69	1.50	1.30	0.93	0.65
5	2.35	2.81	2.87	1.35	1.30	0.88	0.86
6	2.82	3.04	3.28	1.70	1.35	0.77	0.65
7	-	-	-	-	-	-	-
8	2.35	2.58	2.92	1.70	1.30	0.83	0.70
9	-	-	-	-	-	-	-
10	1.70	2.45	2.73	1.23	1.18	0.60	0.58
11	2.05	2.23	2.32	1.60	1.13	0.70	0.54
12	2.17	2.39	2.63	1.30	1.09	0.88	0.54
13	2.00	2.40	2.51	1.33	1.02	0.77	0.52
14	2.05	2.80	3.00	1.35	1.18	0.70	0.55
15	-	-	-	-	-	-	-
16	2.28	2.47	2.69	1.40	1.28	0.73	0.56
17	2.00	2.22	2.75	1.42	1.18	0.65	0.40

TABLE 34. GENERAL DETAILS OF THE FIFTH CROP OF PADDY

Crop	Rice (Transplanted)
Variety	Pavizham
Location	Karappakunnu
Recommendation	90 : 45 : 45 kg ha^{-1}
Duration	115 - 118 days
Type of nursery	Dry
Date of sowing	24 January 1997
Plot size	5.0m x 4.0 m (20.0 m^2)
Spacing	20 x 10 cm
Date of transplanting	21 February 1997
No. of treatments	13
Replications	3
Design	RBD
Date of harvest	31 May 1997

TABLE 35 BASIC SOIL FERTILITY STATUS
OF THE FIFTH CROP OF PADDY

LOCATION : KARAPPAKUNNU	
pH	4.8
EC	0.12 dS m^{-1}
Organic Carbon	0.85 per cent
Available N	190.7 mg kg^{-1}
Available P	12.0 mg kg^{-1}
Available K	91.4 mg kg^{-1}

TABLE 36. POST HARVEST SOIL FERTILITY STATUS OF EXPERIMENTAL PLOTS IN THE FIFTH CROP OF PADDY

Treatment	Organic carbon, %	pH	EC dS m^{-1}
1	-	-	-
2	0.86	4.8	0.09
3	0.88	4.9	0.11
4	0.95	4.8	0.11
5	0.90	4.7	0.11
6	0.85	4.7	0.10
7	-	-	-
8	0.96	4.9	0.09
9	-	-	-
10	0.91	4.9	0.09
11	0.82	4.8	0.09
12	0.92	4.9	0.11
13	0.81	4.2	0.11
14	0.75	4.6	0.11
15	-	-	-
16	0.93	4.8	0.08
17	0.86	4.7	0.11
CD	0.07	0.24	0.02

TABLE 37. MEAN BIOMETRIC OBSERVATIONS ON THE FIFTH CROP OF PADDY

Treatment	No. of productive tillers/hill	1000 grain wt (g)	Height of the plant cm
1	-	-	-
2	8.9	21.40	78.00
3	8.8	19.40	74.50
4	9.0	22.50	69.90
5	9.0	21.40	69.70
6	8.7	19.90	74.40
7	-	-	-
8	9.1	22.40	72.50
9	-	-	-
10	8.7	19.20	72.70
11	8.2	21.00	75.10
12	8.8	19.10	71.50
13	8.2	20.10	69.40
14	8.4	21.10	75.40
15	-	-	-
16	8.7	20.90	70.70
17	7.9	19.10	69.10
CD	0.47	0.99	0.52

MEAN GRAIN AND STRAW YIELD OF THE FIFTH CROP OF PADDY

The mean grain and straw yield of the fourth crop of medium duration paddy variety Pavizam is presented in table 38. It is seen that treatment 8 where NPK @ 90:45:45 has been applied in splits in the form of straight fertilizers, maintained the highest grain yield of 5014 kg/ha. Though treatments 4, 5 & 2 gave lower yield than Tr.1, practically there was no significant difference in grain yield between any of them. From this, it is clear that slow release fertilizer formulations of treatments 4,5 & 2 are as effective as the treatment which gave the highest yield. The advantage of one time application of fertilizers in treatments 4, 5 & 2 weigh more in making these fertilizer formulations popular than treatment 8 where split application is envisaged, necessarily adding more to the cost of cultivation. The lower doses of fertilizer application could not enhance the grain yield of paddy and control plot recorded the lowest yield. Compared to control, all treatments and doses remained significant. The straw yield of paddy was relatively higher in all treatments compared to grain yield. The highest straw yield of straw was recorded by treatment 4 followed by treatments 5 & 8 with practically no significant difference between them and making these treatment effects on par. The effect of reduced doses of fertilizers on straw yield was marked in all treatments.

Summary

There was no significant difference in yield of paddy grain between the best treatment which necessitated the split application and the slow release formulation which necessitated one time application making the latter more acceptable to farmers in reducing the cost of cultivation. Application of spike form of slow release formulation had its own practical problem during placement in the paddy field and for this reason it cannot meet success in the field. However, the mixtures offering slow release mechanism will be a boon to farmers compared to split application of straight fertilizers on two accounts viz., in reducing the cost of application and enhancing the fertilizer efficiency. In this connection fertilizer formulations involved in treatments 4 & 5 can be popularized among the farming community

TABLE 38. MEAN GRAIN AND STRAW YIELD OF PADDY (FIFTH CROP), kg ha^{-1}

Treatment	Grain	Rank	Straw	Rank
1	-	-	-	-
2	4904.00	5	6168.00	5
3	4825.00	6	6273.00	4
4	4967.00	2	6475.00	1
5	4935.00	3	6456.00	2
6	4810.00	8	6016.00	7
7	-	-	-	-
8	5014.00	1	6454.00	3
9	-	-	-	-
10	4794.00	9	5904.00	9
11	4723.00	11	5715.00	11
12	4873.00	5	6090.00	6
13	4653.00	12	5753.00	10
14	4763.00	10	5584.00	12
15	-	-	-	-
16	4811.00	7	6014.00	8
17	3979.00	13	5173.00	13
CD	149.00		186.00	

FIG. 27 MEAN GRAIN YIELD OF PADDY (FIFTH CROP), kg/ha

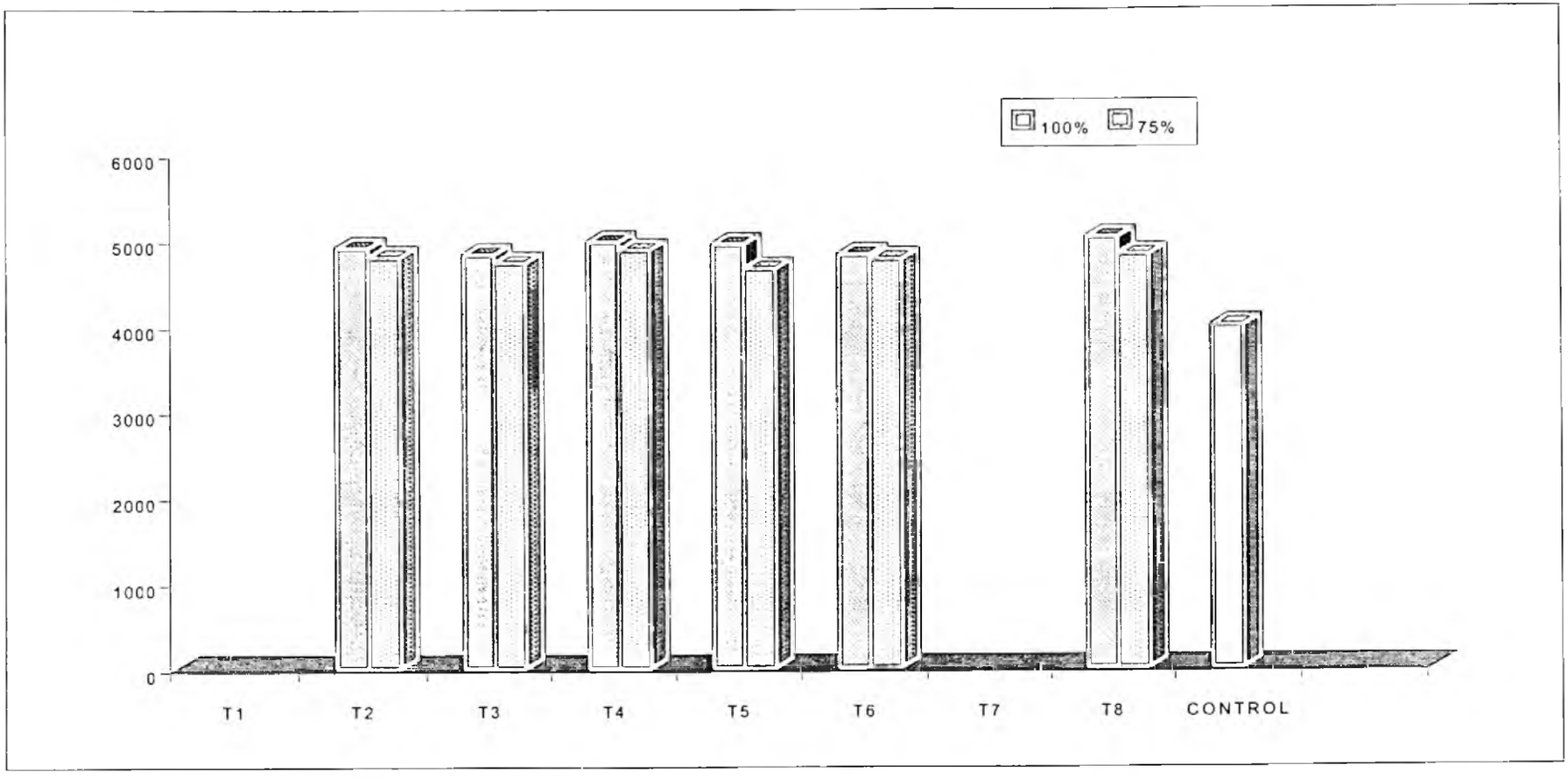


FIG. 28 MEAN STRAW YIELD OF PADDY (FIFTH CROP), kg/ha

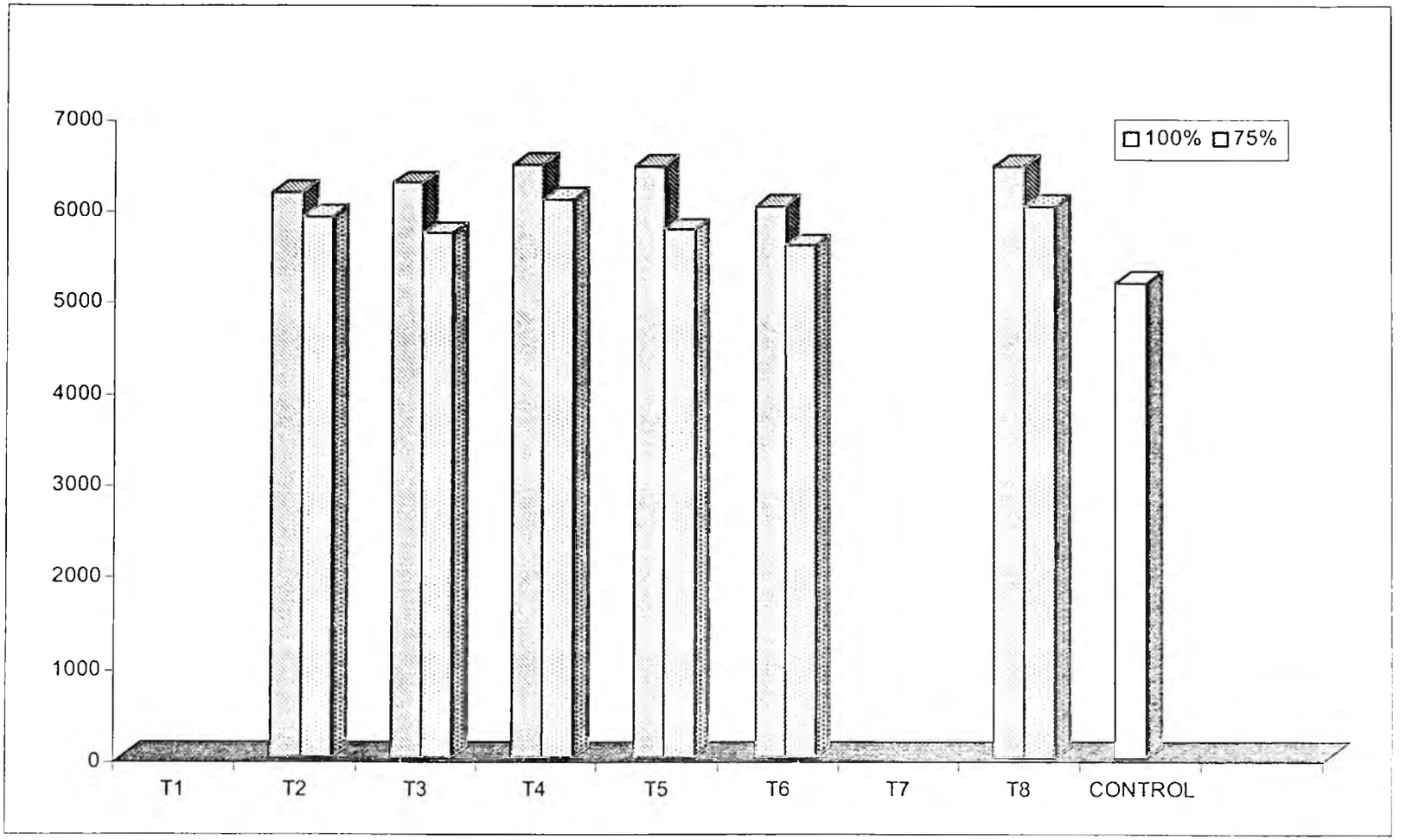


TABLE 39. POST HARVEST SOIL FERTILITY STATUS OF EXPERIMENTAL PLOTS IN THE FIFTH CROP OF PADDY

Treatment	Av. N mg kg $^{-1}$	Av. P mg kg $^{-1}$	Av. K mg kg $^{-1}$
1	-	-	-
2	256.9	13.2	98.0
3	246.7	12.9	97.1
4	260.2	13.3	97.9
5	261.4	13.1	97.6
6	240.1	12.3	96.2
7	-	-	-
8	264.1	13.8	98.3
9	-	-	-
10	233.4	12.2	95.4
11	226.9	11.9	95.1
12	255.1	12.8	97.5
13	224.4	11.7	94.5
14	228.4	12.0	95.9
15	-	-	-
16	239.5	12.5	96.8
17	189.5	11.6	88.7
CD	8.02	0.22	4.4

TABLE 40. MEAN PER CENT NUTRIENT CONTENT IN PADDY GRAINS (FIFTH CROP)

Treatment	N	P	K
1	-	-	-
2	1.17	0.22	0.44
3	1.22	0.20	0.41
4	1.10	0.22	0.48
5	1.28	0.21	0.46
6	1.06	0.19	0.40
7	-	-	-
8	1.07	0.23	0.51
9	-	-	-
10	0.98	0.20	0.43
11	0.95	0.18	0.39
12	1.00	0.21	0.46
13	1.00	0.19	0.43
14	0.96	0.17	0.39
15	-	-	-
16	0.99	0.22	0.48
17	0.89	0.17	0.37
CD	0.04	0.01	0.01

TABLE 41. MEAN PER CENT NUTRIENT CONTENT IN PADDY STRAW (FIFTH CROP)

Treatment	N	P	K
1	-	-	-
2	0.60	0.12	1.36
3	0.65	0.11	1.34
4	0.59	0.14	1.37
5	0.70	0.13	1.36
6	0.57	0.10	1.33
7	-	-	-
8	0.60	0.15	1.38
9	-	-	-
10	0.50	0.11	1.31
11	0.42	0.10	1.33
12	0.47	0.12	1.34
13	0.50	0.11	1.34
14	0.45	0.09	1.29
15	-	-	-
16	0.49	0.12	1.36
17	0.40	0.09	1.16
CD	0.05	0.01	0.02

TABLE 42. MEAN UPTAKE OF NUTRIENTS IN PADDY GRAINS (FIFTH CROP), kg ha^{-1}

Treatment	N	P	K
1	-	-	-
2	57.55	10.63	21.41
3	58.88	9.49	19.78
4	54.48	10.92	23.84
5	63.01	10.37	22.71
6	50.99	9.14	19.23
7	-	-	-
8	53.50	11.87	25.53
9	-	-	-
10	46.82	9.43	20.45
11	45.02	8.66	18.41
12	48.72	10.23	22.41
13	46.69	8.84	20.01
14	45.89	8.25	18.58
15	-	-	-
16	47.47	10.59	23.09
17	35.43	6.89	14.73
CD	2.76	0.53	0.79

FIG. 29 MEAN UPTAKE OF NITROGEN IN PADDY GRAINS (FIFTH CROP), kg/ha

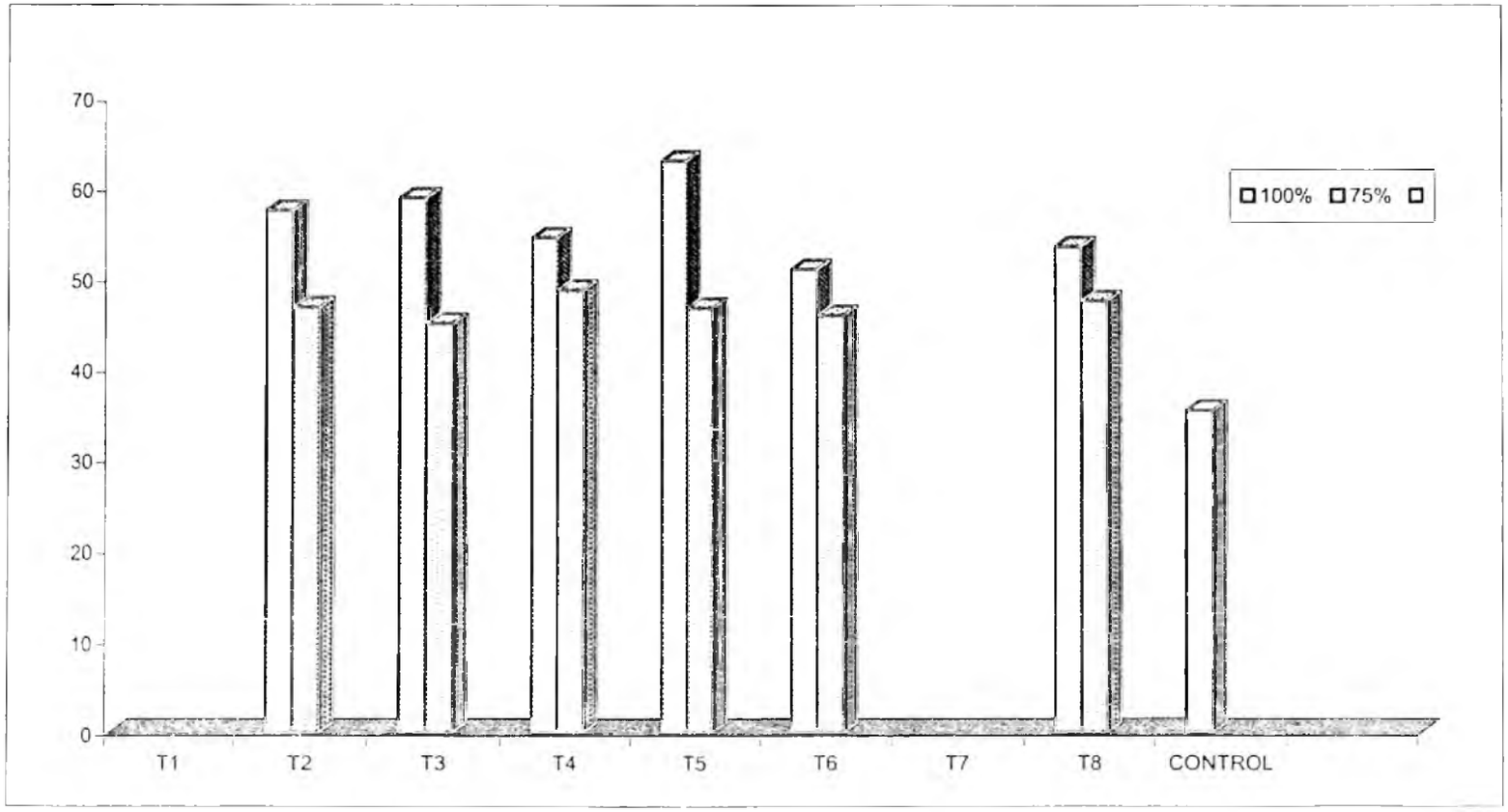


FIG.30 MEAN UPTAKE OF PHOSPHORUS IN PADDY GRAIN (FIFTH CROP), kg/ha

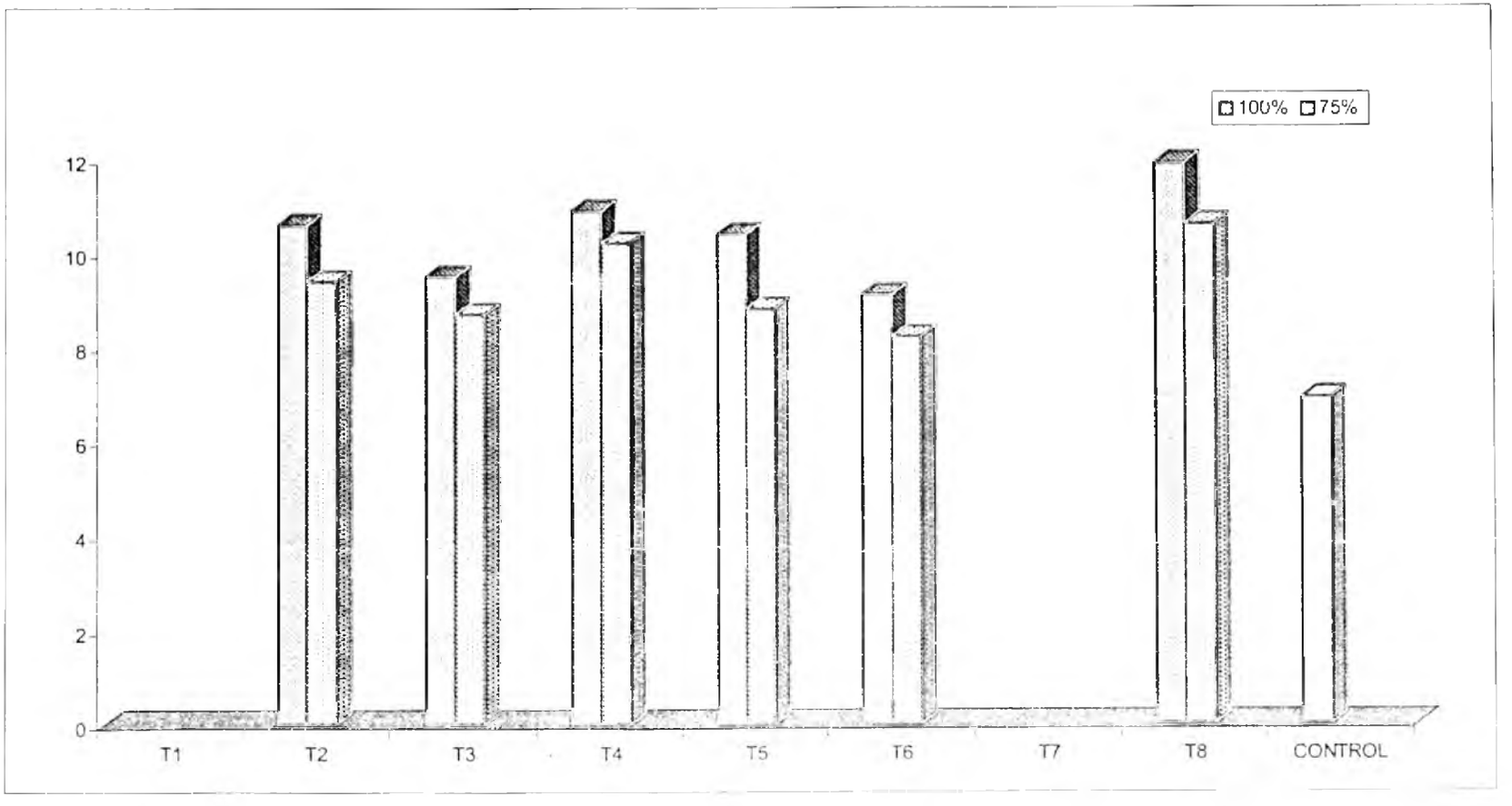


FIG.31 MEAN UPTAKE OF POTASSIUM IN PADDY GRAINS (FIFTH CROP), kg/ha

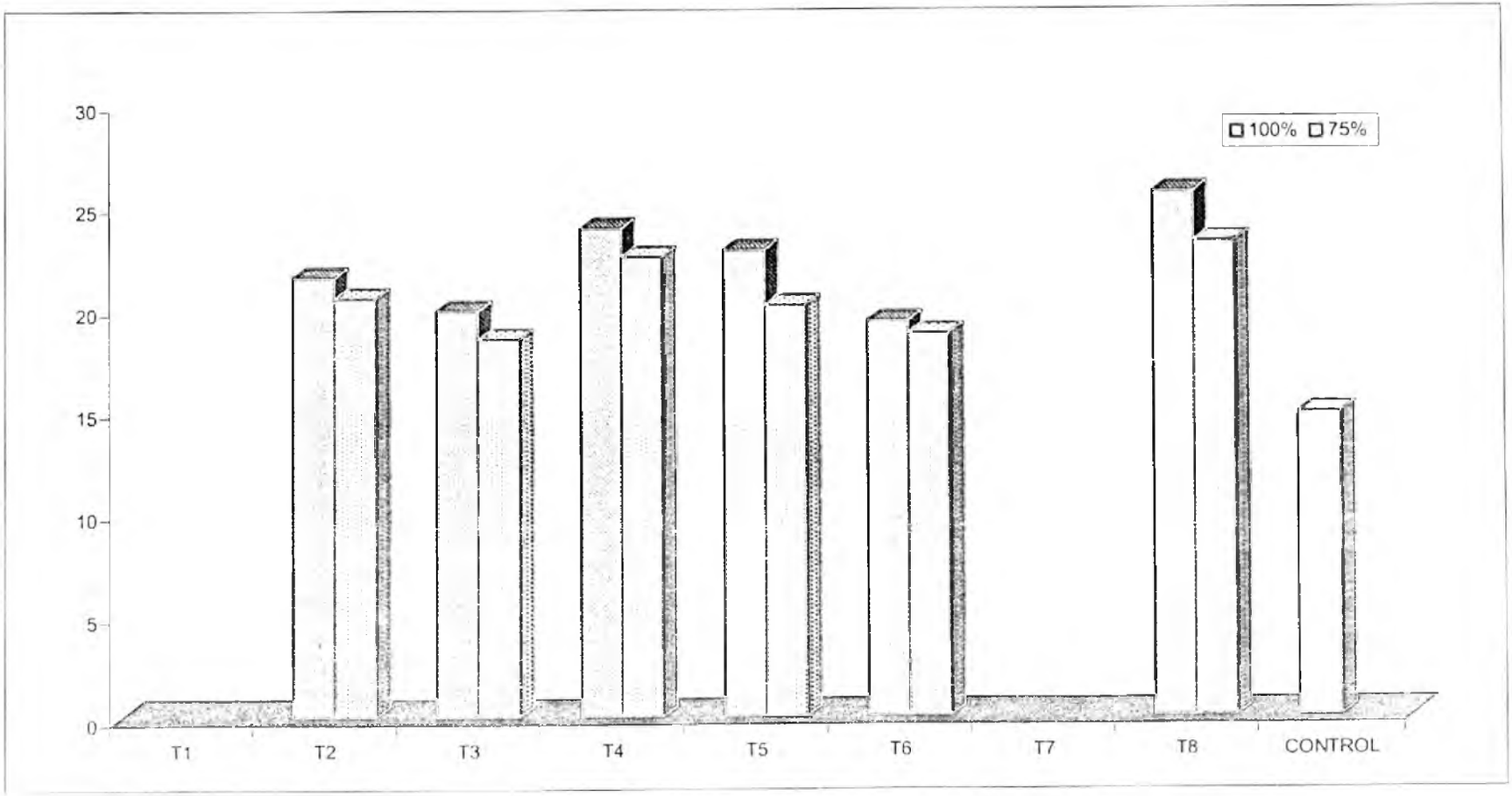


TABLE 43. MEAN UPTAKE OF NUTRIENTS IN PADDY STRAW (FIFTH CROP) , kg ha^{-1}

Treatment	N	P	K
1	-	-	-
2	37.02	7.61	83.89
3	40.79	6.69	83.85
4	37.61	8.71	87.54
5	45.18	8.18	85.59
6	34.28	6.21	79.80
7	-	-	-
8	39.36	9.68	89.06
9	-	-	-
10	29.52	6.69	77.35
11	23.99	5.52	75.82
12	28.62	7.30	81.61
13	28.76	6.14	77.28
14	25.12	4.84	71.84
15	-	-	-
16	29.48	7.42	81.79
17	20.68	4.40	60.00
CD	2.97	0.69	2.93

FIG.32 MEAN UPTAKE OF NITROGEN IN PADDY STRAW (FIFTH CROP), kg/ha

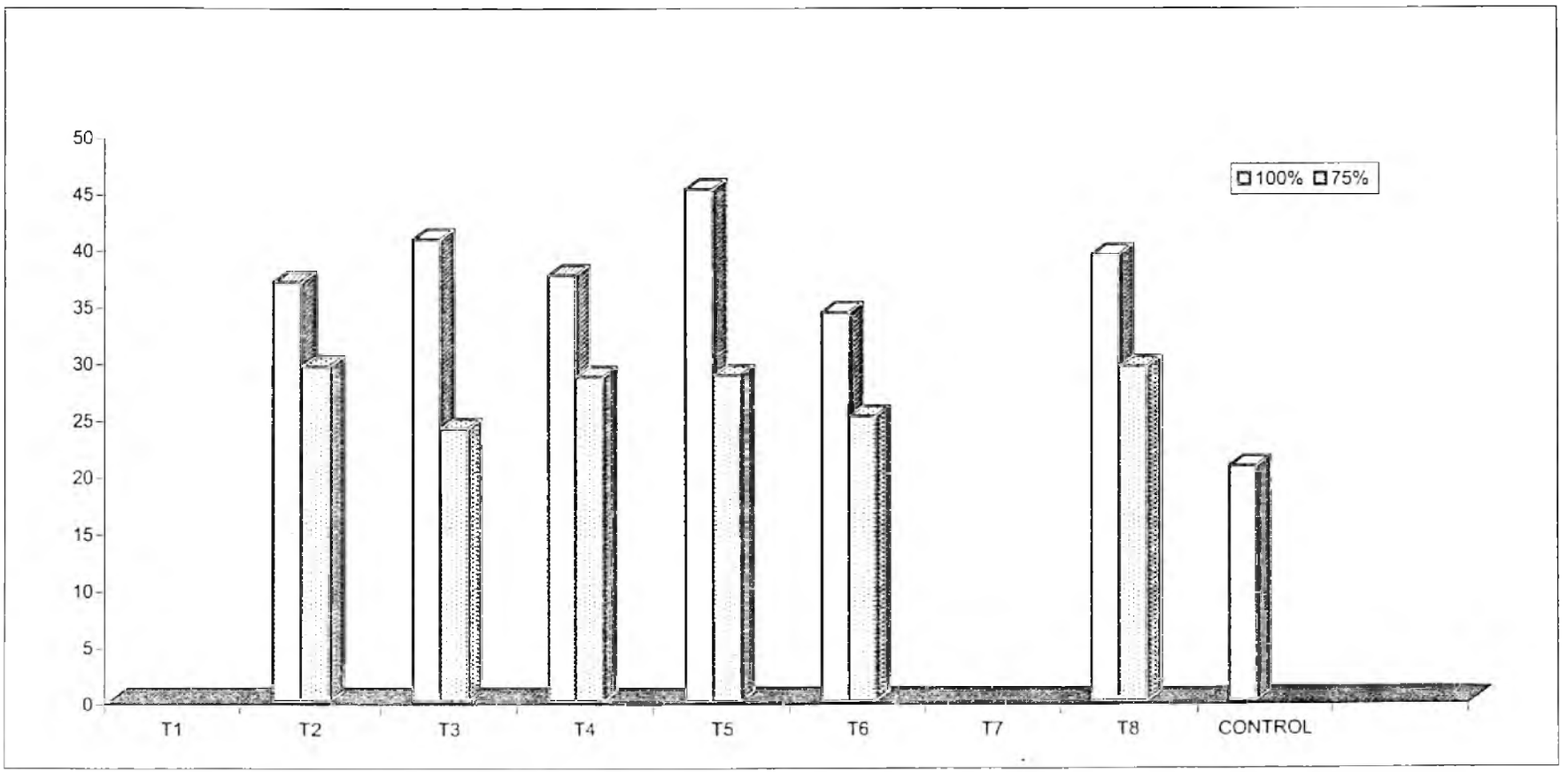


FIG.33 MEAN UPTAKE OF PHOSPHORUS IN PADDY STRAW (FIFTH CROP), kg/ha

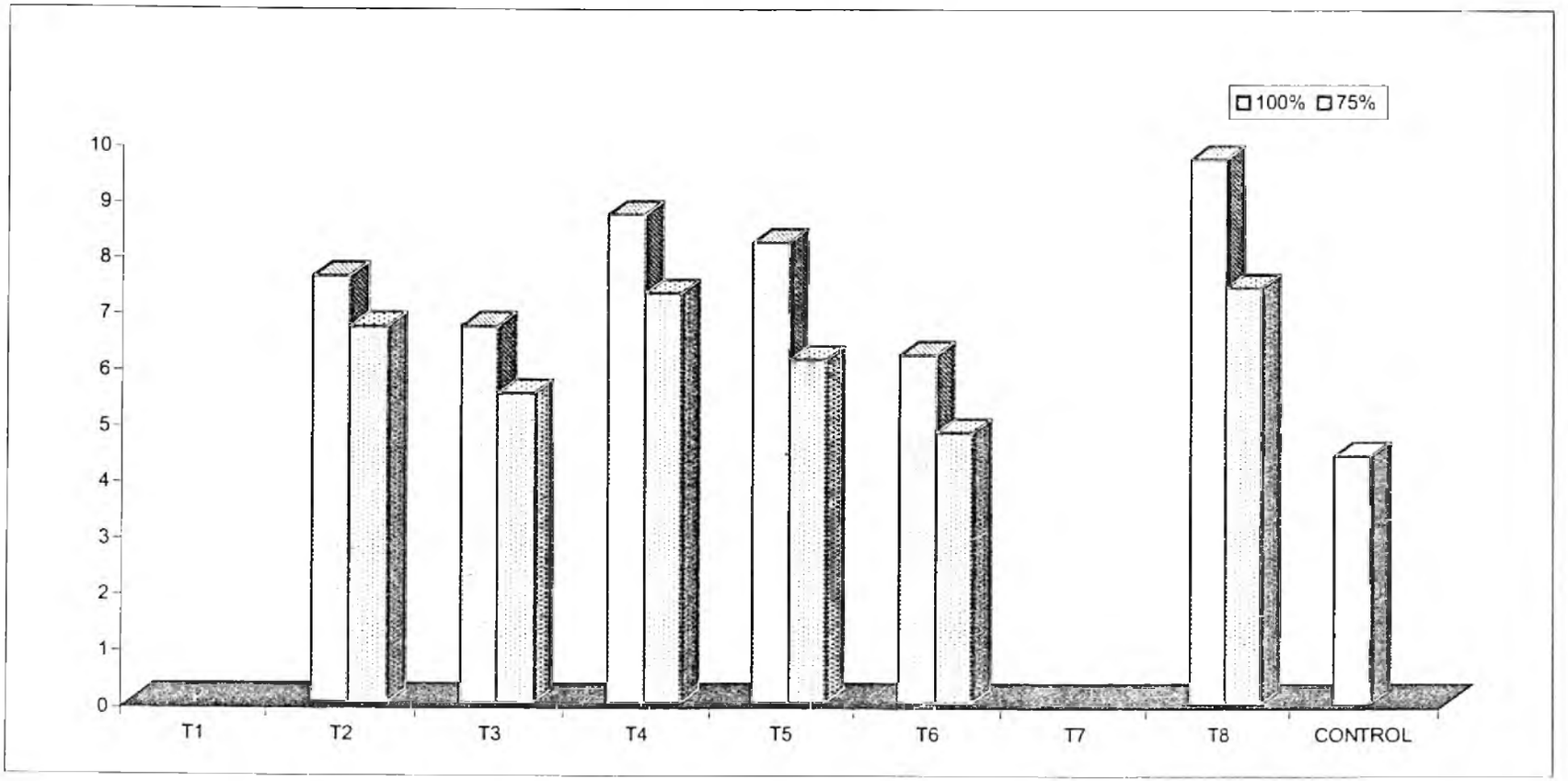


FIG.34 MEAN UPTAKE OF POTASSIUM IN PADDY STRAW
(FIFTH CROP), kg/ha

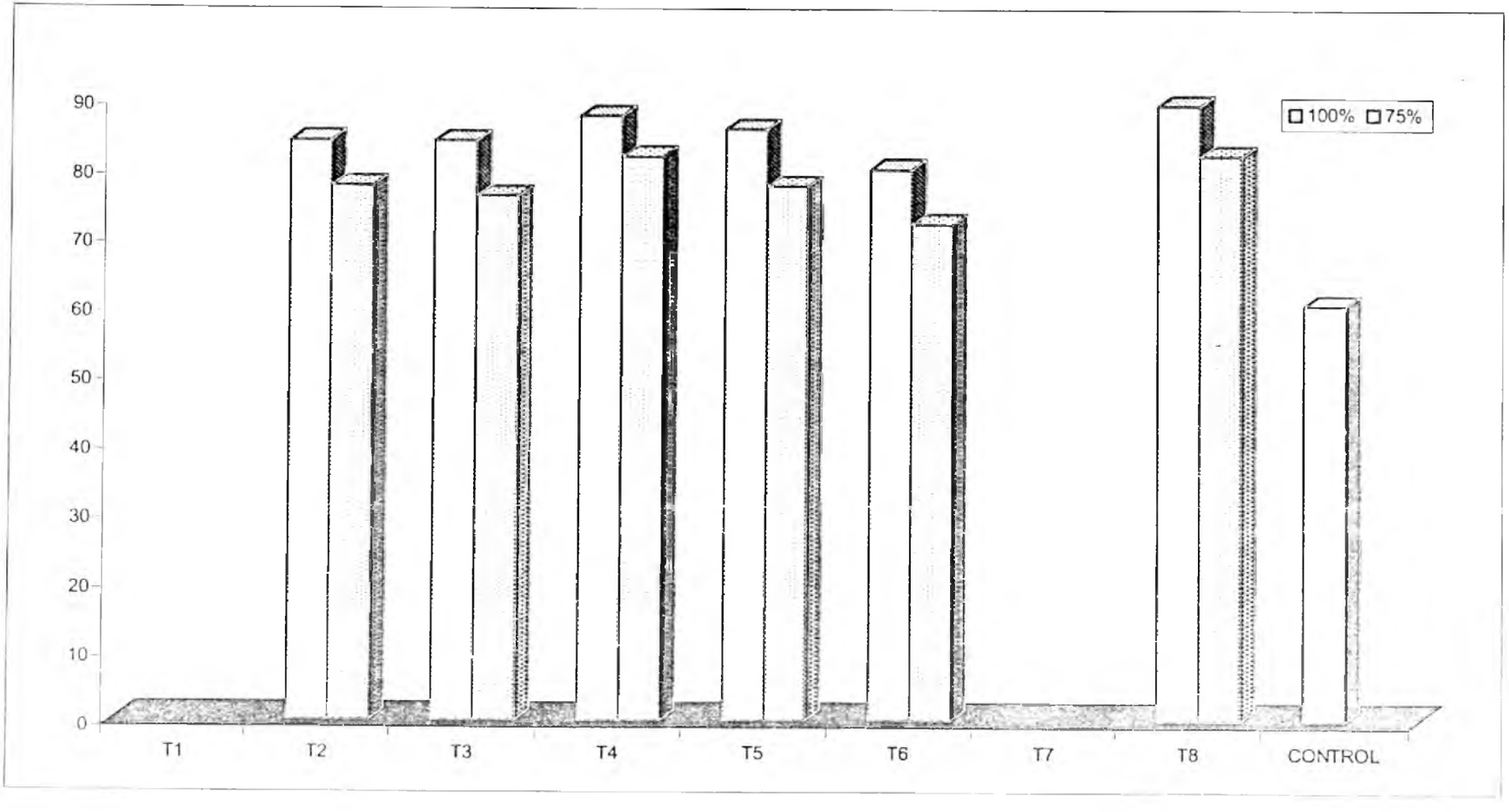


TABLE 43(a). MEAN NITROGEN CONTENT IN FIFTH CROP OF PADDY CROP AT THE DIFFERENT STAGES (VARIETY : PAVIZHAM)

Tr.	DAP 15	DAP 30	DAP 45	DAP 60	DAP 75	DAP 90	At harvest
1	-	-	-	-	-	-	-
2	2.09	2.71	2.84	1.45	1.28	0.98	0.60
3	2.26	2.68	2.96	1.40	1.19	0.92	0.65
4	2.64	2.75	2.89	1.60	1.30	1.02	0.59
5	2.40	2.73	2.81	1.54	1.21	0.95	0.70
6	2.31	2.63	2.72	1.47	1.29	1.00	0.57
7	-	-	-	-	-	-	-
8	2.45	2.94	2.06	1.74	1.32	0.92	0.60
9	-	-	-	-	-	-	-
10	1.82	2.53	2.72	1.39	1.02	0.89	0.50
11	2.09	2.49	2.74	1.36	1.10	0.85	0.42
12	2.19	2.65	2.68	1.48	0.98	0.78	0.47
13	12.00	2.55	2.73	1.43	0.95	0.80	0.50
14	1.91	2.45	2.65	1.26	1.04	0.78	0.45
15	-	-	-	-	-	-	-
16	2.32	2.87	2.96	1.61	1.00	0.80	0.49
17	2.01	2.25	2.38	1.05	0.70	0.55	0.40

TABLE 44. GENERAL DETAILS OF THE FIFTH ADDITIONAL CROP OF PADDY

Crop	Rice (Transplanted)
Variety	Pavizham
Location	Karappakunnu
Recommendation	90 : 45 : 45 kg ha^{-1}
Duration	115 - 118 days
Type of nursery	Dry
Date of sowing	24 January 1997
Plot size	5.0m x 4.0 m (20.0 m^2)
Spacing	20 x 10 cm
Date of transplanting	21 February 1997
No. of treatments	17
Replications	3
Design	RBD
Date of harvest	31 May 1997

TABLE 45. INITIAL SOIL FERTILITY STATUS
BEFORE THE FIFTH ADDITIONAL CROP OF PADDY

LOCATION : KARAPPAKUNNU	
pH	4.7
EC	0.11 dS m^{-1}
Organic Carbon	0.81 per cent
Available N	185.8 mg kg^{-1}
Available P	11.4 mg kg^{-1}
Available K	88.1 mg kg^{-1}

TABLE 46. POST HARVEST SOIL FERTILITY STATUS OF EXPERIMENTAL PLOTS IN THE FIFTH ADDITIONAL CROP OF PADDY

Tr.	Organic carbon (%)	pH	EC dS m^{-1}
1	0.91	4.4	0.09
2	0.75	4.9	0.08
3	0.73	4.8	0.10
4	0.88	4.7	0.11
5	0.84	4.5	0.11
6	0.78	4.7	0.10
7	0.76	4.6	0.10
8	0.92	4.7	0.09
9	0.85	4.8	0.09
10	0.71	4.4	0.11
11	0.71	4.6	0.08
12	0.82	4.8	0.10
13	0.79	4.9	0.12
14	0.74	4.9	0.11
15	0.73	4.6	0.09
16	0.85	4.5	0.10
17	0.79	4.7	0.10
CD	0.06	0.03	0.016

TABLE 47. MEAN BIOMETRIC OBSERVATIONS ON THE FIFTH ADDITIONAL CROP OF PADDY

Treatment	No. of productive tillers/hill	1000 grain wt (g)	Height of the plant cm
1	8.8	21.80	74.40
2	8.6	21.00	76.00
3	8.5	20.90	77.40
4	8.8	21.50	75.30
5	8.7	21.40	73.10
6	8.7	20.60	74.20
7	8.6	21.10	72.10
8	9.1	22.30	74.30
9	8.7	20.90	76.40
10	8.4	20.60	72.60
11	8.3	20.80	70.30
12	8.7	21.30	71.40
13	8.3	20.90	70.70
14	8.6	21.20	73.20
15	8.4	20.20	74.50
16	8.5	21.10	73.50
17	8.1	20.40	70.20
CD	0.35	0.513	0.57

MEAN GRAIN AND STRAW YIELD OF THE FIFTH ADDITONAL CROP OF PADDY

The yield of grain and straw obtained from the 5th additional crop is presented in table 48. From among the treatments which received the full doses it is seen that the split application of straight fertilizers (Tr.8) recorded the maximum yield followed by treatment 1 where urea formaldehyde component had been incorporated in to the formulation. Treatment 4 which provided a grain yield of 4758 kg/ha ranked third in providing the grain yield. Though there had been marginal differences in grain yield between these treatments, all these treatments remained statistically on par with each other. Treatment 5 ranked as fourth in grain yield and this treatment had no significant difference in grain yield when compared between that of treatments 1 & 4. Single application of straight fertilizer could not bring about any significant yield difference. Application of 75% of the fertilizer dose had brought about a reduction in the yield compared to its corresponding full doses. Control plot recorded the lowest yield and this remained significantly lower to all treatments and doses. The straw yields from all treatments were higher than the corresponding grain yield.

Maximum straw yield of 6138 kg/ha was noted from treatment 8 which incidentally favoured the maximum yield of grain also. This was followed by treatment 4, 5 & 1.Though marginal difference in straw yield existed between these treatments, there was no significant difference between any of them. Application of 75% of the fertilizers doses reduced the straw yield proportionately in all the treatments when compared to its full doses. The control plot recorded the lowest straw yield making all other treatments and doses significantly superior.

Summary

Though treatment 8 recorded the highest grain and straw yield, there was no significant difference between the yields recorded from treatments 4, 5 & 1. This indicates that split application of straight fertilizers will attract more labour than a single dose of slow release fertilizers applied as basal dose. Since treatments 4 & 5 are mixtures, the ease of handling & application will be more than that of straight fertilizers. These factors must tip in favour of either treatment 4 or 5 while popularization of slow release fertilizes for rice.

TABLE 48. MEAN GRAIN AND STRAW YIELD OF PADDY (FIFTH ADDITIONAL CROP), kg ha^{-1}

Tr.	Grain	Rank	Straw	Rank
1	4880.00	2	5981.00	4
2	4497.00	10	5969.00	5
3	4465.00	11	5929.00	6
4	4810.00	3	6100.00	2
5	4758.00	4	6060.00	3
6	4660.00	7	5887.00	8
7	4563.00	8	5773.00	9
8	4974.00	1	6138.00	1
9	4669.00	6	5804.00	10
10	4355.00	13	5800.00	11
11	4049.00	16	5749.00	12
12	4700.00	5	5969.00	5
13	4080.00	15	5508.00	13
14	4543.00	9	5422.00	15
15	4091.00	14	5479.00	14
16	4449.00	12	5906.00	7
17	3987.00	17	5345.00	16
CD	168.00		219.00	

FIG. 35 MEAN GRAIN YIELD OF PADDY
(FIFTH ADDITIONAL CROP), kg/ha

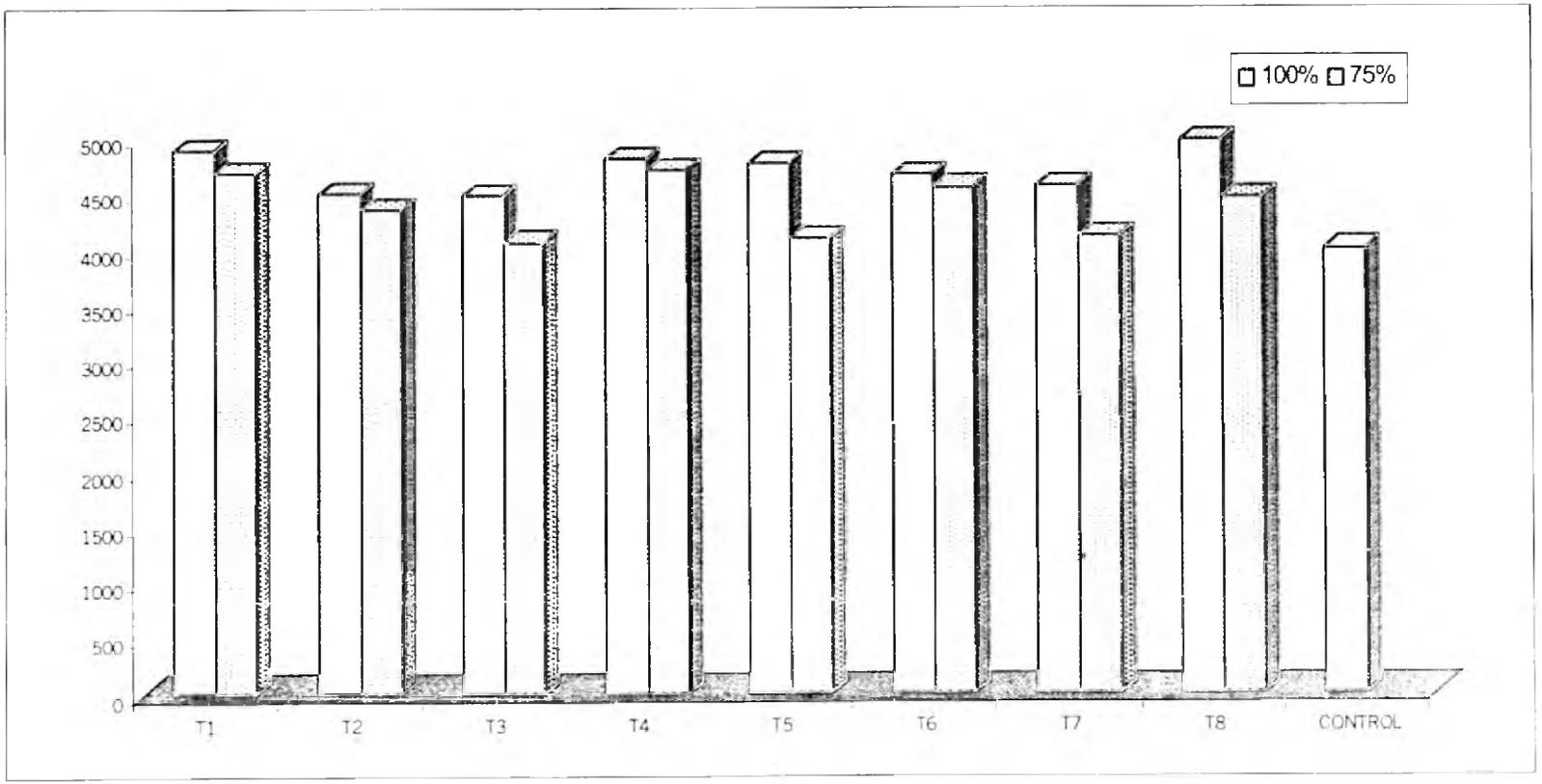


FIG. 36 MEAN STRAW YIELD OF PADDY
(FIFTH ADDITIONAL CROP), kg/ha

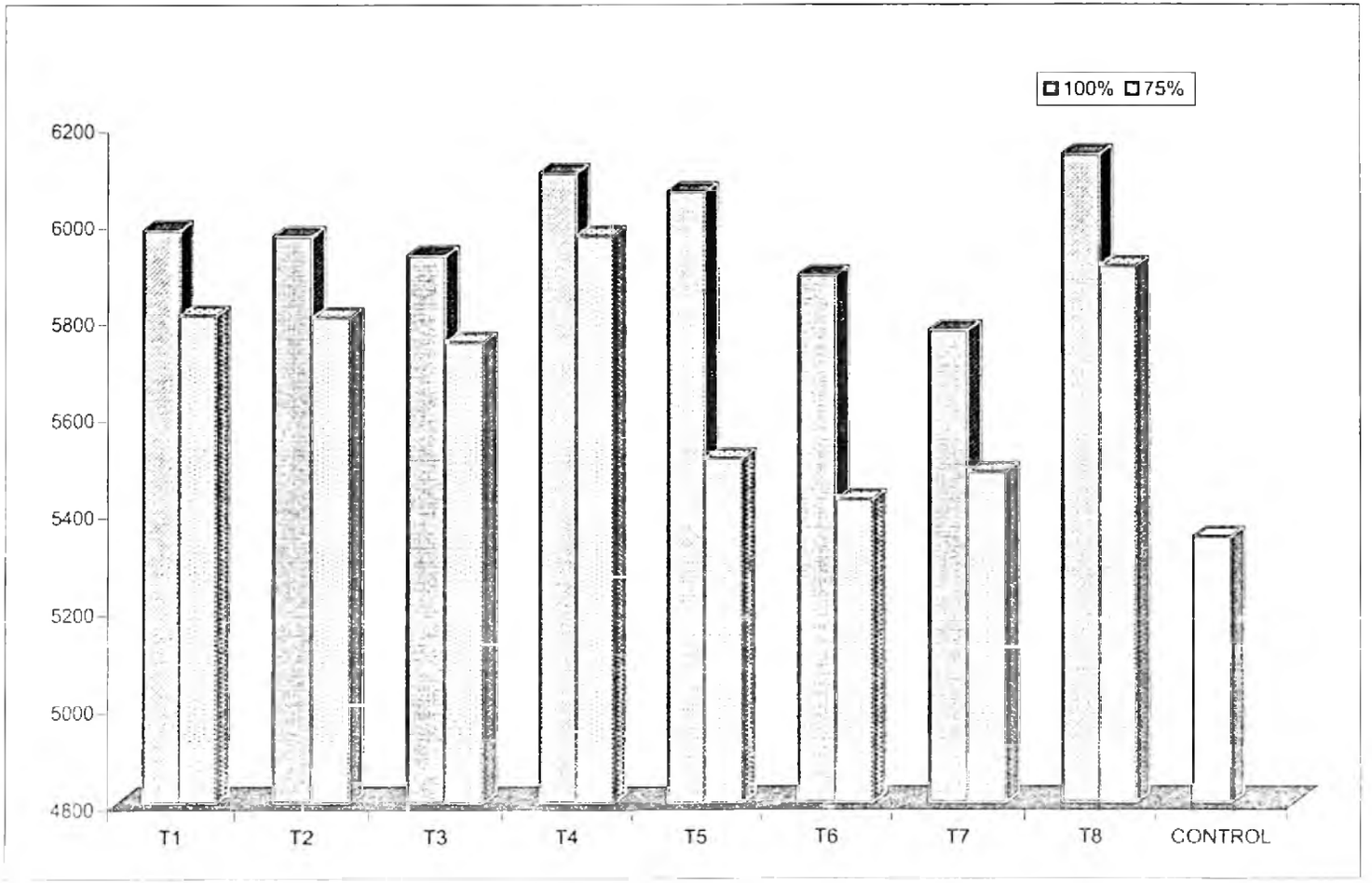


TABLE 49. POST HARVEST SOIL FERTILITY STATUS OF EXPERIMENTAL PLOTS IN THE FIFTH ADDITIONAL CROP

Tr.	Organic carbon (%)	pH	EC dS m^{-1}
1	0.91	4.4	0.09
2	0.75	4.9	0.08
3	0.73	4.8	0.10
4	0.88	4.7	0.11
5	0.84	4.5	0.11
6	0.78	4.7	0.10
7	0.76	4.6	0.10
8	0.92	4.7	0.09
9	0.85	4.8	0.09
10	0.71	4.4	0.11
11	0.71	4.6	0.08
12	0.82	4.8	0.10
13	0.79	4.9	0.12
14	0.74	4.9	0.11
15	0.73	4.6	0.09
16	0.85	4.5	0.10
17	0.79	4.7	0.10
CD	0.06	0.03	0.016

TABLE 50. MEAN PER CENT NUTRIENT CONTENT IN PADDY GRAINS (FIFTH ADDITIONAL CROP)

Treatment	N	P	K
1	1.09	0.24	0.42
2	1.15	0.21	0.44
3	1.20	0.23	0.46
4	1.11	0.22	0.40
5	1.23	0.20	0.52
6	0.99	0.24	0.49
7	1.13	0.19	0.47
8	1.04	0.25	0.50
9	1.00	0.20	0.40
10	1.10	0.17	0.43
11	1.05	0.19	0.43
12	1.06	0.20	0.38
13	1.19	0.18	0.47
14	0.94	0.22	0.45
15	1.03	0.16	0.43
16	0.97	0.23	0.46
17	0.90	0.15	0.36
CD	0.07	0.02	0.05

TABLE 51. MEAN PER CENT NUTRIENT CONTENT IN PADDY STRAW (FIFTH ADDITIONAL CROP)

Treatment	N	P	K
1	0.62	0.13	1.30
2	0.60	0.10	1.31
3	0.67	0.14	1.28
4	0.58	0.12	1.32
5	0.70	0.11	1.25
6	0.56	0.14	1.36
7	0.64	0.10	1.34
8	0.75	0.15	1.27
9	0.51	0.11	1.27
10	0.49	0.08	1.29
11	0.56	0.12	1.25
12	0.42	0.10	1.30
13	0.61	0.09	1.23
14	0.40	0.11	1.32
15	0.52	0.08	1.31
16	0.67	0.13	1.24
17	0.39	0.08	1.17
CD	0.04	0.02	0.05

TABLE 52. MEAN UPTAKE OF NUTRIENTS IN PADDY GRAINS (FIFTH ADDITIONAL CROP), kg ha^{-1}

Treatment	N	P	K
1	53.44	11.72	20.65
2	51.71	9.45	19.79
3	53.59	10.27	20.54
4	53.37	10.57	19.21
5	59.48	9.52	24.72
6	46.05	11.19	22.82
7	51.59	8.67	21.49
8	51.72	12.44	24.86
9	46.69	9.46	18.49
10	47.91	7.41	18.57
11	42.34	7.71	17.36
12	51.46	9.40	17.87
13	48.59	7.35	19.17
14	42.67	10.0	20.41
15	42.16	6.55	17.6
16	43.19	10.23	20.49
17	35.89	5.97	14.34
CD	4.06	0.96	2.04

FIG. 37 MEAN UPTAKE OF NITROGEN IN PADDY GRAINS (FIFTH ADDITIONAL CROP), kg/ha

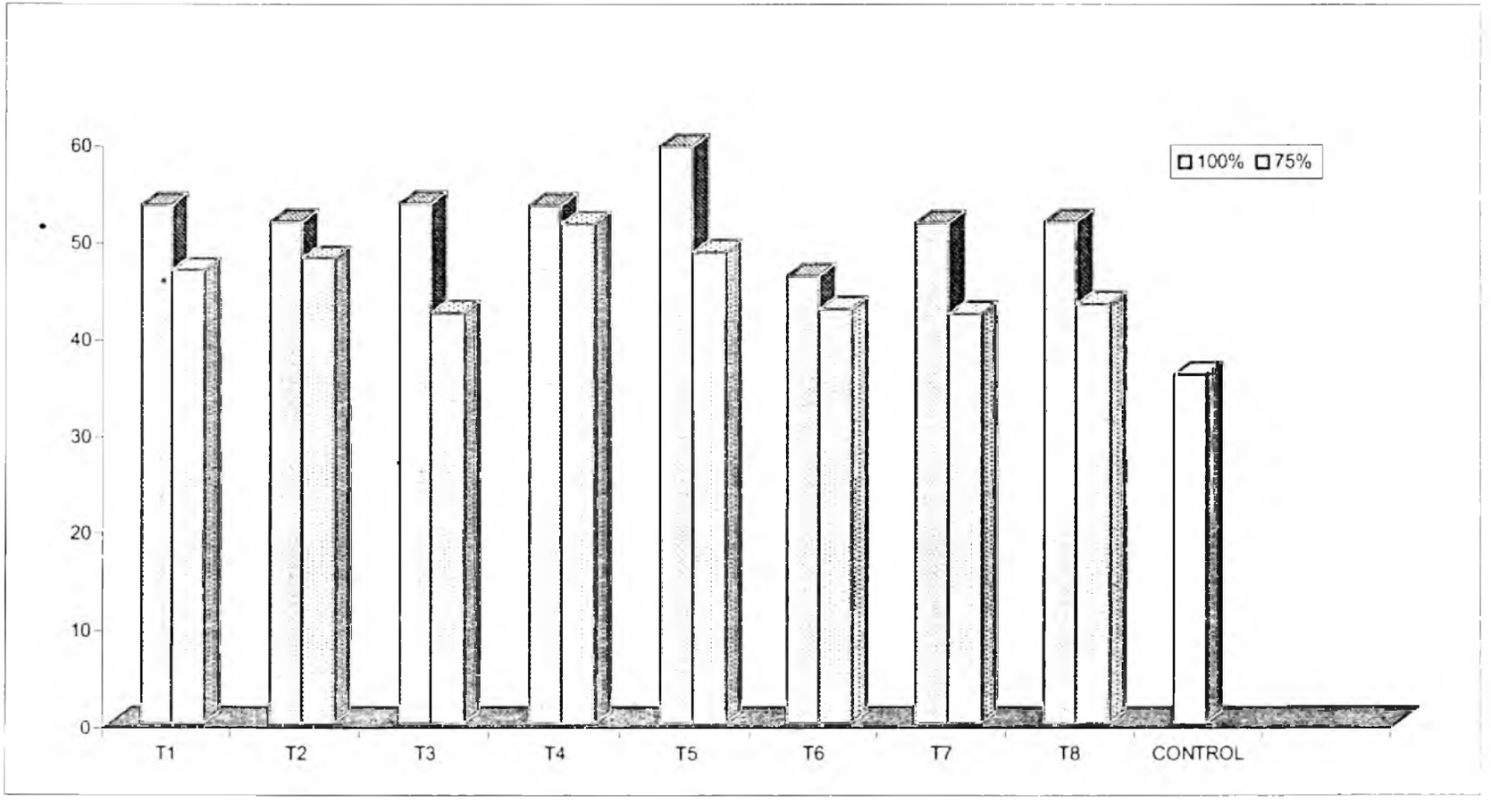


FIG.38 MEAN UPTAKE OF PHOSPHORUS IN PADDY GRAINS (FIFTH ADDITIONAL CROP), kg/ha

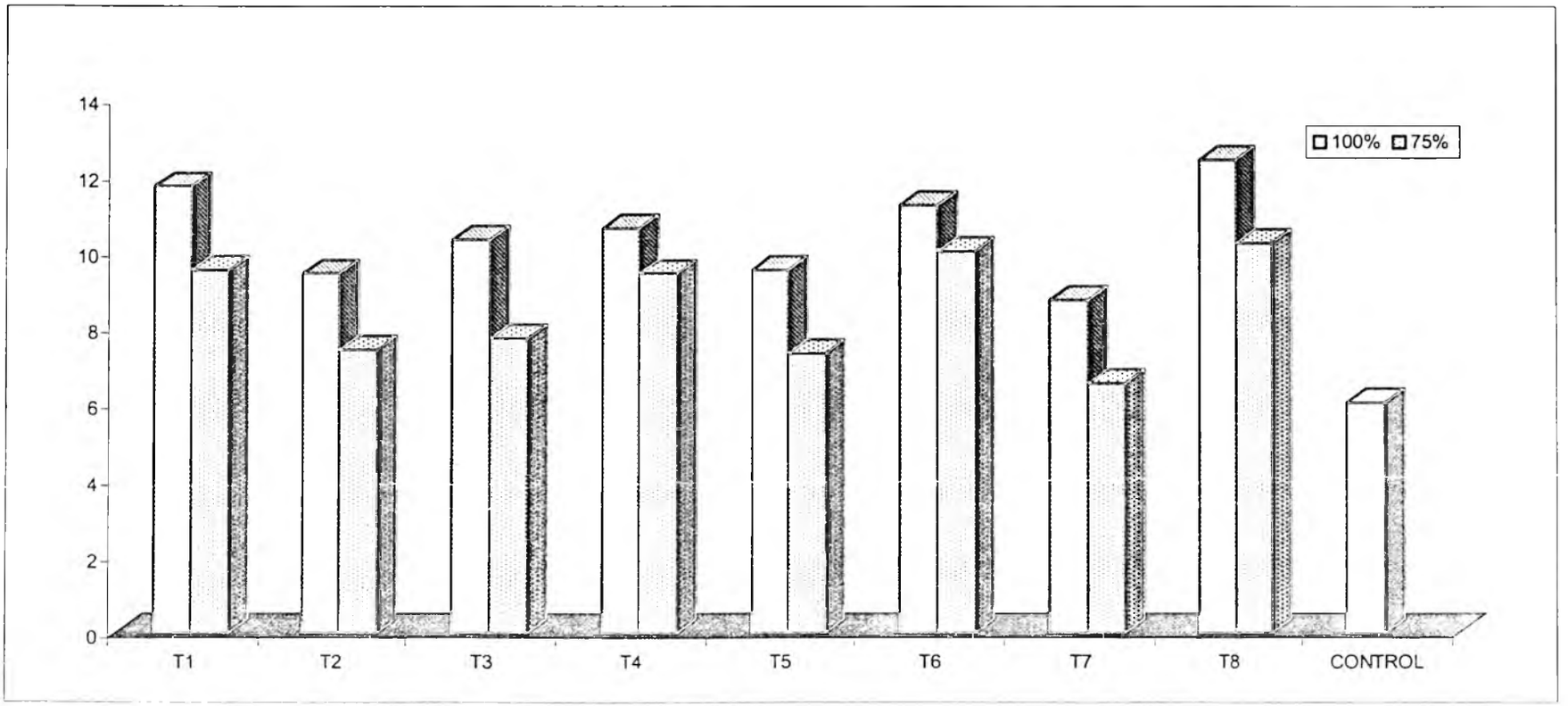


FIG.39 MEAN UPTAKE OF POTASSIUM IN PADDY GRAINS (FIFTH ADDITIONAL CROP) kg/ha

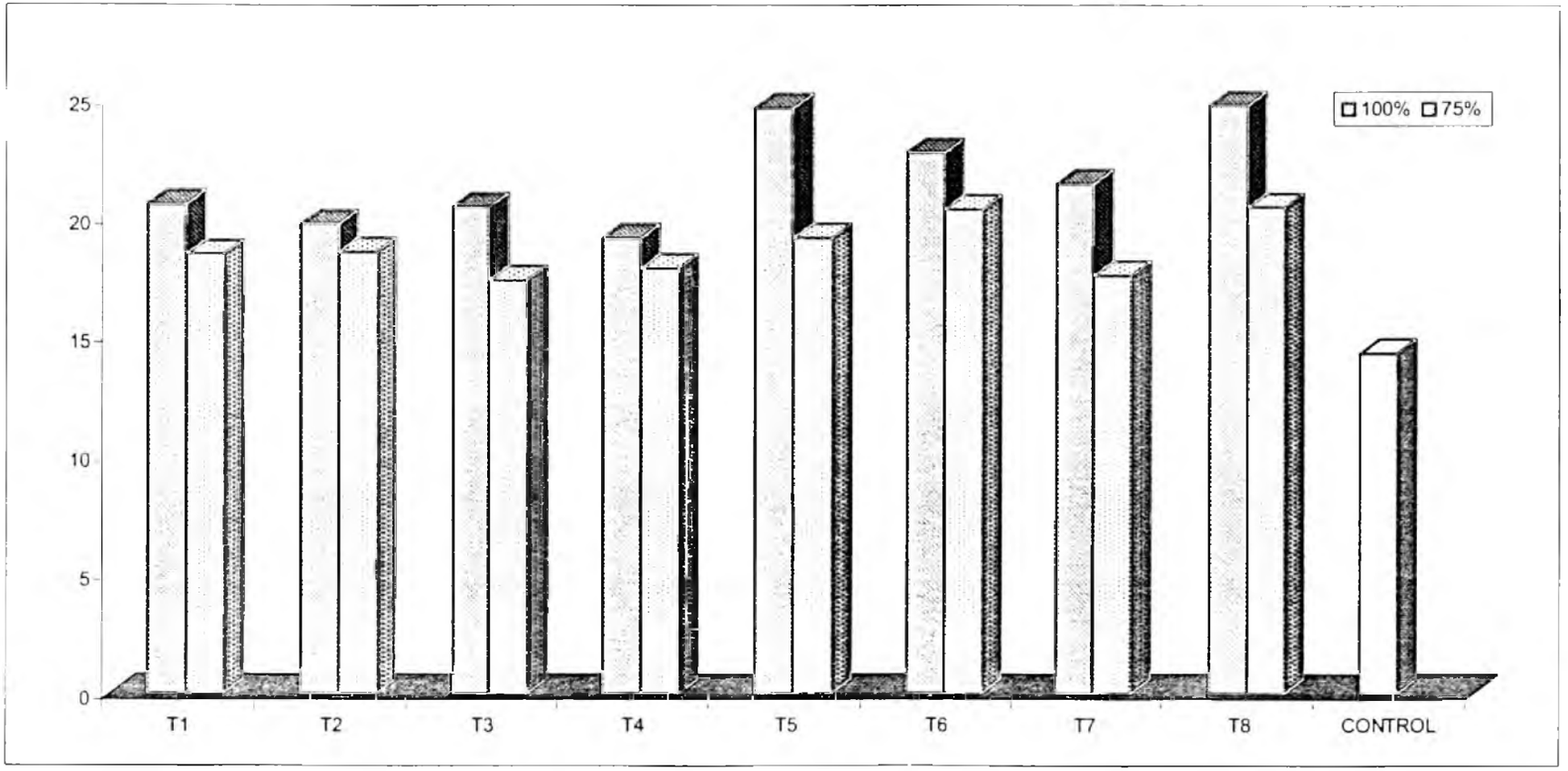


TABLE 53. MEAN UPTAKE OF NUTRIENTS IN PADDY STRAW (FIFTH ADDITIONAL CROP), kg ha^{-1}

Treatment	N	P	K
1	37.08	7.78	77.71
2	35.81	5.97	78.18
3	39.72	8.31	76.29
4	35.38	7.32	80.51
5	42.42	6.65	75.74
6	32.99	8.25	80.09
7	37.61	5.89	78.72
8	46.03	9.21	77.94
9	29.62	6.19	73.73
10	28.42	4.85	74.82
11	29.18	6.91	71.86
12	25.07	5.97	77.58
13	33.61	4.97	67.76
14	21.67	5.95	71.56
15	28.51	4.58	71.78
16	39.59	7.66	73.22
17	20.84	4.27	62.54
CD	3.41	1.17	3.32

FIG. 40 MEAN UPTAKE OF NITROGEN IN PADDY STRAW (FIFTH ADDITIONAL CROP), kg/ha

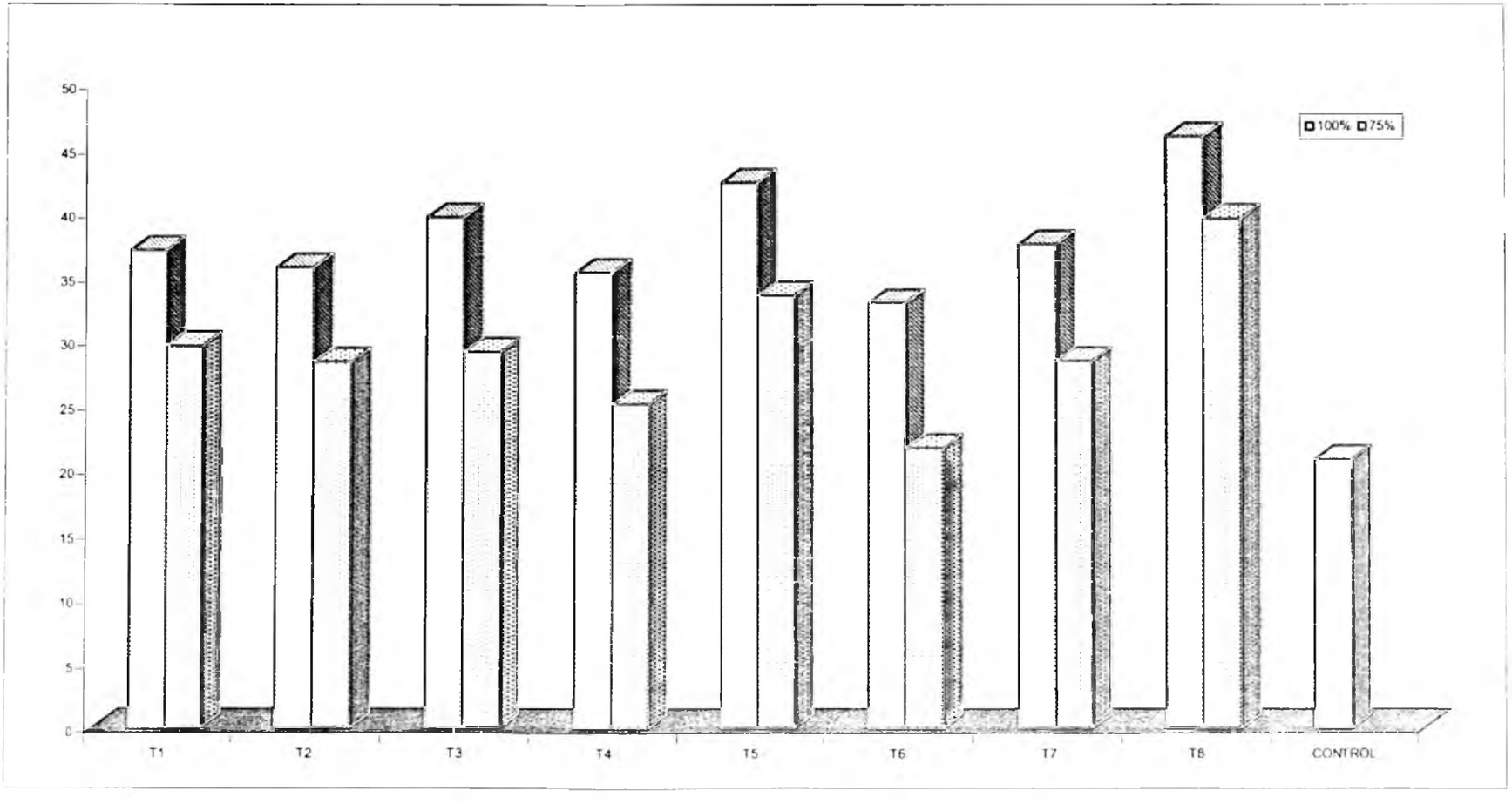


FIG.41 MEAN UPTAKE OF PHOSPHORUS IN PADDY STRAW (FIFTH ADITIONAL CROP), kg/ha

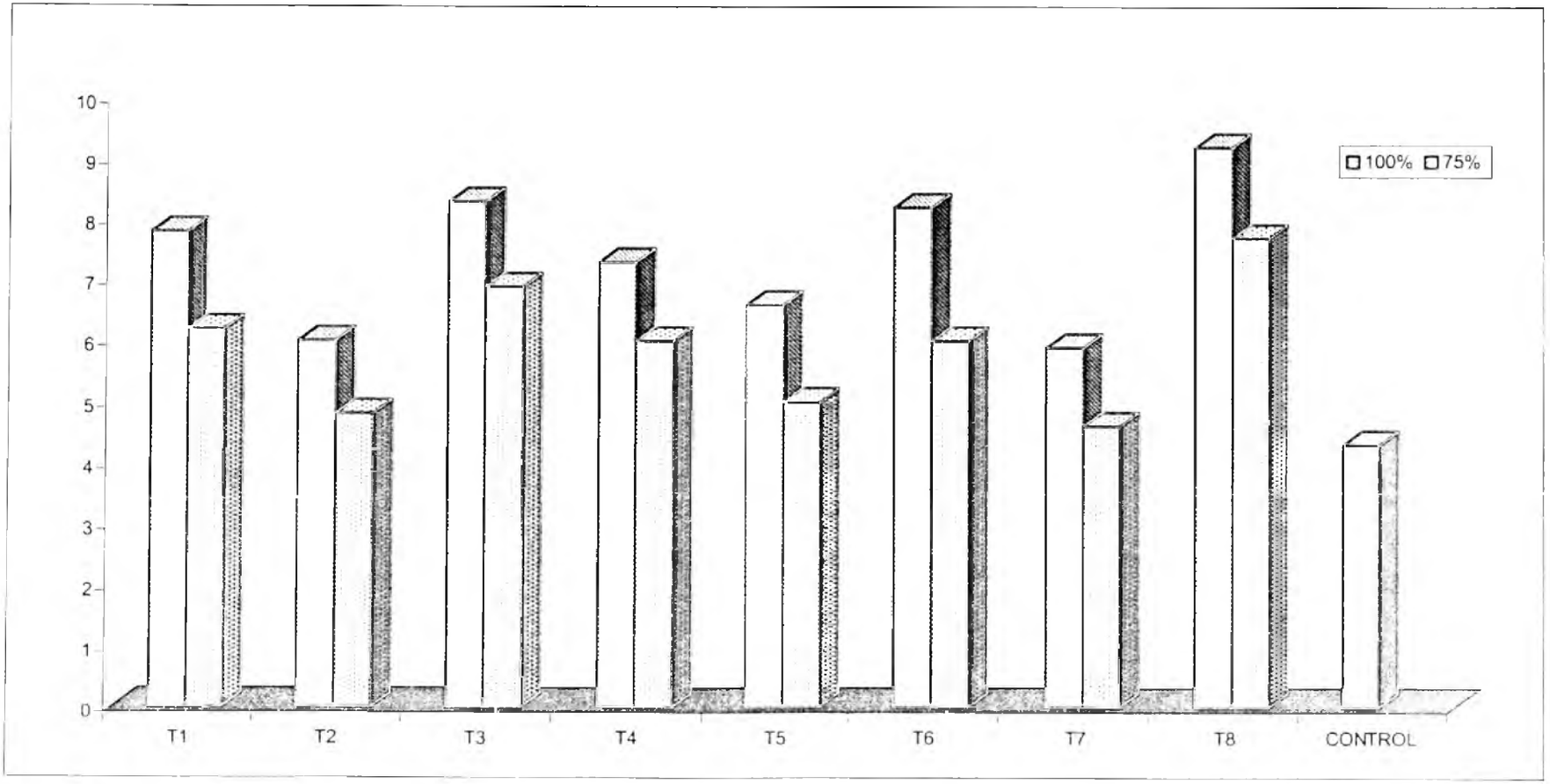
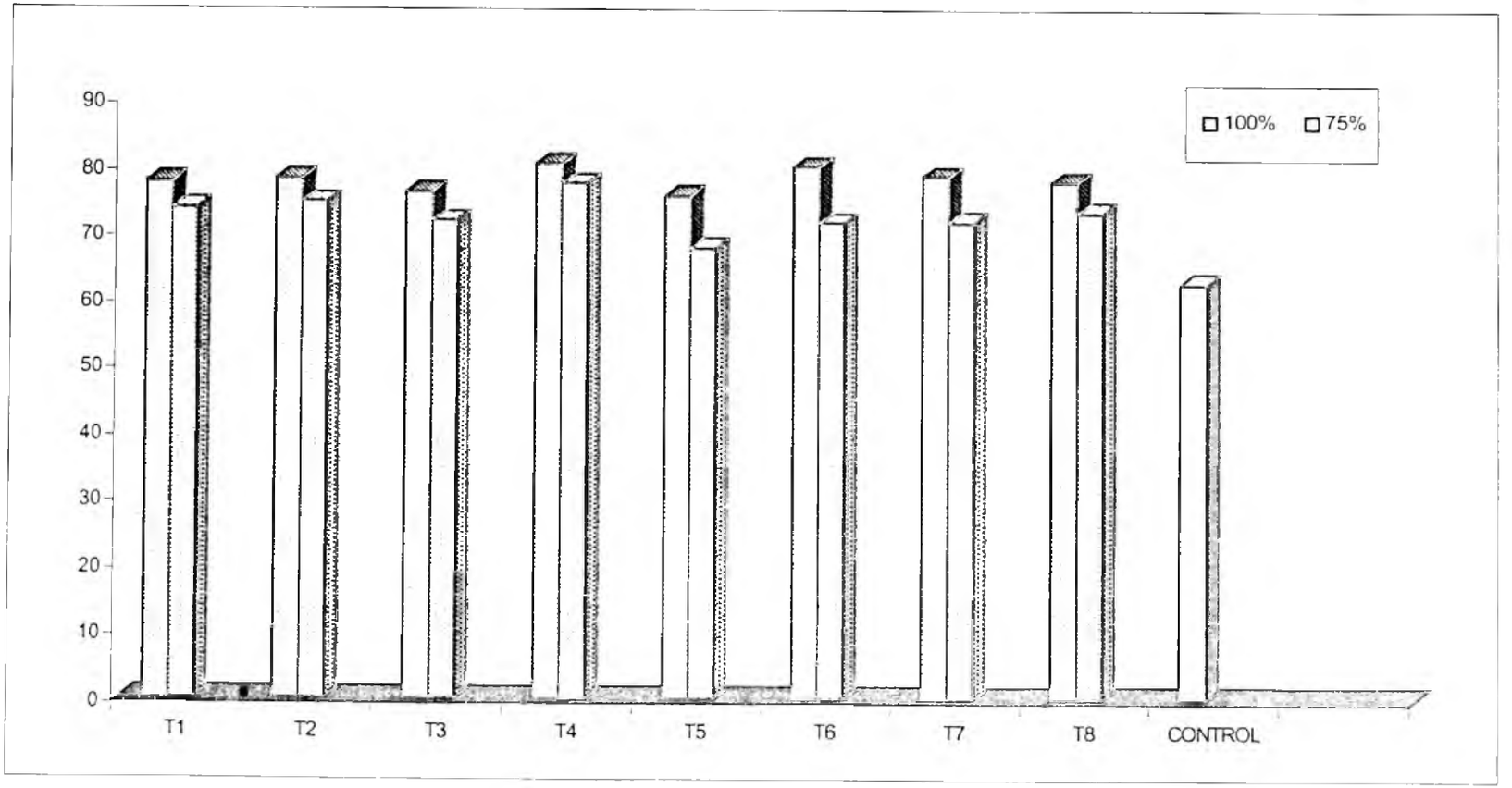


FIG.42 MEAN UPTAKE OF POTASSIUM IN PADDY STRAW (FIFTH ADDITIONAL CROP) kg/ha



EXECUTIVE SUMMARY OF THE VARIOUS EXPERIMENTS ON SLOW RELEASE FERTILIZERS WITH PADDY AND PRACTICAL DIFFICULTIES ENCOUNTERED

1. No single slow release fertilizer formulation could ensure sustained yield in different experiments with rice under acidic and waterlogged soil situations.

2. In spite of the fact that the site of the experiment has been changed after each experiment, there had been erratic tendency among treatments in delivering the highest yields

3. The heavy rainfall in the first crop season, the low content of clay in soil, the poor CEC, poor base saturation, and the acidic pH of the soil might have contributed much for the observed inconsistency in yield at various locations.

4. Under waterlogged conditions and acidic environments, the slow release fertilizers particularly the spike formulations failed to retain their consistency in the field during the entire growth period of paddy.

5. Yellowing of paddy seedlings was noticed invariably in all fields where spike form of fertilizers were applied. This might have been due to initial contact of the root with concentrated and localized sources of these spikes. Plants recovered from the yellowing and picked up a slow growth after two weeks, on account of the fresh roots produced.

6. Shifting of placement zones of spikes in soil had no effect in mitigating the yellowing in paddy. For this reason and also considering the cost of application of this spike, one can never expect economic returns from the crop, though the product remained as slow release fertilizer.

7. Slow release fertilizer mixtures were considered to be superior to and convenient over spikes from the practical point of application in the field.

8. Slow release fertilizers particularly the mixtures (Tr.4 & 5) were found to be on par with the best treatment which provided the maximum yield. The popularization of these mixtures, which could be applied entirely as basal dose may be advantageous to farmers in view of the labour savings when compared to the conventional normal split application of straight fertilizer.

9. Flooding of fields due to heavy rains, especially in the first crop season will reduce the efficiency of the slow release fertilizes. The effect of slow release formulations become more pronounced and conspicuous on paddy during the second crop season where water management could be made more effectively.

Considering these points, the slow release fertilizer formulations for paddy can be restricted to mixtures and not spikes for Kerala conditions. Since the various mixture formulations were on par with the normal package of practices of the Kerala Agricultural University, with respect to yield, the only advantage that might tip the promotion of slow release fertilizer formulation (mixtures) will be the savings in labour cost.

TABLE 54. EVALUATION OF SLOW RELEASE FERTILIZERS INITIAL TECHNICAL PROGRAMME FOR BANANA

Tr.	Formulation	Treatment particulars
1	Tablet	Urea formaldehyde, Factomphos, Ammonium sulphate,Rock phosphate & MOP (filler- gypsum & binder- clay)
2	Tablet	Urea gypsum adduct, Factomphos, Ammonium sulphate, Rock phosphate & MOP (filler- gypsum & binder- clay)
3	Mixture	Urea gypsum adduct, Factomphos, Ammonium sulphate, Rock phosphate & MOP (binder- clay)
4	Mixture	Urea, Factomphos coated with coaltar & MOP
5	Tablet	Urea formaldehyde (proportion different from Tr. 1), Factomphos, Ammonium sulphate, Rock phosphate & MOP (filler- gypsum & binder- clay)
6	Tablet	Factomphos, Ammonium sulphate, Rock phosphate & MOP(filler- gypsum & binder- clay)
7	Mixture	Single application of straight fertilizers at the full recommended dose
8	Mixture	Split application of the recommended dose as per the POP of KAU
9 - 16	Similar to Tr.1-8 except that the total NPK supplied will be at 75% of the recommended doses	
17	Absolute control with out any NPK fertilizers	

TABLE 55. GENERAL DETAILS OF THE FIRST CROP OF BANANA

Crop	Banana
Variety	Nendran
Location	ARS, Mannuthy
Duration	11-12 months
Recommendation	190 : 115 : 300 (g/plant/year)
Date of planting	23 October 1995
Spacing	2.0 m x 2.0 m
Date of fertilizer application	2 December, 1995
Design	RBD
Treatments	17 (1 treatment = 4 plants)
Replication	3
Date of harvest	September 1996 onwards

TABLE 56 INITIAL SOIL FERTILITY STATUS BEFORE THE FIRST CROP OF BANANA

LOCATION : ARS MANNUTHY	
pH	5.5
EC	0.16 dS m^{-1}
Organic Carbon	0.71 per cent
Available N	128.8 mg kg^{-1}
Available P	7.4 mg kg^{-1}
Available K	86.4 mg kg^{-1}

TABLE 57. MEAN BIOMETRIC OBSERVATIONS ON THE FIRS CROP OF BANANA

Treatment	No. of leaves		Girth of plants (cm)	
		Rank		Rank
1	10.9	1	27.6	1
2	10.1	7	25.7	8
3	10.2	6	26.4	4
4	10.7	3	26.0	6
5	10.8	2	27.2	2
6	10.5	4	26.1	5
7	9.3	12	23.7	9
8	10.5	4	26.8	3
9	10.3	5	23.1	11
10	9.5	11	22.9	13
11	9.6	10	22.9	13
12	9.7	9	22.2	14
13	9.5	11	23.0	12
14	9.7	9	23.1	11
15	9.0	13	21.5	15
16	9.8	8	23.2	10
17	9.0	13	19.3	16
CD	0.8		1.9	

YIELD OF FIRST CROP OF BANANA

The yield of the first crop of banana planted at Agricultural Research Station, Mannuthy is presented in Table no58. The maximum mean yield of 7.23 kg was recorded from Tr. 1 where urea formaldehyde component had been incorporated into the fertilizer material. Though treatment 5 recorded the next lower yield in this experiment, there was no significant difference between their yield. Treatment 5 had a different proportion of urea formaldehyde in the formulation and it was clear that inclusion of urea formaldehyde in the formulations has resulted in enhanced yield possibly through their effective slow release nitrogen mechanism. Though Tr. 4, Tr. 8, Tr. 3 and Tr. 6 ranked next to Tr.1 in terms of yield, there was no significant difference between any of these treatments and all formulations were equally effective in providing the yield. From this, it is further clear that these slow release fertilizer formulations at 100 pr cent doses is comparable with Tr. 8 which necessitates six split applications of straight fertilizers (Package of Practices, KAU). Considering the cost of labour and the yield from the slow release fertilizer formulation, especially Tr. 4, Tr. 3 and Tr. 6 can be considered as better economic sources of fertilizers. Single application of straight fertilizers (Tr.7) failed to produce any negative effect on the yield in the first crop. Reduction of fertilizer doses to 75% has invariably decreased the yield of banana emphasizing that sustained yields cannot be obtained from lower doses. No specific effect of any fertilizer formulations on the production of number of hands and fingers were noticed in this experiment.

Summary

Incorporation of urea formaldehyde in the fertilizer formulation has been beneficial in enhancing the yield of banana. In view of the cost of production of such formulations, mixtures especially Tr. 4, which had proved to be equally effective in providing the maximum significant yield is worth trying. Both tablets as well as mixtures had the ease of handling and application. The reduction in doses of fertilizer had generally resulted in lower yield. No specific effect of any fertilizer formulations on the production of number of hands and fingers were noticed in this experiment

TABLE 58. MEAN YIELD OF THE FIRST CROP OF BANANA, kg / plant

Treatment	Yield	Rank
1	7.23	1
2	5.33	11
3	6.68	6
4	7.10	3
5	7.11	2
6	6.60	7
7	6.23	8
8	6.75	5
9	5.78	10
10	5.00	13
11	4.93	15
12	5.93	9
13	6.92	4
14	4.32	16
15	5.13	12
16	4.97	14
17	4.10	17
CD	1.45	

FIG.43 MEAN YIELD OF BANANA (FIRST CROP), kg/plant

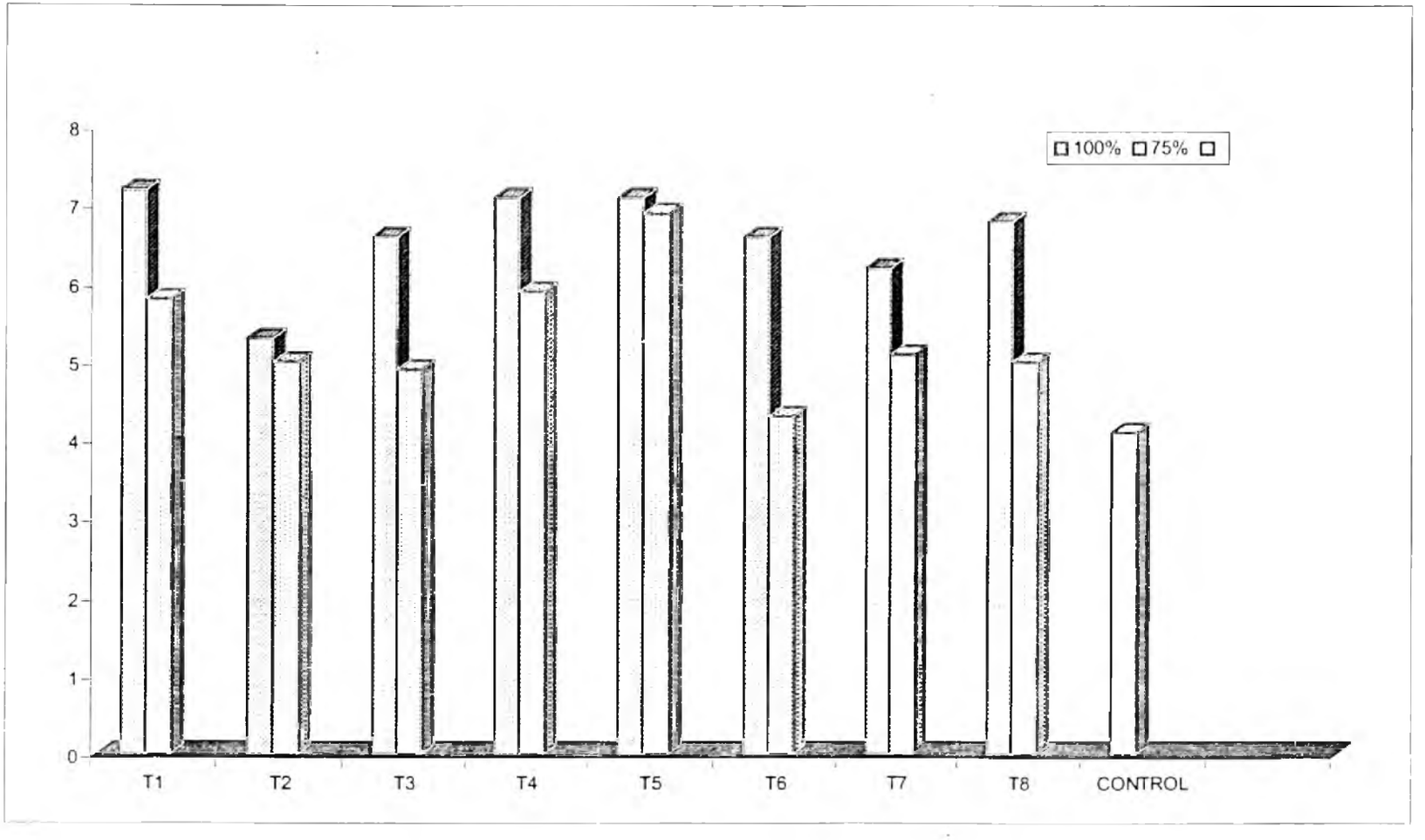


TABLE 59. MEAN YIELD PARAMETERS OF THE FIRST CROP OF BANANA

Treatment	No. of hands	No. of fingers
1	4.5	36.2
2	4.4	31.1
3	4.5	34.8
4	5.0	39.3
5	5.1	38.4
6	4.7	42.8
7	4.0	27.8
8	4.4	35.3
9	5.1	36.67
10	4.2	31.08
11	4.3	31.5
12	4.6	33.0
13	5.7	41.9
14	3.9	27.4
15	4.3	33.3
16	4.3	33.7
17	3.8	23.9
CD	0.9	5.1

TABLE 60. GENERAL DETAILS OF THE SECOND CROP OF BANANA

Crop	Banana
Variety	Nendran
Location	Ponchal
Duration	11-12 months
Recommendation	190 : 115 : 300 (g/plant/year)
Date of planting	November '96
Spacing	2.0 m x 2.0 m
Date of fertilizer application	5 December, 1996
Design	RBD
Treatments	17 (1 treatment = 4 plants)
Replication	3
Date of harvest	October 1997 onwards

TABLE 61 INITIAL SOIL FERTILITY STATUS
BEFORE THE SECOND CROP OF BANANA

LOCATION : PONCHAL	
pH	5.4
EC	0.14 dS m^{-1}
Organic Carbon	1.1 per cent
Available N	192.6 mg kg^{-1}
Available P	13.6 mg kg^{-1}
Available K	95.3 mg kg^{-1}

YIELD OF SECOND CROP OF BANANA

The second crop of banana was raised in the farmers' fields at Ponchal and it was altogether different from the first crop in view of an assured water supply all through the growth period and better soil fertility status of the field necessarily enhancing the general yield performance of crop. The highest yield was again recorded from Tr. 1 and Tr. 5 with practically no significant difference between them. Once again these treatments have emphasized the positive and significant contribution of urea formaldehyde in delivering higher yields. Treatments 4, 6 and. 8 though followed Tr. 1 and Tr. 5 with lower yields, there was no significant difference in yield between them and all treatment formulations were equally effective in delivering significantly higher yield. From the second crop of banana, also similar trend as observed in the first crop of banana was noted. The slow release fertilizer formulations envisaged especially in Tr. 4 and Tr. 6 were comparable with treatment 1. Considering the cost of formulation and performance, Tr. 4 and Tr. 6 ought to be popularized over Tr. 1 or Tr. 5. Fertilizer formulations of Tr. 4 and 6 can again be considered as superior sources of fertilizers for banana in view of the cost of application especially when they are compared against Tr. 8 (package of practice), which necessitates six split applications. Seventy five per cent of the doses could render only a lower yield as compared to their corresponding full doses of fertilizers. Control plants recorded only a significantly lower yield when compared to any treatments. The influence of the various fertilizer formulations in specifically enhancing the number of finger and hands in banana bunches were not noticed in the experiment

Summary

The highest yield from the second crop of banana was again recorded from Tr. 1 and. 5 with practically no significant difference between them. Once again these treatments have emphasized the positive and significant influence of urea formaldehyde in delivering higher yields. The performance of fertilizer formulations of treatments like 4, 6, & 8 were equally effective as Tr. 1 & 5, necessarily making treatment formulations of 4 and 6 superior in view of the cost of application especially when they are compared against Tr. 8 (package of practice) which necessitates six split applications. Seventy five per cent of the doses could render only a lower yield as compared to their corresponding full doses of fertilizers. Control plants recorded only a significantly lower yield when compared to any treatments. The influence of the various fertilizer formulations in specifically enhancing the number of finger and hands in banana bunches were not noticed in the experiment

TABLE 62. MEAN BIOMETRIC OBSERVATIONS ON THE SECOND CROP OF BANANA

Treatment	No.of leaves		Girth of seedlings	
		Rank		Rank
1	12.3	2	23.6	13
2	11.7	4	23.7	12
3	12.0	3	24.5	2
4	11.7	4	23.8	11
5	12.7	1	23.1	14
6	12.3	2	24.2	5
7	12.3	2	24.7	1
8	12.3	2	23.8	10
9	12.3	2	24.1	6
10	12.3	2	23.9	8
11	12.0	3	23.9	9
12	11.7	4	24.2	4
13	11.3	5	24.0	7
14	11.7	4	24.1	6
15	12.0	3	24.5	3
16	12.7	1	24.2	5
17	11.7	4	22.3	15
CD	1.35		1.87	

TABLE 63. MEAN YIELD OF THE SECOND CROP OF BANANA, kg / plant

Treatment	Yield	Rank
1	12.2	1
2	11.5	5
3	11.5	5
4	11.8	3
5	12.0	2
6	11.6	4
7	11.3	6
8	11.5	5
9	11.0	7
10	10.2	11
11	10.3	10
12	10.7	8
13	10.7	8
14	10.3	10
15	10.0	12
16	10.6	9
17	7.6	13
CD	0.9	

FIG. 44 MEAN YIELD OF BANANA (SECOND CROP), kg/plant

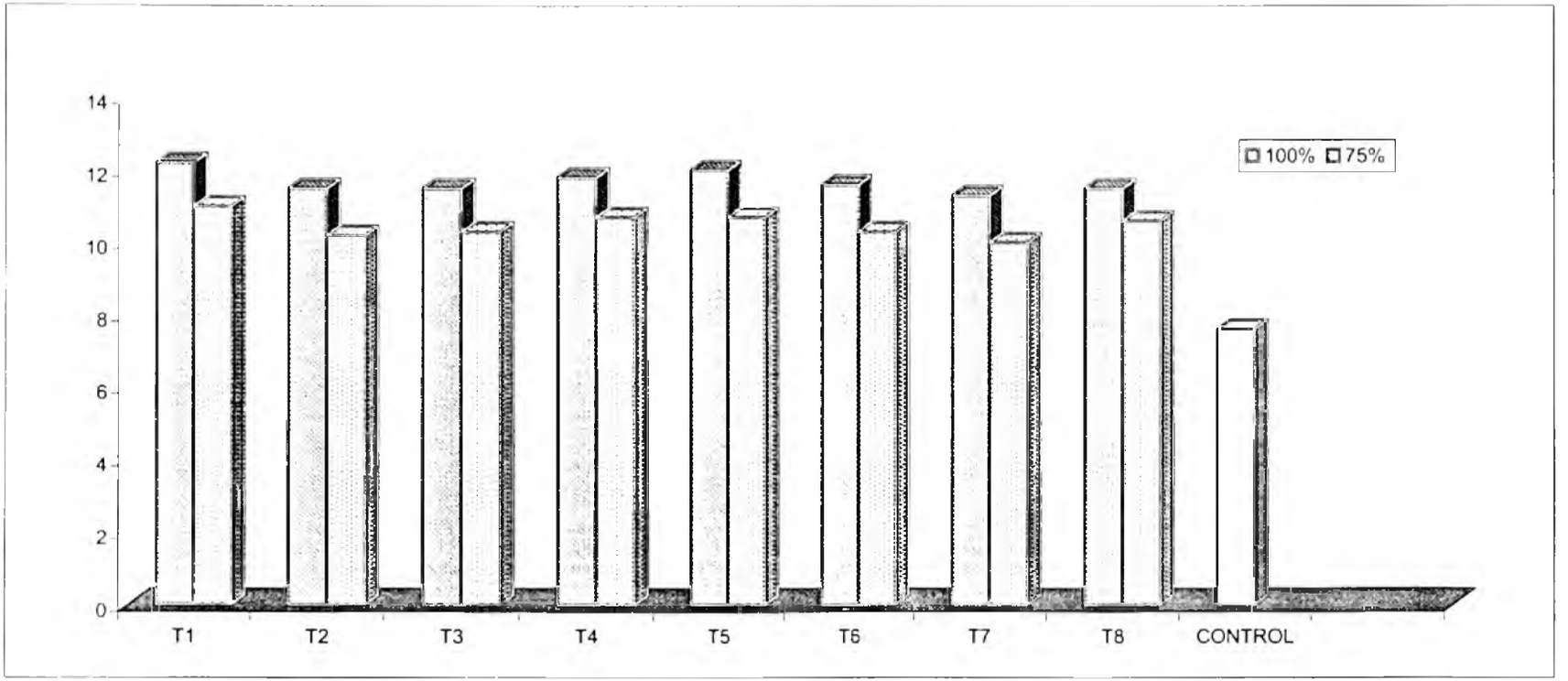


TABLE 64. MEAN YIELD PARAMETERS OF THE SECOND CROP OF BANANA

Treatment	No. of hands	No. of fingers
1	5.5	56.5
2	5.7	61.2
3	5.4	56.2
4	5.6	59.7
5	5.2	56.2
6	5.8	62.0
7	5.8	61.3
8	5.8	60.5
9	5.4	54.7
10	5.6	57.8
11	5.3	53.0
12	5.5	52.2
13	5.5	52.7
14	5.5	52.7
15	5.9	50.0
16	6.0	54.0
17	5.6	42.5
CD	0.5	3.6

TABLE 65. MODIFIED TREATMENTS FOR THE THIRD CROPOF BANANA (SHORTLISTED IN THE THIRD PRC MEETING)

SL. NO	TREAT-MENT	COMPOSITION	NUTRIENT LEVEL %
1	Tr. A (Tr-2)	AS - PGUA – FACTOMPHOS - RP- MOP (GYPSUM & CLAY) - SINGLE APPLICATION	75
2	Tr. A (Tr-2)	AS – PGUA – FACTOMPHOS - RP- MOP (GYPSUM & CLAY) - SINGLE APPLICATION	100
3	Tr. A (Tr-2)	AS – PGUA – FACTOMPHOS - RP- MOP (GYPSUM & CLAY) - SINGLE APPLICATION	125
4	Tr. B (Tr-5)	UF - AS – FACTOMPHOS - RP - MOP - (GYPSUM & CLAY) - SINGLE APPLICATION	75
5	Tr. B (Tr-5)	UF - AS – FACTOMPHOS - RP - MOP - (GYPSUM & CLAY) - SINGLE APPLICATION	100
6	Tr. B (Tr-5)	UF - AS – FACTOMPHOS - RP - MOP - (GYPSUM & CLAY) - SINGLE APPLICATION	125
7	Tr. C (Tr-8)	UREA – FACTOMPHOS - MOP - SPLIT APPLICA-TION*	75
8	Tr. C (Tr-8)	UREA – FACTOMPHOS - MOP - SPLIT APPLICA-TION*	100
9	Tr. C (Tr-8)	UREA – FACTOMPHOS - MOP - SPLIT APPLICATION*	125
10	CONTROL	NO FERTILIZER APPLICATION	NIL

* *DETALS OF SPLIT APPLICATION*

Sl . no.	Details of split application	Net NPK recommendation 190 : 115: 300 g / plant		
		N	P	K
First split	At planting	40	65	60
Second split	1 Month after planting	30	50	60
Third split	2 Months after planting	30	-	60
Fourth split	4 Months after planting	30	-	60
Fifth split	5 Months after planting	30	-	60
Sixth split	Just afer the emergence of the bunch	30	-	-

TABLE 66. GENERAL DETAILS OF THE THIRD CROP OF BANANA

Crop	Banana
Variety	Nendran
Duration	11-12 months
Location	Choolippadam
Recommendation	190 : 115 : 300 (g/plant/annum)
Date of planting	10 November '97
Spacing	2.0 m x 2.0 m
Date of fertilizer application	1 December, 1997
Design	RBD
Treatments	10 (1 treatment = 4 plants)
Replication	3
Date of harvest	October 1998 onwards

TABLE 67 INITIAL SOIL FERTILITY STATUS BEFORE THE THIRD CROP OF BANANA

LOCATION : CHOOLIPPADAM	
pH	5.5
EC	0.24 dS m^{-1}
Organic Carbon	0.98 per cent
Available N	198.7 mg kg^{-1}
Available P	11.5 mg kg^{-1}
Available K	105.2 mg kg^{-1}

YIELD OF THIRD CROP OF BANANA

The third crop of banana was raised in the farmers' fields at choolippadam with selected and modified treatments. The details of the modified technical programme are provided in table 65. Table 68 provides the yield detail of the third crop of banana. The highest yield from the third crop of banana was recorded from Tr. B where100% of the doses had been applied (formerly treatment 5). Neither the enhancement, nor the reduction in fertilizer does to 125 and 75 % respectively from the conventional 100 % doses in certain selected formulation for the third crop of banana had proved any worth. This experiment had proved that 100 % of the doses were sufficient and at higher and lower doses the yield were not positively influenced. Treatment C (at 100% dose, formerly Tr. 8) had given the next lowest yield and this yield was significantly different from Tr. B (at 100 % dose, formerly Tr. 5) thus making Tr. 5 (100 %) the best treatment. However between Tr. C and Tr. A (both at 100 % dose), there was no significant difference. In view of the six split applications envisaged in the treatment C (100%), Tr. A (100 %) would definitely be preferred over Tr. C (100 %) by the fanning community. It may kindly be noted that from the earlier results of banana experiments treatments 5 and 4 were observed to be equally effective in delivering higher yields. In view of the earlier results, it will be worth popularizing the formulations of treatment 4, which incidentally disappeared during the final short listing of treatments. Control plants recorded significantly lower yields when compared to any treatment and its levels. The influence of the various fertilizer formulations in specifically enhancing the number of finger and hands in banana bunches were not noticed in the experiment

Summary

The highest yield from the third crop of banana was recorded from Tr. B (100 %) followed by Tr. C (100 %) with significant difference between them, making Tr. B(100 %) superior to all other treatments. The third highest yielder viz., Tr. A (100 %) was observed to be on par with Tr. C (100 %). Due to obvious advantages, Tr. A (100 %) will find better preference in the field by the farmers. Increasing or decreasing the doses of fertilizers from the normal 100 % has no effect in delivering economic returns. Treatment 4 which was deleted from the final of treatments is worth popularization since it was almost on par with the currently selected best treatment viz., Tr.5 (Tr. B 100 %) in many earlier experiments.

TABLE 68. MEAN YIELD OF BANANA (THIRD CROP), kg/plant

SL.NO.	TREATMENT	NUTRIENT LEVEL %	YIELD	RANK
1	Tr. A (Tr-2)	75	12.3	8
2	Tr. A (Tr-2)	100	14.2	3
3	Tr. A (Tr-2)	125	13.9	5
4	Tr. B (Tr-5)	75	13.2	6
5	Tr. B (Tr-5)	100	14.9	1
6	Tr. B (Tr-5)	125	14.0	4
7	Tr. C (Tr-8)	75	12.5	7
8	Tr. C (Tr-8)	100	14.3	2
9	Tr. C (Tr-8)	125	14.0	4
10.	CONTROL	0	5.9	9
CD			0.5	

FIG. 45 MEAN YIELD OF BANANA (THIRD CROP), kg/plant

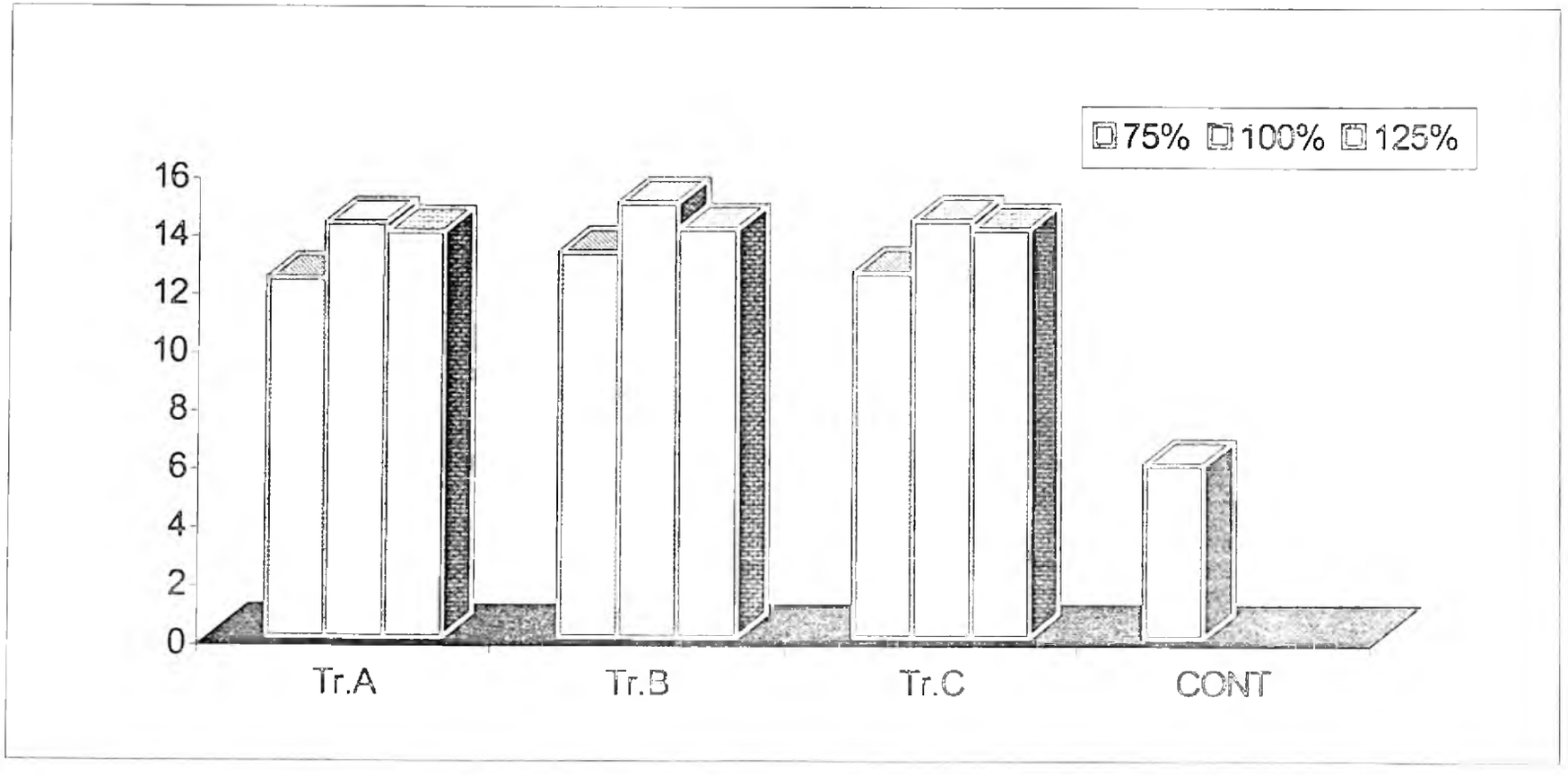


TABLE 69. MEAN YIELD PARAMETERS OF THE THIRD CROP OF BANANA

SL.NO.	TREATMENT	NUTRIENT LEVEL %	No. OF HANDS	NO. OF FINGERS
1	Tr. A (Tr-2)	75	5.6	60.2
2	Tr. A (Tr-2)	100	6.6	61.7
3	Tr. A (Tr-2)	125	5.9	64.6
4	Tr. B (Tr-5)	75	5.8	63.4
5	Tr. B (Tr-5)	100	6.1	65.8
6	Tr. B (Tr-5)	125	6.3	65.1
7	Tr. C (Tr-8)	75	6.3	62.5
8	Tr. C (Tr-8)	100	6.2	63.4
9	Tr. C (Tr-8)	125	6.4	64.3
10	CONTROL	NIL	4.0	30.4
CD			0.5	1.8

TABLE 70. EVALUATION OF SLOW RELEASE FERTILIZERS
INITIAL TECHNICAL PROGRAMME FOR COCONUT

Tr.	Formulation	Treatment particulars
1	Tablet	Urea formaldehyde, Factomphos, Ammonium sulphate,Rock phosphate & MOP (filler- gypsum & binder- clay)
2	Tablet	Urea gypsum adduct, Factomphos, Ammonium sulphate, Rock phosphate & MOP (filler- gypsum & binder- clay)
3	Mixture	Urea gypsum adduct, Factomphos, Ammonium sulphate, Rock phosphate & MOP (binder- clay)
4	Mixture	Urea, Factomphos coated with coaltar & MOP
5	Tablet	Urea formaldehyde (proportion different from Tr. 1), Factomphos, Ammonium sulphate, Rock phosphate & MOP (filler- gypsum & binder- clay)
6	Tablet	Factomphos, Ammonium sulphate, Rock phosphate & MOP(filler- gypsum & binder- clay)
7	Mixture	Single application of straight fertilizers at the full recommended dose
8	Mixture	Split application of the recommended dose as per the POP of KAU
9 - 16	Similar to Tr.1-8 except that the total NPK supplied will be at 75% of the recommended doses	
17	Absolute control with out any NPK fertilizers	

TABLE 71. GENERAL DETAILS OF THE COCONUT SEEDLINGS

Crop	Coconut
Variety	West-Coast Tall
Location	Alppara
Duration	Perennial crop
Recommendation	1.0 : 0.5 : 2.0 (kg/palm/year) First year 1/3 dose Second year 2/3 dose Third year onwards full dose
Date of planting	21 June 1996
Spacing	7.9 m x 7.9 m
Design	RBD
Treatments	17
Replication	3
Date of fertilizer application	
First year Second year Third year	August 1996 September 1997 December 1998

TABLE 72. INITIAL SOIL FERTILITY STATUS OF COCONUT GARDEN

Basic data on the physico-chemical properties of soil	
pH	5.5
EC	0.18 dS m^{-1}
Organic Carbon	0.98%
Mechanical composition of soil	
Coarse sand	33.1%
Fine sand	25.9%
Silt	20.8%
Clay	10.5%
Texture	Sandy loam
Available nutrient status in soil	
N	194.7 mg kg^{-1}
P	14.6 mg kg^{-1}
K	128.9 mg kg^{-1}

EXPERIMENTS WITH SLOW RELEASE FERTILIZERS ON COCONUT SEEDLINGS (FIRST YEAR)

West coast tall variety of coconut seedlings with uniform age (one year old with 4-5 leaf stage) and with uniform girth were selected from the Central nursery of the KAU, and were planted in the farmers field at Alpara during June 1996. In order to ensure the proper uptake of nutrients by the seedling, fertilizer were applied only one month after planting. Pre calculated quantities of fertilizers were applied through different formulation to deliver 1/3 of the full dose during the first year of growth.

The effect of fertilizers on the growth of coconut seedlings were monitored through two parameters viz., production of new leaves and enhancement of the girth of coconut seedling especially at the collar region. The first biometric observation on the number of leaves and the girth of seedlings were made during Septemberber1996, one month after the fertiliser addition. In majority of the treatments, the response was quite uniform as more or less same number of new leaves were produced and the increase in girth of seedlings were proportionate. However, the production of new leaves observed in seedlings where treatments 1 and 2 have been applied were marginally higher over the others. During this observation not much of significance to the effect of fertiliser application nor the effect of formulations were evident in any treatment, as it might further require a few more months to express the real effect of individual formulations.

Over a period of one year, on stabilization of growth, the effect of various formulations on the biometric observations became very distinct and from September onwards, treatment 1 where urea formaldehyde had been applied showed remarkable enhancement in the production of new leaves and girth. Though there had been enhancement in the number of leaves and girth in many treatments, most of them were observed to be statistically on par. The prominent treatments among them were 2, 3, 4, 5, 6, and 8. The effect of control plants became conspicuous only towards the end of the first year. The effect of reduction of fertilizer doses to 75 % were very much marked on the seedlings by an apparently visible decrease in both the parameters studied.

TABLE 73. MEAN BIOMETRIC OBSERVATION ON COCONUT SEEDLINGS DURING SEPTEMBER 1996

Treatment	Leaf No.	Rank	Girth, cm	Rank
1	6.7	1	12.0	9
2	6.7	1	13.7	4
3	6.3	2	15.0	2
4	6.0	3	12.7	7
5	6.7	1	14.0	3
6	5.7	4	12.7	7
7	6.3	2	15.0	2
8	5.3	5	13.3	5
9	5.3	5	13.7	4
10	5.7	4	13.3	5
11	5.3	5	14.0	3
12	5.7	4	17.0	1
13	5.3	5	13.3	5
14	5.0	6	12.7	7
15	5.7	4	13.0	6
16	5.0	6	12.3	8
17	5.0	6	10.3	10
CD	1.4		2.9	

TABLE 74. MEAN BIOMETRIC OBSERVATION ON COCONUT SEEDLINGS DURING FEBRUARY 1997

Treatment	Leaf No.	Rank	Girth, cm	Rank
1	8.3	2	19.3	7
2	8.7	1	21.7	3
3	8.3	2	22.0	2
4	8.3	2	19.3	7
5	8.7	1	20.0	6
6	7.7	4	19.0	8
7	8.7	1	22.0	2
8	7.3	5	20.0	6
9	7.7	4	20.7	5
10	8.0	3	20.7	5
11	7.3	5	20.0	6
12	8.0	3	25.0	1
13	7.7	4	20.0	6
14	7.3	5	19.0	8
15	8.3	2	21.3	4
16	8.0	3	19.3	7
17	7.0	6	12.0	9
CD	1.4		3.8	

TABLE 75. MEAN BIOMETRIC OBSERVATIONS ON COCONUT SEEDLINGS DURING MAY 1997

Treatment	No. of leaves	Rank	Girth of seedlings, cm	Rank
1	6.7	7	26.3	10
2	6.7	7	29.0	3
3	7.3	5	27.3	8
4	7.3	5	28.7	4
5	8.3	2	28.0	6
6	6.3	8	25.7	12
7	6.3	8	32.7	2
8	7.0	6	27.3	8
9	6.7	7	27.7	7
10	6.7	7	27.0	9
11	8.0	3	26.3	10
12	8.7	1	35.3	1
13	8.0	3	26.0	11
14	7.0	6	27.7	7
15	8.0	3	28.3	5
16	7.7	4	27.3	8
17	7.0	6	19.0	13
CD	2.3		7.3	

TABLE 76. MEAN BIOMETRIC OBSERVATIONS ON COCONUT SEEDLINGS DURING SEPTEMBER 1997

Treatment	No. of leaves	Rank	Girth of seedlings, cm	Rank
1	8.7	1	43.7	1
2	8.3	2	42.7	3
3	8.3	2	42.0	4
4	8.0	3	41.0	5
5	8.3	2	43.3	2
6	8.0	3	41.0	5
7	7.3	5	34.0	10
8	8.0	3	39.3	6
9	6.7	6	41.0	5
10	6.7	6	39.3	6
11	7.7	4	38.3	7
12	7.7	4	38.3	7
13	7.7	4	37.3	8
14	6.3	7	37.0	9
15	6.7	6	32.3	11
16	7.3	5	39.3	6
17	6.3	7	25.7	12
CD	1.3		11.6	

EXPERIMENTS WITH SLOW RELEASE FERTILIZERS ON COCONUT SEEDLINGS (SECOND AND THIRD YEAR)

The second year growth of seedlings were much prominent than the previous years growth. Treatments receiving 100% and 75% of the doses showed marked difference in growth characters. Coconut seedlings receiving treatments 1 and 5 continued to show higher values for the observed parameters with no significant difference between them. The mean biometric observations recorded from treatments 2, 3, 4, 5, 6, and 8 though different from one another, were comparable with that of Tr. 1 as there was no statistical difference between any of them. Thus majority of the treatments which received 100% of doses were as effective as one another. However the ease of handling slow release fertiliser mixtures and tablets over the normal straight fertilisers which need to be applied in splits, were observed as a positive aspect in reducing the application cost. Towards the end of the second year, the specific and supreme effect of treatment 1 and 5 Over others, became apparent on the seedlings. Many treatments which remained statistically on par with Tr. 1 were relegated to lower positions, making majority of them different from one another, thus projecting the influence of various formulations on the expression of growth parameters.During the third year of growth also, treatments 1 and 5 continued to maintain its supremacy over the others with significant difference between them. Though the normal package of practice (Tr.8) was relegated to lower ranks in terms of its response to growth parameters, the same is comparable with majority of the slow release formulations, but definitely not with treatment 1.

Summary

Treatment 1 is adjudged as the best slow release material for a perennial crop like coconut. Lowering the concentration of urea formaldehyde in treatment 5, has made it comparable with other formulations with the result treatments 2, 3, 4 and 8 are comparable with treatment 5. Slow release fertiliser formulation has the advantage of one time application, while the conventional straight fertilisers have to be applied in splits which will have its own impact in reducing the cultivation and management cost. Lowering the dose of fertiliser to 75% cannot be taken as positive step in incresing the fertiliser efficiency.

TABLE 77. MEAN BIOMETRIC OBSERVATION ON COCONUT SEEDLINGS DURING JANUARY 1998

Treatment	Leaf No.	Rank	Girth, cm	Rank
1	9.7	1	56.0	1
2	8.7	3	52.0	3
3	8.7	3	51.3	4
4	8.3	4	48.7	6
5	9.0	2	53.7	2
6	8.7	3	51.3	4
7	7.7	5	41.3	12
8	8.7	3	47.0	7
9	7.7	5	49.7	5
10	7.3	6	44.0	10
11	8.3	4	40.7	13
12	7.7	5	49.7	5
13	8.7	3	45.0	9
14	7.0	7	42.3	11
15	7.3	6	41.3	12
16	8.3	4	42.3	11
17	6.7	8	13.7	13
CD	1.4		14.6	

TABLE 78. MEAN BIOMETRIC OBSERVATIONS ON COCONUT SEEDLINGS DURING JUNE 1998

Treatment	No. of leaves	Rank	Girth of seedlings, cm	Rank
1	8.3	1	93.7	1
2	7.0	5	78.3	3
3	7.0	5	78.0	4
4	6.3	8	71.7	7
5	8.0	2	83.3	2
6	7.3	4	74.7	6
7	7.0	5	60.3	12
8	7.7	3	76.3	5
9	6.6	7	58.0	13
10	7.0	5	62.0	11
11	7.0	5	64.0	9
12	7.3	4	63.0	10
13	7.3	4	58.3	13
14	7.0	5	68.3	8
15	7.0	5	53.3	14
16	6.7	6	62.0	11
17	5.3	9	50.0	15
CD	0.8		8.0	

TABLE 79. MEAN BIOMETRIC OBSERVATIONS ON COCONUT SEEDLINGS DURING DECEBER 1998

Treatment	No. of leaves	Rank	Girth of seedlings, cm	Rank
1	8.9	1	96.4	1
2	8.0	3	80.1	4
3	7.8	4	82.0	3
4	7.5	7	74.3	7
5	8.4	2	85.9	2
6	8.0	3	78.1	6
7	7.2	9	61.6	13
8	8.0	3	79.5	5
9	6.5	11	60.1	14
10	7.7	5	64.6	12
11	7.5	7	65.3	9
12	7.5	7	65.0	10
13	7.6	6	60.1	14
14	7.6	6	70.9	8
15	7.4	8	56.0	15
16	6.8	10	64.9	11
17	5.9	12	51.4	16
CD	0.9		6.9	

TABLE 80. MEAN BIOMETRIC OBSERVATIONS ON COCONUT SEEDLINGS DURING MARCH 1999

Treatment	No. of leaves	Rank	Girth of seedlings, cm	Rank
1	10.0	1	99.7	1
2	8.0	4	82.0	4
3	8.0	4	84.0	3
4	7.3	7	76.7	7
5	8.6	2	88.0	2
6	7.6	6	79.6	6
7	7.0	8	63.7	12
8	8.3	3	81.0	5
9	6.3	10	62.0	14
10	8.0	4	67.0	10
11	8.0	4	68.7	9
12	7.6	6	67.0	10
13	8.0	4	62.7	13
14	7.7	5	73.0	8
15	6.7	9	57.3	15
16	7.0	8	66.3	11
17	6.0	11	53.0	16
CD	1.2		8.7	

SUMMARY AND CONCLUSION

Collaborative Research Project on the Evaluation of Slow Release Fertilizers for the Important Crops of Kerala was entrusted with Kerala Agricultural University in 1995 by the R&D Division of FACT. In order to fulfill the objectives of the project, six crops of paddy and three crops of banana were raised under different locations, together with three years of observation on coconut seedling in the farmers field at Alpara. The different formulations were applied as per the technical programme and the results are concluded below:

RICE

Slow release fertilizer formulations could not ensure sustained yield in paddy under acidic and waterlogged conditions .The low content of clay , poor CEC, poor base saturation and the acidic pH of the soil might have contributed much for the observed inconsistency in yield from different locations. The application of spike form of fertilizer formulation was difficult. Yellowing of paddy was noticed invariably in all fields immediately after placement of spike form of fertilizers. However, in the application of mixtures this problem of yellowing was not noticed. The yields obtained form the different slow release formulations were comparable with the package of practices of the University. There are considerable savings in the labour cost on account of a single basal application of mixtures over the conventional split application of straight fertilizers. This will offset the cost of cultivation to a great extent. Treatment 4 and 5 were observed to be best and comparable with the treatments, which provided maximum yield. The effect of slow release fertilizers on plant growth and yield will not be prominent in the first crop season on account of the flooding in paddy fields consequent to incessant rains. The second crop season is likely to give better response to slow release fertilizers in view of the efficient management of water resources. The residual effect of these slow release fertilizers was not much available in soils although the same from Tr. 1 where urea formaldehyde was incorporated was higher. The grain yield from all the experiments were comparatively lesser than the straw yields. Reduction in fertilizer doses to 75% had only decrease the yield of both grain and straw. Control plots recorded the lowest yield in all the experiments making all treatments and doses significantly superior to it.

BANANA

Three crops of banana were raised at three different locations to test the different formulations. From all the experiments, it was clear that wherever urea formaldehyde component has been incorporated into the formulation, the yields were higher indicating the positive influence of this chemical in enhancing the yield. Package of practices of the University was observed to be on par with most of the treatments. However, the slow release fertilizer formulations for banana has innate advantages over the normal package of practice, where six-split applications of fertilizers are necessitated. This points out to an important fact that application of slow release fertilizer will definitely decrease the cost of cultivation of banana without compromising on the yield. Application of tablets and mixtures had not posed any problems on growth of banana. In earlier experiments with banana, mixtures especially Tr. 4, was observed to be on par with treatment 5 which was considered to be one of the best. However, after the short listing of the treatments for the third crop of banana, Tr. 4 was deleted. Later in the third crop of banana, it was observed that Tr. 5 had given the highest yield. Application of both higher (125%) and lower dose (75%) of fertilizers resulted in lowering the yield of yield of banana. As long as efficiency of some slow release formulations remains on par, their market cost will decide the popularity among farmers.

COCONUT

Uniformly coconut seedlings were selected and planted at the farmers' field at Alppara in order to evaluate the efficiency of different fertilizer formulations. The influence of fertilizers were not apparently evident during the first year, as growth remained uniform in all plants. But towards the end of the second year, the specific influence of Tr. 1 and 5 were pronounced on seedlings. Though Tr. 1 & Tr. 5 had a different composition of urea formaldehyde, its influence on the biometric observation was not significantly apparent. During the third of growth, the influence of treatment 1 over the rest, were much pronounced and this treatment was adjudged as the best one. The influence of Package of Practices of the university was observed to be inferior to Tr. 1 in the third year though the difference remained only marginal. The advantage of one time application of slow release fertilizers is likely to tip the farmers over the normal conventional straight fertilizers which necessitates split application to ensure fertilizer efficiency.