Indian Journal of Agricultural Sciences **81** (1): 60–6, January 2011

Season-wise performance of groundnut (*Arachis hypogaea*) cultivars as influenced by local and foreign strain of *Rhizobium* inoculation

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Received: 26 November 2008; Revised accepted: 29 October 2010

ABSTRACT

A field experiment was conducted during rainy and winter season of 2005 and 2006 in acidic soil (*p*H: 5.6) of *terai* region of west Bengal to compare the performance of different groundnut (*Arachis hypogaea L.*) cultivars in respective seasons as influenced by local and foreign *Rhizobium* strains. All the cultivars were earlier in germination and days to 50% flowering, and shorter in duration in pre-rainy (*kharif*) season in comparison to winter (*rabi)* season. The pre-*kharif* season was more suitable in terms of nodulation, growth, yield-attributing characters and yield of all the cultivars of groundnut than *rabi* season. Among the cultivars, 'ICGV 95111' performed better with respect to different growth-attributing characters and gave the highest yield which was 21.8 and 23.7% higher over the local check 'Gangapuri' in *rabi* and pre-*kharif* season, respectively. The overall performance of local strain of *Rhizobium* was significantly better than the foreign strain in pre- *kharif* season as well as in *rabi* season and was superior in nodule formation and pod yield of groundnut. Correlation analysis as well as the multivariate step-wise regression analysis of crop growth rate (CGR), number and weight of nodules/plant with different abiotic factors in both the seasons showed that pre-*kharif* was more conducive than *rabi* season for groundnut cultivation in *terai* agro-climatic region of West Bengal.

Key words: Coefficient of correlation, Foreign and local strain of *Rhizobium*, Groundnut cultivar, Multivariate step-wise regression model, Seasonal performance, Yield

Groundnut (*Arachis hypogaea* L.) is a new alternative oilseed crop in *terai* region of West Bengal. Although it can be grown throughout the year irrespective of season, some peculiarities in climatic conditions of this zone have forced the farmers to optimize season of cultivation. High rainfall in *kharif* season causes viviparous germination of mature kernels. Again, very low temperature in winter hampers the germination and ceases the crop growth drastically. Sowing time is also an important factor to be considered for this zone. If sown earlier than February, the lower temperature hampers the germination and early growth of the crop and when it is sown beyond February it may face heavy rainfall at harvest and yield may reduce considerably. Apart from that the red *testa* type kernels get higher market value simply because of local consumer preference. Taking into consideration all these situations apart from higher yield, North Bengal demands for some special characteristic features of groundnut cultivars, like shorter in duration, cold tolerant, resistant against viviparous germination, red testa type etc. Being a leguminous crop, it can fix the atmospheric N (27–206 kg/ha) with the help of *Rhizobium* and thereby improves the soil fertility but that requires proper strain for inoculation for getting higher nodulation in new areas (Reddy and Reddi 2002) like *terai* region of West Bengal. According to Hassan (2003) if the *Rhizobium* already existing in the soil is sufficient for growth and yield of groundnut, introduction of new strain of *Rhizobium* has no benefit for groundnut production as compared with local strain. So, considering these aspects the present experiment was conducted to compare the season-wise performance of different newly introduced groundnut cultivars in combination with different strains of *Rhizobium*.

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MATERIALS AND METHODS

The field experiment was carried out at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar (26°19'86"N latitude, 89°23'53" E longitude and 43 m elevation), West Bengal during winter (*rabi*) 2005 and pre-rainy (*kharif*) season of 2006. The soil was sandy loam in texture (59–63% sand, 19–22% silt and 16–19%

clay) and acidic in reaction (*p*H 5.6). The initial available N, P_2O_5 and K_2O status of soil were 110 kg, 15 kg and 72 kg/ha, respectively. In both pre-*kharif* (R) and *rabi* season (W) of 2005 and 2006 the experiment was laid out in split-plot design with three replications comprising three main plot treatments of microbial inoculation and 11 sub-plot treatments consisting 11 different cultivars of groundnut. The main plot treatments were B_0, without *Rhizobium* inoculation (control); B_1, inoculation with local strain (Pundibari local) and B_2, inoculation with foreign strain (JCg 12). Yeast extract mannitol agar was used for the selective isolation, enumeration and mass multiplication of local strain of *Rhizobium* from root nodule of greengram (*Vigna radiata* L.) at University Research Farm. Another strain JCg 12 was considered as a foreign strain which was collected from the Nodule Research Laboratory of Bidhan Chandra Krishi Vishwavidhyalaya. The sub-plot treatments were the 11 groundnut cultivars, viz V_1: 'ICGV 95100', V_2: 'ICGV 95101', V_3: 'ICGV 95104', V_4: 'ICGV 95107', V_5: 'ICGV 95111', V_6: 'ICGV 97156', V_7: 'ICGV 98371', V_8: 'ICGV 97163', V_9: 'ICGV 98369', V_{10}: 'ICGV 98370' and V_{11}: 'Gangapuri respectively'. Ten cultivars were brought from International Crop Research Institute of Semi Arid and Tropic, Hyderabad and 'Gangapuri' was selected as local check cultivar. Seeds were treated with *Rhizobium* culture @15 g/kg of seed. A 10% solution of gum Arabic in water was prepared and molasses was added to make a solution of 5%. Then kernels were poured and when all the kernels had a uniform coating of slurry, they were spread on paper in shade. A common dose of 20 kg N/ha in the form of urea, 60 kg P_2O_5/ha in the form of single super phosphate and 60 kg K_2O/ha in the form of muriate of potash were applied as basal dose in all the plots, irrespective of treatments in both the seasons. Meteorological data pertaining to the period of experiments were collected from Principal Agricultural Office, Cooch Behar, West Bengal. Soil *p*H of (1: 2.5) soil-water suspension was determined with Systronics *p*H meter (model: 335). Available nitrogen content in soil was estimated by the procedure of Modified Macro Kjeldahl method. Available phosphorus in soil was determined by Bray's No.I method and was estimated by Systronics Spectrophotometer (Model: 106). Available potassium was estimated by ammonium acetate method with the help of flame photometer and was determined by Systronics Flame photometer (Model: 128). Finally using the statistical procedure for analysis of groups of experiments over different seasons as suggested by Gomez and Gomez (1983), pooled analysis of the experimental data obtained from two different seasons, Pre-*kharif* and *rabi* were done to study the seasonal influence. Different dependent variables like crop growth rate (CGR), number and weight of nodules etc. of the best performing cultivar, V_5 ie 'ICGV 95111' with local strain of *Rhizobium* as better inoculants was correlated with different abiotic factors and their contribution was studied by performing step-wise multiple regression. Cost of cultivation was calculated on the basis of sale price of groundnut 15/kg; Fixed cost: 15 637.80 ₹/ha for *rabi* season and 13 637.80 ₹/ha for pre-*kharif* season was considered; Variable cost: without inoculation: ₹ 0, whereas with inoculation (1.5 kg/ha) @ ₹ 60.

RESULTS AND DISCUSSION

In *terai* agro-climatic region of West Bengal in *rabi* season the cultivars took 8–15 days for 80% germination, 37–41 days for 50% flowering and 135–147 days for total duration whereas in pre-*kharif* season the respective values were 5 to 7 days, 24–30 days and 105–114 days only. Probably the comparatively lower atmospheric temperature prevailing in winter season delayed the germination and hampered the crop growth considerably. According to Reddy and Reddi (2002), at optimum temperature the activity of auxin, gibberallins, and cytokinins (growth promoters) remains high and the activity of abscisic acid (growth regulators) is low with the result that the growth rate is increased. Crop when exposed to variety of climatic conditions during different phases of crop growth is subjected to too large variation in growth rate during different phenological stages and duration of growth as well.

During the pre-*kharif* season significantly higher number as well as weight (158.2 and 0.70, respectively) of nodule were noticed (Table 1) probably because of prevalence conducive soil and climatic condition in this season. Among the varieties, V_5 gave significantly higher number of nodules/ plant in both the seasons of crop growth. *Rhizobium* inoculation with local strain produced significantly higher number of nodules/plant (*rabi*: 149.6 and pre-*kharif*: 166.4) and nodule dry weight/plant (*rabi:* 0.63 g and pre-*kharif:* 0.71 g) in both the seasons over foreign strain and control as well. Mane *et al.* (1993) reported that local strains had the better adoptability in local condition than the foreign strain which is more remarkable in acidic soil condition. They also reviewed that the introduced strain may face severe competition from the local *Rhizobium* strain which is already present in the native soil.

The dry matter accumulation/plant was significantly higher during pre- *kharif* season (Table 1). Again, V_5 recorded the maximum dry biomass/plant (*rabi*: 65.7 g and pre-*kharif*: 84.5 g) at harvest. During both the seasons, inoculation with local strain increased the dry weight of plant significantly (*rabi*: 60.9 g and pre-*kharif*: 74.8 g) over B_2 (*rabi*: 55.9 g and pre-*kharif*: 73.3 g).

The higher root weight as well as root volume were noticed during the pre- *kharif* season. Inoculation with local strain of *Rhizobium* increased the root weight and root volume during both the seasons over foreign strain and control. Further, seasonal data showed that cultivar V_5 recorded highest values of root dry weight (*rabi*: 2.43 g, pre-*kharif*: 2.18 g/plant) at

Table 1 Effect of seasons, *Rhizobium* inoculation and cultivars on the number of nodules, nodule weight, root dry weight and root volume/plant at 60 DAS and dry biomass, number of mature pods/plant, 100' kernel weight and pod yield at harvest of groundnut

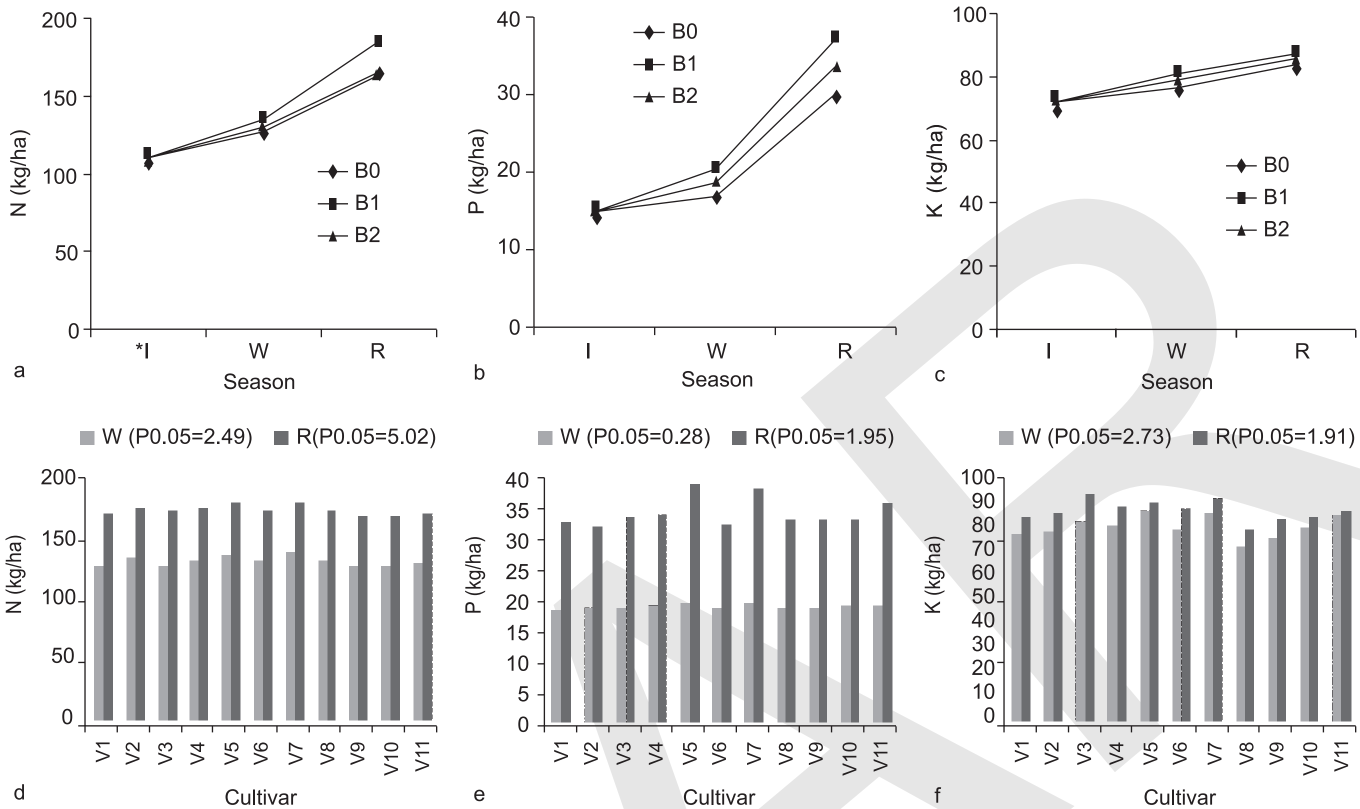
Treatment	Nodules/ plant		Nodule weight/ plant (g)		Root dry weight/ plant (g)		Root volume/ plant (cc)		Dry biomass/ plant (g)		Mature pods/ plant		100-kernel weight (g)		Pod yield (tonnes/ha)	
	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R
Season (S)	136.2	158.2	0.58	0.70	1.657	1.816	3.62	3.81	56.7	73.3	18.5	19.6	38.9	42.0	2.10	2.40
CD (*P*=0.05)	10.83	0.06	0.055	0.07	3.10	0.69	2.03	0.01								
Rhizobium (B)																
B_0	122.2	147.9	0.52	0.68	1.522	1.727	3.42	3.68	53.3	71.8	15.1	15.7	35.9	39.1	2.00	2.30
B_1	149.6	166.4	0.63	0.71	1.746	1.980	3.84	3.96	60.9	74.8	21.5	22.7	42.3	45.3	2.22	2.50
B_2	138.7	160.2	0.59	0.70	1.703	1.742	3.59	3.78	55.9	73.3	18.9	20.4	38.7	41.7	2.09	2.40
CD (*P*=0.05)	10.84	5.19	0.06	0.01	0.203	0.063	0.08	0.05	3.51	2.73	2.09	1.54	3.54	3.59	0.10	0.12
Cultivar(C)																
V_1	99.7	119.9	0.53	0.56	1.33	1.48	3.56	3.35	52.2	63.0	15.9	17.7	32.3	35.3	1.95	2.22
V_2	89.8	99.9	0.53	0.59	1.25	1.42	3.64	3.53	52.8	61.7	20.8	19.4	27.7	30.7	2.14	2.34
V_3	123.0	132.4	0.55	0.60	1.13	1.34	3.55	3.48	48.2	69.1	16.4	18.3	35.3	38.3	1.85	2.17
V_4	161.9	181.6	0.63	0.83	1.93	2.10	3.93	3.91	63.0	81.6	20.9	23.5	35.5	39.2	2.36	2.72
V_5	175.0	198.7	0.73	0.85	2.18	2.43	3.86	4.30	65.7	84.5	24.4	26.4	38.4	41.4	2.68	3.03
V_6	145.3	186.6	0.53	0.82	1.59	2.02	3.62	3.96	48.3	59.4	20.8	18.8	52.7	55.7	2.05	2.35
V_7	157.0	193.6	0.72	0.85	2.15	2.31	3.78	4.08	64.7	82.6	21.9	23.6	46.0	49.0	2.52	2.95
V_8	125.0	168.5	0.49	0.67	1.87	1.79	3.71	3.81	58.8	72.7	19.4	21.1	56.5	59.6	1.89	2.14
V_9	95.7	139.2	0.53	0.64	1.68	1.72	3.56	3.91	55.0	78.0	11.5	12.9	25.5	28.5	1.75	2.05
V_{10}	159.7	175.3	0.61	0.64	1.27	1.48	3.36	3.73	56.0	75.6	10.9	12.2	37.6	40.5	1.72	1.95
V_{11}	165.8	184.0	0.52	0.60	1.85	1.91	3.30	3.72	58.8	78.1	19.4	21.7	41.1	44.1	2.22	2.45
CD (*P*=0.05)	11.65	10.16	0.04	0.01	0.134	0.292	0.15	0.06	5.76	5.53	1.78	1.59	4.65	4.67	0.27	0.10
Pooled (*P*=0.05)																
B	4.99		0.023		0.088		0.04		1.86		1.08		2.09		0.01	
S×B	7.06		0.033		0.047		0.06		2.64		1.53		2.41		0.01	
C	7.65		0.020		0.159		0.09		3.95		1.18		3.26		0.01	
S×C	10.82		0.028		0.100		0.13		5.59		1.68		2.80		0.02	
B×C	13.25		0.034		0.122		0.162		6.84		2.05		2.98		0.02	

harvest. However, cultivar V_4 recorded highest value of root volume (3.91) during *rabi* season, whereas V_5 recorded highest value of root volume (4.30) during the pre-*kharif*. Mane *et al*. (1993) reviewed that the local strain of *Rhizobium* has the better capacity to release some growth-promoting substances which may have induced the root growth of host plant.

Data from Table1 revealed that there was significantly higher number of matured pods/plant during the pre- *kharif* season (19.6) than during *rabi* season (18.5). Highest number of matured pods/plant was recorded by the cultivar V_5 (*rabi*: 24.4; pre-*kharif*: 26.4) during both the seasons. Results of two seasons also revealed that number of matured pods/plant was higher with local strain of *Rhizobium* inoculation during both the seasons of crop growth. However, highest number of mature pods/plant was recorded during the pre-*kharif* season because the environmental conditions for plant growth were more suitable during pre- *kharif* season. This might help in increasing the efficiency of transportation of the photosynthates from source to sink and ultimately increased the numbers of pods/plant. The value of 100=kernel weight was higher during the pre-*kharif* season. Cultivar V_8 exhibited the highest 100=kernel weight (58.1). Highest value of 100=kernel weight was achieved by B_1 (43.8 g), followed by B_2 (40.2 g).

Yield of groundnut cultivars were significantly higher during pre- *kharif* season (2.40 tonnes/ha) than in *rabi* season (2.10 tonnes/ha). Season-wise data of two years revealed that the cultivar V_5 gave highest yield (*rabi*: *2*.68 tonnes and pre-*kharif*: 3.03 tonnes/ha) which was 21.8 and 23.7% higher over local check ‘Gangapuri’ in *rabi* and pre-*kharif* season, respectively. Local strain of *Rhizobium* inoculation also performed better (*rabi* 2.22 tonnes/ha and pre- *kharif*: 2.50 tonnes/ha) than foreign strain and control during both the seasons of crop growth. The uptake of nitrogen was higher in plots inoculated with local strain of *Rhizobium* in more conducive pre- *kharif* season which ultimately increased pod yield.

Irrespective of cultivars and *Rhizobium* inoculation, NPK availability in groundnut increased significantly after each season of crop harvested. The increment in availability of nutrients was much higher after the pre-*kharif* season than after



*I= Initial nutrient status of soil

Fig 1 Effect of *Rhizobium* inoculation and cultivar on soil nutrient status after harvest of groundnut in two different seasons

rabi season. Maximum availability of NPK was observed in the plots inoculated with local strain of *Rhizobium* in both the seasons (|Fig 1). Foreign strain was not able to cross the increment achieved by local strain of *Rhizobium*. This was probably because of the fact that the local strains had the better adoptability in acidic soil condition than the foreign strain and introduced strain might have faced severe competition from the local *Rhizobia* that were already present in the native soil. All the cultivars achieved higher NPK availability under pre-*kharif* season than in *rabi* season (Fig 1).

Economics

It is clear from Table 2 that during pre-*kharif* season both gross returns and benifit : cost ratio (BCR) were comparatively higher. The combination of local strain of *Rhizobium*, irrespective of cultivars was used, fetched higher gross returns and BCR in groundnut. However, V_5 achieved the higher gross returns during both the seasons of their growth (*rabi*: ₹ 42 257.40 pre- *kharif*: ₹ 46 671.10) and maximum BCR (*rabi*: 2.41; pre- *kharif*: 2.47) in combination with local strain of *Rhizobium* (B_1).

It was observed that with the advancement of crop age both the maximum and minimum temperature was decreased in *rabi* season but in pre-*kharif* season (February-June) they were in increasing trend. Though in general, maximum as well as minimum temperature was higher in pre-*kharif* season. Relative humidity was also higher during the pre-*kharif* season than *rabi*. Rainfall during the crop-growing period under pre- *kharif* season was noticed, whereas, in *rabi* season there was no rainfall except the earlier crop growth stage (up to 30 days after sowing). It is thus revealed from Fig 2 that different meteorological parameters in two different seasons behaved differently in a distinct manner during the crop growth period.

The dependent variables like CGR, nodule number and nodule weight/plant were correlated with different independent abiotic factors like maximum temperature (X_1), minimum temperature(X_2), maximum relative humidity (X_3) and minimum relative humidity (X_4), total monthly rainfall(X_5), mean daily sunshine hours (X_6) in *rabi* and pre-*kharif* seasons. The same data were also subjected to multivariate regression models.

Correlation

Irrespective of season, minimum temperature was significantly correlated with crop growth rate of groundnut, whereas maximum temperature had no impact on CGR (Table 3). However, the correlation was negative in *rabi* season when the minimum temperature was in decreasing trend with the advancement of crop growth, whereas, it was

Table 2 Effect of *Rhizobium* inoculation and cultivar on economics of groundnut cultivation

Treatment combination	*Rabi*				pre- *kharif*			
	Total cost (₹)	Pod yield (tonnes/ha)	Gross returns (₹)	Benefit: cost ratio	Total cost (₹)	Pod yield (tonnes/ha)	Gross returns (₹)	Benefit: cost ratio
B_0V_1	15 637	1.875	28 129	0.79	13 637	2.159	32 388	1.37
B_0V_2	15 637	2.015	30 226	0.93	13 637	2.237	33 549	1.45
B_0V_3	15 637	1.768	26 521	0.69	13 637	2.017	30 250	1.21
B_0V_4	15 637	2.239	33 567	1.14	13 637	2.654	39 807	1.91
B_0V_5	15 637	2.543	38 149	1.43	13 637	2.939	44 086	2.23
B_0V_6	15 637	1.946	29 187	0.86	13 637	2.24	33 607	1.46
B_0V_7	15 637	2.418	36 264	1.31	13 637	2.857	42 861	2.14
B_0V_8	15 637	1.814	27 212	0.74	13 637	2.049	30 731	1.25
B_0V_9	15 637	1.645	24 674	0.57	13 637	1.978	29 664	1.17
B_0V_{10}	15 637	1.627	24 406	0.56	13 637	1.849	27 730	1.03
B_0V_{11}	15 637	2.116	31 742	1.03	13 637	2.361	35 422	1.59
B_1V_1	15 697	2.037	30 557	0.94	13 697	2.262	33 934	1.47
B_1V_2	15 697	2.277	34 157	1.17	13 697	2.466	36 994	1.70
B_1V_3	15 697	1.935	29 022	0.84	13 697	2.319	34 785	1.54
B_1V_4	15 697	2.461	36 921	1.35	13 697	2.762	41 426	2.02
B_1V_5	15 697	2.817	42 257	1.69	13 697	3.111	46 671	2.41
B_1V_6	15 697	2.145	32 172	1.04	13 697	2.475	37 128	1.71
B_1V_7	15 697	2.636	39 537	1.51	13 697	3.052	45 776	2.34
B_1V_8	15 697	1.982	29 725	0.89	13 697	2.215	33 228	1.42
B_1V_9	15 697	1.876	28 137	0.79	13 697	2.149	32 232	1.35
B_1V_{10}	15 697	1.821	27 317	0.74	13 697	2.079	31 179	1.27
B_1V_{11}	15 697	2.377	35 651	1.27	13 697	2.553	38 296	1.79
B_2V_1	15 697	1.944	29 158	0.86	13 697	2.249	33 732	1.46
B_2V_2	15 697	2.138	32 067	1.04	13 697	2.327	34 904	1.54
B_2V_3	15 697	1.845	27 671	0.76	13 697	2.187	32 810	1.39
B_2V_4	15 697	2.367	35 507	1.26	13 697	2.731	40 966	1.99
B_2V_5	15 697	2.676	40 152	1.55	13 697	3.03	45 450	2.32
B_2V_6	15 697	2.045	30 669	0.95	13 697	2.327	34 898	1.54
B_2V_7	15 697	2.507	37 607	1.39	13 697	2.954	44 303	2.23
B_2V_8	15 697	1.879	28 183	0.79	13 697	2.16	32 393	1.36
B_2V_9	15 697	1.737	26 057	0.66	13 697	2.038	30 563	1.23
B_2V_{10}	15 697	1.701	25 519	0.62	13 697	1.936	29 037	1.11
B_2V_{11}	15 697	2.166	32 491	1.06	13 697	2.428	36 416	1.65

Table 3. Correlation coefficient (r) values of dependent variables with different abiotic factors *rabi season*

Dependent variable	Temperature (ºC)		Humidity (%)		Rainfall (mm)	Sunshine hour
	Max.	Min.	Max.	Min.		
CGR	–0.596	–0.950**	0.688	–0.856**	–0.604	0.252
Number of nodules	–0.228	–0.975*	0.088	–0.725	–0.897	0.731
Weight of nodules	–0.440	–0.942	0.272	–0.762	–0.940	0.567
Pre- *kharif season*						
CGR	0.745	0.898**	–0.596	–0.089	0.790*	0.159
Number of nodules	0.650	0.926	–0.829	–0.591	0.950*	0.267
Weight of nodules	0.389	0.950*	–0.699	–0.440	0.779	0.098

*P=0.05; **P=0.01.

in increasing trend in pre-*kharif* season with the increase in crop growth rate and that established the positive correlation between CGR and minimum temperature. Among the two types of humidity, only the minimum had significantly negative correlation with CGR during *rabi* season, but none of them had any significant relation in pre-*kharif* season. There was considerably higher amount (656.3 mm) of rain fall in pre-*kharif* season which was well distributed throughout the crop growth and thus had a significantly positive correlation with CGR. But, in *rabi* season though a good amount (504.2 mm) of rainfall occurred, it was confined within the first 30 days of the crop and failed to establish any significant relation with crop growth rate. Irrespective of season, sunshine hour had no significant relation with CGR.

The number and weight of nodule of groundnut had a decreasing trend in natural courses after 60 days of sowing of the crop due to the death of nodules and ageing of the crop. That is why it was tried to establish the relation between the abiotic factors and the number and weight of nodules/ plant up to the 60 days after sowing. The minimum temperature had significantly negative correlation with the number of nodules in *rabi* season and significantly positive correlation with the weight of nodules/plant during pre- *kharif* season which was due to the different trend of minimum temperature in two different seasons. The significant amount (656.3 mm) of well distributed rainfall during the pre- *kharif* season established a significantly positive correlation with the number of nodules/plant by providing sufficient amount of soil moisture for favourable growth of nodules. However, humidity and sunshine hour had no significant relation with the nodule formation in any season.

Multivariate regression models

The results depicted in Table 4 regarding step-wise multivariate regression models revealed that minimum temperature contributed 90.27% role in fluctuating the CGR. In pre-*kharif* season the contribution of minimum temperature on CGR fluctuation was 80.57%. From careful and close look at the equation no.1,2,3,8,9,10,11 and 12 it can be therefore inferred that the minimum temperature as a single factor had a greater percentage of contribution to the total variation in the CGR of groundnut in both the seasons, though the impact of minimum temperature on CGR was negative in *rabi* season and thereby plays the primary and most crucial role on the said parameter of groundnut. In consideration of the number of nodules/plant, only the minimum temperature and rainfall had significant contribution in both the seasons. Though in *rabi* season the major contribution was due to minimum temperature, in pre-*kharif* season the major contributor was the rainfall. In *rabi* season, the effect of minimum temperature on the variation in weight of nodules/ plant in the plots inoculated with local strain of *Rhizobium* was 88.78%. However, in pre-*kharif* season, minimum temperature contributed 89.35% in the total variation in weight of nodules/plant.

Thus, prevalent minimum temperature in decreasing trend with ill distributed rainfall was the main barrier against groundnut cultivation in *rabi* season under *terai* zone of West Bengal. On the other hand, since the increasing trend of minimum temperature with advancement of crop growth

Table 4 Multivariate step-wise regression models of dependent variables with different abiotic factors

	Regression equation	R^2	Equation no.
Rabi			
Y_1	$= 21.170 – 0.9501 X_2$	0.9027	…(1)
Y_1	$= 1.462 – 0.8237X_2 + 0.2311X_3$	0.9401	…(2)
Y_1	$= –28.755 – 0.6162X_2 + 0.4662X_3 + 0.2802X_6$	0.9740	…(3)
Y_2	$=186.396 – 0.9753X_2$	0.9512	…(4)
Y_2	$=196.842 – 0.0.7139X_2 + 0.3284X_5$	0.9910	…(5)
Y_3	$= 20.946 – 0.9422X_2$	0.8878	…(6)
Y_3	$= 29.920 – 0.3269X_1 – 0.9013X_2$	0.9930	…(7)
Pre- *kharif*			
Y_1	$= –16.015 + 0.8976 X_2$	0.8057	…(8)
Y_1	$= 17.832 + 0.7909 X_2 – 0.3653 X_3$	0.9277	…(9)
Y_1	$= 13.934 + 0.2601X_1 + 0.6110 X_2 – 0.3711 X_3$	0.9636	…(10)
Y_1	$= 19.630 + 0.4103X_1 + 0.3306 X_2 – 0.6956 X_3 + 0.3664 X_4$	0.9847	…(11)
Y_1	$= 28.126 + 0.6428X_1 + 0.1255 X_2 – 0.7960 X_3 + 0.3550X_4 - 0.2318 X_6$	0.9981	…(12)
Y_2	$= 65.399 + 0.9506 X_5$	0.9026	…(13)
Y_2	$= 59.199 + 0.4612 X_2+ 0.5815 X_5$	0.9795	…(14)
Y_3	$= –16.082 + 0.9452 X_2$	0.8935	…(15)
Y_3	$= 0.948 + 0.8908 X_2– 0.2172 X_4$	0.9377	…(16)

X_1, Maximum temperature; x_2= minimum temperature; x_3, maximum relative humidity; x_4, minimum relative humidity; x_5, total rainfall; x_6, mean daily sunshine hour; Y_1, CGR; Y_2, nodule number/plant; Y_3, nodule weight/plant; R^2, coefficient of determination; r, correlation coefficient stage and significant amount of well distributed rainfall in pre-*kharif* season have been found to exercise positive impact on crop growth and nodule formation of groundnut from the statistical point of view, pre-*kharif* season can be advocated as the most conducive for groundnut cultivation in *terai* agro-climatic region of West Bengal.

Based on above findings, it is apparent that the cultivar V_5 ('ICGV 95111') performed better in both the seasons of experimentation in growth as well as in yield-attributing characters in combination with local strain *Rhizobium*. The *rabi* season crop on an average took at least 30 days longer duration than pre-*kharif* crop and also showed lower productivity. So, the aforesaid cultivar treated with locally isolated strain of *Rhizobium* may be introduced in more suitable pre-*kharif* season in adverse acidic soil condition of *terai* agro-climatic region of West Bengal to popularize and establish it as a potential alternate oilseed crop.

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