CHAPTER IV

RESULTS

4.1 Field observation and farmer interview

Among 20 interviewed soybean farmers, eight of them live in Chamkaar Andong village, while 7 and 5 are from village No.2 and No.11 respectively. Most of interviewed farmers were the labors of the rubber tree plantations. These farmers rent a part of the field in the rubber tree plantations which the old rubber trees were cut down and the new rubber tree seedlings have been transplanted for cultivation of soybean. These soybean fields are all rainfed. The cost of the land rent varied with the number of years after the rubber trees being cut down. It cost 400 US$/ ha/ year for the area which the rubber trees were cut down for one year and decreased 100 US$/ ha/ year in each of subsequent year. Soybean plants were cultivated between the rows of the young rubber trees without application of chemical fertilizers. All fields have never been inoculated with root nodule bacteria. Among 20 interviewed farmers, only 5 of them used insecticide spraying for controlling of soybean leaf rollers. However, they did not know the name of insecticide used because the sprayed chemicals were prepared by insecticide traders. Soil preparation and seed harvest in all fields of interviewed farmers were done by machine. The normal time for soybean seed sowing in Chamkaar Andong started from middle of June to the end of July. After harvest, soybean residues from each farmer's field were left in soybean cultivated field until the next soybean growing season. There were two types of soybean used by interviewed farmers, early and intermediate maturity types which

takes about 65–85 days and 85–120 days from seed sowing to harvest respectively. Though intermediate maturity soybean varieties were used by some interviewed farmers but harvest at 85 DAS in which some of the pods remained green seemed to be common in order to avoid seed damage by rain. Surprisingly, none of the interviewed farmers could tell the name of the soybean variety that they used. The farmers kept their own soybean seeds for the next growing season. One system of soybean seed storage used by the farmers was keeping the bag of soybean seeds in 200 liters metal cylinder (normal used for gasoline) containing rice hush as moisture absorbent material. The price of soybean seeds sold by the farmers depended on the quality of the seeds. The poor quality with a lot of damage seeds could be sold at least 300 US$ per ton while the better quality were about 400-500 US$ per ton. The farmers used the areas in rubber trees plantation for soybean cultivation for 4 years after the old rubber tree were cut down. After the fourth year, seed yield of soybean was low. Reduction of soil fertility after 4 years under soybean cultivation was one of the yield limiting factor considered by the interviewed farmers.

The data on farm size, land use history, seed yield and types of cultivated soybean of the interviewed farmers were shown in Table 2. Fifty five percent of the total number of interviewed farmers grew soybean in rubber tree plantations in the first year after the trees were cut down while 35 and 10 percent grew soybean for two and three years respectively. Only one farmer grew soybean in the rubber tree plantation for 4 years. About 64% of the farmers who grew soybean in the studied area in the first year had farm size about 4–8 ha while those with farm size about 1–3 ha and 9–15 ha were about 18%.

Table 2. Farm size, land use history type of cultivated soybean and seed yield of interviewed farmers

data	number of year under soybean cultivation				
	1	2	3	4	
Farm size	no. of farmers				total no.
1 – 3	2	4	2	0	8
4 – 8	7	3	0	0	10
9 – 15	2	0	0	1*	2
	11 (55%)	7 (35%)	2 (10%)		20 (100%)
	no. of farmers				total no.
types of cultivated soybean:					
early variety	6	3	1		12 (60%)
intermediate variety	5	2	1	1*	8 (40%)
average seed yield (T/ha)	1.91	1.81	1.50	1.30	

* This farmers had two fields, one under the fist year of soybean, the other under forth year.

In the fields which were used for soybean cultivation for 2 years about 57% of the farmers had farm size about 1–3 ha and 42% had farm size about 4–8 ha. Only two farmers grew soybean in the rubber tree plantations for 3 years and they had farm size about 1–3 ha. There was one farmer who grew soybean in two fields with different land use history. One of his soybean field with the area about 13 hectars was used for soybean cultivation for 4 years.

In general, early maturity type of soybean was more preferable by the interviewed farmers (60%) than the intermediate type (40%). The average seed yield

of soybean of interviewed farmers were as follow: 1.91 T/ha for the first year-group, 1.81 T/ha for the two years-group, 1.50 T/ha for the three years-group and 1.30 T/ha for the four year-group.

At the time in which field observation and farmer interview were conducted (October, 2008), soybean plants cultivated in most of soybean fields in the studied areas were already harvested thus only some fields cultivated with intermediate maturity type soybean could be observed for nodulation. It was found that, through the fields were not inoculated but soybean plants could form nodules.

4.2 Isolation of root nodule bacteria from Cambodia soil

From field observation, soybean plants cultivated in the farmers fields at Chamkaar Andong and Chamkaar Leu (Table 3) could form nodules even the site where soybean was cultivated in the first year. Since all fields have not been inoculated, nodule formation indicating the occurrence of native of root nodule bacteria which are able to infect soybean host plants. The data from farmers' interview indicated that after the old rubber trees were cut down and the areas between the rows of the new rubber transplanted seedlings were used for soybean cultivation, the yield of soybean in subsequent years decreased. The interviewed farmers thought that reduction of plant nutrients in the soil was the factor involved with decrease of soybean seed yield in the following year after the rubber trees were cut down. However, soil analysis data showed that there were no differences of soil pH, available P, exchangeable K, and soil organic matter among the soils with different soybean cultivated periods suggesting that soil quality might not be yield limiting factor but shading by the grown up rubber trees seemed to be the possible factor involving with yield reduction of soybean. Existing of native root nodule

bacteria even in the site where soybean was cultivated for the first year supporting that soybean cultivated in the rubber tree plantation could fix atmospheric nitrogen.

Table 3. Origin of collected root nodule bacterial isolates from Chamkaar Andong and Chamkaar Leu in Kampong Cham Province, Cambodia

isolate no	isolate code	soybean variety	location	no. of year under soybean	type of land
1	CD_1YD1	Yellow Dark	Chamkaar	1 year	Rubber
2	CD_1YD4	-	Andong		Tree
3	CD_1YD5	-			Plantation
4	CD_1YD8	-			(RTP)
5	CD_1YD10	-			
6	CL_3B1	B3039	Chamkaar	3 years	Agronomy
7	CL_3B3	-	Leu		Field
8	CL_3B5	-			
9	CL_3B8	-			
10	CL_4HK1	Hung Kry	Chamkaar	4 years	RTP
11	CL_4HK3	-	Leu		
12	CL_4HK7	-			
13	CL_4HK8	-			
14	CD_2P	Purple	Chamkaar Andong	2 years	RTP

From this research, a variation among different Cambodian root nodule bacterial isolates from different soybean trap hosts on the infectiveness abilities and N_2 fixation were observed from the control room experiment (Table 4).

Table 4. Effect* of native soybean root nodule bacterial isolates from Cambodia on nodule dry weight (NDW), total biomass and N-uptake of the whole plant of DT 84 soybean variety at one month after inoculation

rhizobium	nodule dry weight (g/plant)		total plant dry weight (g/plant)		N-uptake (gN/plant)		effectiveness index
CD_2P	0.024	gh#	0.686	ef#	0.0219	fg#	22.64
CL_4HK1	0.036	efg	0.776	ef	0.0245	efg	27.55
CL_4HK3	0.044	defg	0.938	def	0.0332	cdef	43.96
CL_4HK7	0.056	bcdef	1.048	cdef	0.0342	cdef	45.85
CL_4HK8	0.046	defg	1.034	cdef	0.0338	cdef	45.09
CL_3B1	0.078	bc	1.164	bcde	0.0391	cde	55.09
CL_3B3	0.054	cdefg	0.918	def	0.0331	cdef	43.77
CL_3B5	0.026	fgh	0.65	f	0.0223	fg	23.40
CL_3B8	0.078	bc	1.302	bcd	0.0386	cde	54.15
CD_1YD1	0.068	bcd	1.014	cdef	0.0318	def	41.32
CD_1YD4	0.064	bcde	1.28	bcd	0.0467	bcd	69.43
CD_1YD5	0.114	a	1.562	b	0.044	bcd	64.34
CD_1YD8	0.086	ab	1.662	ab	0.0557	ab	86.42
CD_1YD10	0.066	bcde	1.446	bc	0.0475	abc	70.94
NO_3	0	h	2.078	a	0.0629	a	
Control	0	h	0.6346	f	0.0009	g	

*Means of 5 replications
#Means in the same columns followed by the same letters do not differ significantly by LSD at 0.05

Table 5. Colony and cell morphologie of collected native soybean root nodule bacteria from Cambodia

isolate code	colony formation on YMA (days)	color change in YMA with BTB[1]	gram strain	cell shape
CD_1YD1	5	no change	negative	rod
CD_1YD4	3	yellow	-	-
CD_1YD5	5	no change	-	-
CD_1YD8	2	yellow	-	-
CD_1YD10	5	no change	-	-
CL_3B1	2	yellow	-	-
CL_3B3	3	yellow	-	-
CL_3B5	5	no change	-	-
CL_3B8	5	blue	-	-
CL_4HK1	3	yellow	-	-
CL_4HK3	5	no change	-	-
CL_4HK7	2	yellow	-	-
CL_4HK8	5	no change	-	-
CD_2P	2	yellow	-	-

BTB[1] : brom thymol blue

4.3 Pot experiments

4.3.1 V_6 stage

At V_6 stage, DT 84 soybean plant from U treatment had SDW, RDW, NDW and TDW about 1.413, 0.543, 0.005 and 1.961 g/plant respectively and had shoot N uptake about 0.0346 gN/plant (Table 6). Inoculation of each root nodule bacterial isolate/strain resulted in increasing of NDW within the range of 140–285% over that of U treatment and only one treatment (Th7) was not different significantly from U

treatment. Though Th7 Bradyrhizobial inoculation could not improve significantly NDW of DT 84 soybean at V_6 stage but this Bradyrhizobial strain did not from the rest root nodule bacteria for the effect on NDW except CL_4HK7 which showed the best performance among single root nodule bacterial inoculated treatments, no significant differences of NDW at V_6 stage among native root nodule bacterial treatments were also found. In single EA inoculated treatment, DT 84 soybean plant had about 198% more NDW at this growth stage than that of U treatment though the differences of NDW between EA and U treatments was not significant. When NDW of single EA inoculated treatment were compared which those of root nodule bacterial inoculated ones, it was found that only that of CL_4HK7 was significantly higher than EA treatment. When the effect of each single root nodule bacterial inoculated treatment were compared with coinoculation with EA, it was found that there was no significant difference of NDW between single inoculation of each root nodule bacterial isolate/strain and coinoculation with EA.

Regarding to SDW, RDW and TDW, it was found that two native isolates root nodule bacteria from Cambodia. CD_2P and CL_4HK7 were significantly effective for improvement of those three growth parameters compared to U treatment while Th7 Bradyrhizobial strain was effective only for improvement of RDW. Single inoculation of EA was also effective to significant improvement of SDW, NDW and TDW and this treatment was the only treatment which could improve significantly shoot N uptake. None of coinoculated treatments were significantly better than single inoculation except one case, CD_2P + EA treatment which showed synergistic effects on RDW, NDW and TDW at V_6 stage. At 46 DAS or $R_{3.5}$ stage, DT 84 soybean plant from U treatment had average nodule dry weight about 0.024 g/plant (Table 6) which

was about 2.6 times of nodule dry weight at V_6 stage. Increasing of nodule mass of soybean plants in the other treatments were observed also as compared to the early stage even though the degree of mass increasing were rather less than that of U treatment.

Table 6. Effects* of endophytic actinomycetes and root nodule bacterial inoculation of shoot (SDW), root (RDW), nodule (NDW), total plant dry weight (TDW) g/plant and shoot N uptake of Cambodia soybean DT 84 variety at V_6 stage

treatment	SDW (g/plant)	RDW (g/plant)	NDW (g/plant)	TDW (g/plant)	N-uptake (gN/plant)
U	1.4127 c (100)	0.5433 de (100)	0.0052 f (100)	1.9612 ef (1.9612)	0.0346 b (100)
CD_2P	1.7073 ab (121)	0.636 c (117)	0.02 bcde (385)	2.3633 bcd (2.3633)	0.0415 ab (120)
CL_4HK7	1.726 ab (122)	0.6713 abc (124)	0.0275 abc (529)	2.4249 abc (2.4249)	0.041 ab (119)
CL_3B1	1.302 c (92)	0.5227 e (96)	0.0178 cde (342)	1.8425 f (1.8425)	0.0367 ab (106)
CD_1YD8	1.4833 bc (105)	0.616 cd (113)	0.0169 cde (325)	2.1163 cdef (2.1163)	0.0437 ab (126)
Th7	1.5087 bc (107)	0.6587 bc (121)	0.0125 ef (240)	2.1798 cde (2.1798)	0.0437 ab (126)
EA	1.706 ab (121)	0.6293 c (116)	0.0155 def (298)	2.3508 bcd (2.3508)	0.0444 a (128)
CD_2P + EA	1.9367 a (137)	0.7414 a (136)	0.0323 a (621)	2.7103 a (2.7103)	0.0457 a (132)
CL_4HK7 + EA	1.7887 a (127)	0.728 ab (134)	0.0309 ab (594)	2.5476 ab (2.5476)	0.0447 a (129)
CL_3B1 + EA	1.5153 bc (107)	0.624 c (115)	0.0249 abcd (479)	2.1643 cde (2.1643)	0.035 b (101)
CD_1YD8 + EA	1.386 c (98)	0.602 cd (111)	0.0196 cde (377)	2.0076 ef (2.0076)	0.0365 ab (106)
Th7 + EA	1.4193 c (101)	0.64 c (118)	0.0123 ef (236)	2.0717 def (2.0717)	0.0444 a (128)
CV%	**12.55**	**9.63**	**44.21**	**11.14**	**17.85**

* means of five replications

* means in the same column follow by the different letters differs significantly by LSD 0.05

Table 7. Effects* of endophytic actinomycetes and root nodule bacterial of shoot, root, nodule dry weight (g/plant) of Cambodia soybean DT 84 variety at $R_{3.5}$ stage

treatment	SDW (g/plant)		RDW (g/plant)		NDW (g/plant)		TDW (g/plant)	
U	2.2967	c (100)	0.8113	e (100)	0.024	b (100)	3.132	c (3.132)
CD_2P	3.288	b (143)	1.084	d (134)	0.0667	ab (278)	4.4387	b (4.4367)
CL_4HK7	3.868	ab (168)	1.302	abcd (161)	0.0944	a (393)	5.2645	ab (5.2645)
CL_3B1	3.4853	ab (152)	1.244	bcd (153)	0.0736	a (307)	4.8029	ab (4.5029)
CD_1YD8	3.5447	ab (154)	1.0987	d (135)	0.0958	a (399)	4.7392	ab (4.7392)
Th7	3.796	ab (165)	1.1367	d (140)	0.0824	a (343)	5.0151	ab (5.0151)
EA	3.4127	ab (149)	1.1687	cd (144)	0.0669	ab (279)	4.6482	b (4.6482)
CD_2P + EA	4.046	a (176)	1.3913	abc (172)	0.0895	a (373)	5.5268	a (5.5268)
CL_4HK7 + EA	3.9627	a (173)	1.4773	a (182)	0.0974	a (406)	5.5374	a (5.5374)
CL_3B1 + EA	3.698	ab (161)	1.454	ab (179)	0.0936	a (390)	5.2456	ab (5.2456)
CD_1YD8 + EA	3.614	ab (157)	1.2793	abcd (158)	0.0624	ab (260)	4.9558	ab (4.9558)
Th7 + EA	3.662	ab (159)	1.2853	abcd (158)	0.059	ab (245)	5.0063	ab (5.0063)
CV%	**14.41**		**14.79**		**51.07**		**14.04**	

* means of five replications
* means in the same column follow by the different letters differs significantly by LSD 0.05

Surprisingly, soybean plant from EA + N treatment did not show any development at $R_{3.5}$ stage compared to that at V_6 stage. Soybean plants from all single root nodule bacterial treatment included single inoculation of EA had more nodule dry weight about 2.8–3.9 times that of U treatment. There was no significant differences of nodule dry weight among all single microbial inoculated treatments but only 4 root nodule bacterial inoculated treatments CL_4HK7, CL_3B1, CD_1YD8 and Th7 were significantly better than the control (U). The significant differences of nodule dry weight between single and EA coinoculated treatments for each root nodule bacteria did not observed at $R_{3.5}$ stage however some combinations (EA + CD_2P, EA + CL_3B1) seemed to have synergistic trend which negative trend was observed in EA + Th7 treatment.

4.3.2 $R_{3.5}$ stage

At $R_{3.5}$ stage, the beneficial effects of microbial inoculated treatments on root dry weight improvement of DT 84 soybean could be observed more clearly than the early stage. There were no significant differences of root dry weight of DT 84 soybean at $R_{3.5}$ stage among single microbial inoculated treatments and all could increase root dry weight which the range of 33–60% over that of U treatment with CL_4HK7 as the best (60%) followed by CL_3B1 (53%). Among coinoculated treatments, only one combination (CD_2P + EA) showed significant synergistic effects on root dry weight of DT 84 soybean at $R_{3.5}$ stage compared to single inoculated of each microbial partner. In CD_2P + EA, root dry weight of DT 84 soybean increased about 71 of that from uninoculated control plant while root dry weight increment by single inoculation of CD_2P and EA treatments were about 33.35 and 44% respectively.

Regarding to shoot dry weight of DT 84 soybean at $R_{3.5}$ stage, it was found that the plant from uninoculated control treatment had shoot biomass about 2.3 g/plant (Table 7). All single microbial inoculated treatments were effective to increase significantly shoot dry weight of this soybean variety at this growth stage within the range of 43-65% over that of the control. There were no significant differences of shoot dry weight at $R_{3.5}$ stage among single microbial inoculated treatments. Among coinoculated treatments, all except Th7 + EA seemed to have synergistic effect to improve shoot dry weight particularly CD_2P + EA which showed significant synergistic effect compared to single inoculation of CD_2P. Shoot dry weight from CD_2P + EA treatment was 76% of CD_2P + EA that from uninoculated control plant while those from CD_2P and EA were about 43 and 49% respectively. At $R_{3.5}$ stage,

shoot N uptake (Table 8) of the control plant was about 0.0617 gN/plant. Th7 inoculated treatment was the best treatment in term of the effect for N uptake improvement (43%) of DT 84 soybean compared to uninoculated control. All single Cambodian root nodule bacterial inoculated treatments could increase shoot N uptake within the range of 17–29% of that from U treatment but the differences of shoot N uptake between each of single inoculation of these root nodule bacteria and control or Th7 inoculated treatment was not significant. Significant beneficial effect of combined usage of EA with each of root nodule bacterial inoculation on N uptake of shoot of DT 84 soybean at $R_{3.5}$ stage were not found compared to single inoculated treatment.

Based on relative ureide indices (RUI), at $R_{3.5}$ stage (Table 8) it was found that DT 84 soybean plant from U treatment had low N_2 fixing activity with RUI value only 18%. Among single microbial inoculated treatments, CD_1YD8 treatment had the highest RUI value (77%) while CD_2P treatment has the lowest RUI (61%). All single microbial inoculated treatment resulted in significant improvement of RUI or N_2 fixation compared to uninoculated control. Soybean plants from the following root nodule bacterial treatments, CL_4HK7, CL_3B1 and Th7 including single EA inoculated treatment had RUI values of 72, 71, 63 and 70% respectively.

Anyhow, each of these treatments did not differ significantly from CD_2P and CD_1YD8 treatments. Depressive effect on RUI was clearly observed in coinoculation of EA + CD_1YD8 treatment ($P<0.05$). Another two coinoculated treatments (CL_4HK7 + EA, CL_3B1 + EA) also showed depressive trend for the effect on RUI while CD_2P + EA showed synergistic trend compared to single inoculation of each of root nodule bacterial partner.

When RUI values were used for calculation of percentage and amount of seasonal fixed N of DT 84 soybean, it was found that uninoculated control plant could fix about 9.3 mgN/plant or about 12% of total N uptake of shoot. Among single root nodule bacterial inoculated treatments, CD_1YD8 was the most effective.

In this treatment soybean could fix N_2 seasonally about 73 mgN/plant or about 91% of total N uptake, CD_2P was the least effective isolate among five tested root nodule bacteria but this Cambodian native root nodule bacteria was not different significantly from the rest except CD_1YD8 isolate. CD_2P inoculated soybean plant could fix N seasonally about 0.0507 gN/plant or about 70% of total N uptake. The other isolates/strain were not different significantly from CD_2P or CD_1YD8 or EA treatments for the effects on improving of both amount and percentage of seasonal fixed N.

The quantities of seasonal fixed N from CL_4HK7, CL_3B1, Th7 and EA treatments were 0.0622, 0.0631, 0.0642 and 0.0504 gN/plant about 84, 83, 73 and 82% of total N uptake respectively. When EA was used combination with each of root nodule bacterial isolate/strain, it was found there were no significant beneficial nor depressive effects on improving of amount of seasonal fixed N of DT 84 soybean except one case, EA + CD_1YD8 treatment which showed, significant depressive effect on percentage of fixed N was found compared to single inoculation of CD_1YD8.

Table 8. Effects* of endophytic actinomycetes and root nodule bacterial on relative ureide indices at $R_{3.5}$ stage (%), percentage and amount of seasonal fixed N P-fix (%) and total N accumulation in the shoot and amount of fixed N of Cambodia soybean DT 84 variety

treatment	N-uptake (gN / plant)		%RUI		Fixed N			
					% of TN uptake		gN / plant	
U	0.0617	c (100)	17.813	c	12.284	c	0.0093	c (100)
CD_2P	0.072	bc (117)	61.402	b	70.403	b	0.0507	b (545)
CL_4HK7	0.0745	abc (121)	71.549	ab	83.932	ab	0.0622	ab (669)
CL_3B1	0.0742	abc (120)	71.12	ab	83.36	ab	0.0631	ab (679)
CD_1YD8	0.0797	ab (129)	77.172	a	91.429	a	0.073	a (785)
Th7	0.0884	a (143)	63.084	b	72.645	b	0.0642	ab (690)
EA	0.0612	c (99)	70.574	ab	82.632	ab	0.0504	b (542)
CD_2P + EA	0.0822	ab (133)	69.983	ab	81.844	ab	0.0656	ab (711)
CL_4HK7 + EA	0.0665	bc (108)	68.37	ab	79.694	ab	0.0528	b (568)
CL_3B1 + EA	0.0716	bc (116)	67.957	ab	79.143	ab	0.0575	ab (618)
CD_1YD8 + EA	0.074	abc (120)	61.835	b	70.98	b	0.0527	b (567)
Th7 + EA	0.072	bc (117)	75.844	a	89.659	a	0.0642	ab (691)
CV%	**17.38**		**15.45**		**17.61**		**24.79**	

* means of five replications
* means in the same column follow by the different letters differs significantly by LSD 0.05

4.4 Number of pods per plant and seed yield of Cambodia soybean DT 84 Variety

At harvest, uninoculated control plant have 7 pods/plant with seed yield of 1.45 g/plant (Table 9). All single microbial inoculated treatments except Th7 could increase significantly numbers of pods/plant with CD_1YD8 as the best treatment compared to uninoculated control. By single inoculation of CD_1YD8 the numbers of pod per plant increased about 141%. Inoculation of Th7 strain, though was not effective to improve significantly numbers of pod per plant but this treatment was not different from the other Cambodian native isolates (CD_2P, CL_4HK7, and CL_3B1) for the effect on increasing of numbers of pod per plant. Single inoculation of EA was

the second best treatment for the effect on improvement of pod formation. However this treatment was not different from CD_2P, CL_4HK7, and CL_3B1 for the effect on pod formation. When EA was used incombination with each root nodule bacterial inoculation, it was found that the combination which provided significant synergistic effect on pods number per plant were CL_4HK7 + EA and Th7 + EA while CD_1YD8 + EA had depressive effect compared to that of single inoculation of each root nodule bacterial partner ($P<0.05$). At harvesting stage, uninoculated soybean plant about 1.45 g of seed yield per plant (Table 9).

Among five single inoculations of the tested microbes there was only one treatment, CL_4HK7 inoculation which could not significant improve seed yield of DT 84 soybean. Nevertheless, single inoculation of each root nodule bacterial isolate/strain including single inoculation of EA was able to increase seed yield within the range of 80-260% over that of uninoculated control. There were no significant different among these root nodule bacteria CD_2P, CL_4HK7, CL_3B1 and Th7 including EA for the effects on DT 84 seed yields and all were significantly less effective than CD_1YD8 which provided the highest seed yield about 5.2 g/plant.

Significant depressive effect of EA + CD_1YD8 on seed yield was also found compared to inoculation of CD_1YD8 alone. In case of EA + CL_4HK7 and EA + Th7 coinoculated treatments, significant synergistic effect on seed yield were observed compared to that from each of root nodule bacterial partner.

Table 9. Effects* of endophytic actinomycetes and root nodule bacterial inoculation on no. of pods per plant and seed yield of Cambodia soybean DT 84 variety at harvesting

treatment	pod per plant	seed yield (g/plant)
U	7.067 e	1.452 d (100)
CD_2P	12.6 bcd (176)	3.0653 bc (211)
CL_4HK7	11 cd (154)	2.604 cd (179)
CL_3B1	12 bcd (168)	2.958 c (204)
CD_1YD8	17.2 a (241)	5.2147 a (360)
Th7	10.2 de (143)	2.66 cd (184)
EA	14 abc (196)	3.6647 bc (253)
CD_2P + EA	12.933 bcd (181)	3.8073 bc (263)
CL_4HK7 + EA	17.267 a (242)	5.064 a (349)
CL_3B1 + EA	12.133 bcd (170)	2.9333 c (202)
CD_1YD8 + EA	12.533 bcd (176)	3.1047 bc (214)
Th7 + EA	15.733 ab (220)	4.208 ab (290)
CV%	**23.12**	**28.45**

* means of five replications
* means in the same column follow by the different letters differs significantly by LSD 0.05

Correlation between RDW at $R_{3.5}$ stage and the following parameters, SDW, shoot N uptake, %RUI at the same growth stage including their relationship with seed yield were analyzed (Table 10). It was found that RDW correlated significantly with SDW, nodule dry weight, shoot N uptake, %RUI and also seed yield. The significant correlation between %RUI and SDW, root dry weight, nodule dry weight, N uptake of shoot and seed yield were also found. Two parameters, RDW and %RUI correlated significantly with seed yield. The following parameters shoot dry weight, nodule dry weight, shoot N uptake were also correlated significantly with seed yield.

Table 10. Coefficients of correlation among studied parameters of DT 84 soybean at $R_{3.5}$ stage including seed yield

	shoot dry weight (g/plant)	root dry weight (g/plant)	nodule dry weight (g/plant)	N uptake (gN/plant)	%RUI	N fix per plant
root dry weight (g/plant)	0.9937 **					
nodule dry weight (g/plant)	0.9206 **	0.9057 **				
N-uptake (gN/plant)	0.9811 **	0.9727 **	0.8918 **			
%RUI	0.9811 **	0.9750 **	0.9204 **	0.9586 ns		
N fix per plant	0.9672 **	0.9562 **	0.9152 **	0.9657 **	0.9836 **	
seed yield (g/plant)	0.9260 **	0.9274 **	0.8470 **	0.9142 **	0.9257 **	0.9092 **

** significant different $P < 0.01$
n 60