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Growth and development of groundnut (*Arachis hypogaea*) under foliar application of *panchgavya* and leaf extracts of endemic plants

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ABSTRACT

A field experiment was conducted at Regional Research Station, CAZRI, Jaisalmer during *kharif* 2006 and 2007 to evaluate the efficacy of foliar applied *panchgavya* on the physiological growth, nutrient uptake, yield and economics of groundnut (*Arachis hypogaea*) with and without mixing leaf extracts of neem (*Azadirachta indica*), datura (*Datura metel*) and tumba (*Citrullus colocynthis*). The results of the experiment revealed that foliar application of *panchgavya* + neem leaf extract (NLE) recorded significant improvement in chlorophyll content, nitrate reductase activity, root nodule weight, leaf area index, dry matter accumulation, nutrient content and uptake of groundnut when compared with control and *panchgavya* alone. Yield attributes (pod weight, pod index, kernel index, shelling per cent) and harvest index were also recorded significantly higher with *panchgavya* + NLE. The pod, haulm and biological yield increased by 54, 25 and 39% with foliar application of *panchgavya* + NLE over the control. Maximum net return (Rs 45,399/ha) and B: C ratio (2.19) was recorded with foliar application of *panchgavya* + NLE over other sources. Foliar application at branching (35 DAS) and flowering (55 DAS) recorded significantly higher growth and yield of groundnut, net return (Rs 42,880/ha) and benefit: cost (2.06) than foliar application of the sources either one of these two stages.

***Key words**:* Chlorophyll, Dry matter content, Groundnut, Leaf extract, Nitrate reductase, Yield

Organic farming in recent years is gaining impetus due to realization of inherent advantages it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment (Lokanath and Parameshwarappa, 2006). Farmyard manure, compost, vermicompost, green manuring, agro-wastes and plant wastes form sources both for sustainability of soil organic carbon (Tolanur and Badanur, 2003) and supply of plant nutrients in traditional organic farming. In the existing technologies of organic farming where FYM and compost are used as sources of nutrient supply, productivity of soils depletes during the transitory period (until fertility, structure and microbial activity of the soil had been restored) leading to low yield levels in initial years of cultivation (Natarajan, 2002). Besides, in the light textured soils of arid and semi-arid regions bulky organic materials remain in undecomposed state for years due to inherent deficiency of soil organic carbon and microbial biomass responsible for decomposition of these materials. Hence it is imperative to evolve an alternative technology of organic farming that provides reasonable yields while restoring the fertility of soil during transitory period. The use of fermented, liquid organic fertilizers, effective micro-organisms (EM) and fermented plant extracts (FPE) as foliar fertilizers have been introduced to modern agriculture in recent years to produce food with good quality and safety (Galindo *et al*., 2007). Use of fermented curd, rich in beneficial microorganisms, is also practiced elsewhere both to augment plant growth and suppress pest loads on crop plants. The benefits of EM in increasing crop yields, improving crop quality, and protecting plants from pests and disease have been demonstrated for a wide range of crops and soil conditions. Of late, use of fermented cow dung, urine, milk fat, curd and milk with the name of *panchgavya* is getting adaptive popularity in Indian agriculture largely through the efforts of small groups of farmers. Role of foliar applied *panchgavya* in production of many plantation crops had been well documented in India (Selvaraj, 2003). There are reports indicating that efficacy of *panchgavya* solution enhanced manifold with the mixing of endemic plant leaves. In waste land of Indian Thar desert, plants like tumba (*Citrullus colocynthis*) and *datura* (*Datura metel*) grow wildly producing lot of biomass. The present investigation was hypothesized to

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examine the effect of *panchgavya* along with the leaf extracts of the wild plants on different physiological parameters, yield and yield attributes of groundnut (*Arachis hypogaea* L.).

MATERIALS AND METHODS

An experiment on the lines of organic farming was conducted at Central Arid Zone Research Institute (CAZRI), Regional Research Station, Jaisalmer (26°52'N, 70°55'E and 194.5 m altitude) under irrigated conditions during *kharif* seasons of the year 2006 and 2007. The climate of the region is typically characterized by aridity of the atmosphere and salinity in the rhizosphere with extremes of temperature both in summer (May–June) and winter (January–February). The average annual rainfall and potential evapo-tanspiration are 188.1 mm and 2064.0 mm, respectively. During the crop growth period (26 to 46 standard meteorological weeks), 369 and 190 mm rainfall was received in 2006 and 2007, respectively. The soil of the experimental field was sandy in texture and taxonomically classified as Typic Torripsamments. The sandy soils of the experimental field was shallow in depth (30 cm) having 0.08% organic carbon, 72.80 kg/ha available N, 6.45 kg/ha available P, 215.78 kg/ha available K, 6.92 kg/ha available S, and 7.55% free $CaCO_3$ with pH 9.2. Concretions of $CaCO_3$ at an average depth of 50 cm below soil surface are common characteristics of the study region. The experiment was laid out in factorial Randomized Block Design with 3 replications. The 15 treatment combinations in the experiment comprised of 5 sources of foliar application and 3 stages of application. The leaf-extract (in cow urine) of 3 commonly available arid plants, *viz.*, neem (*Azadirachta indica*), *datura* (*Datura metel*), and tumba (*Citrullus colocynthis*) along with *panchgavya* and control (water spray) were used as sources of foliar application. These sources of foliar application were applied either at branching (35 DAS) or flowering (55 DAS) and both at branching plus flowering. *Panchgavya* solution was prepared by thorough mixing of fresh cow dung (7 kg), cow-ghee (butter oil, 1 kg), fresh cow urine (10 l), cow milk (3 l), cow milk curd (2 l), jaggery (unrefined sugar from sugarcane juice, 3 kg), and ripe banana (2 kg) in a open plastic container. On the first day, 7 kg cowdung was mixed with 1 kg cow-ghee and kept for 72 hours followed by addition of 10 l cow urine and 10 l water. The mixture was stirred twice in a day and allowed to ferment for 15 days. On the 18 day, 3 kg cow milk, 2 kg cow curd, 3 kg jaggery, and 2 kg banana were added in the mixture and allowed to ferment for seven days while stirring twice a day. The *panchgavya* was ready for use after a period of 25 days. Fresh ground leaves of neem, datura, and tumba were mixed with cow urine in a ratio of 1:1 and allowed to ferment for 7 days in open plastic bucket. The filtrates of leaf extract were mixed with the previously prepared and filtered *panchgavya* solution in a ratio of 1:1 to prepare the foliar solutions of respective plants. Twenty litre filtered solutions each of *panchgavya* as well as plant leaf extracts / ha was used for a single application. The panchgavya and leaf extract solutions were analyzed for pH, electrical conductivity (EC), OC, total N, and total P content (Fig. 1).

The field was prepared by ploughing with tractor drawn disc plough followed by a cross harrowing and planking to obtain thoroughly pulverized seed bed. A recommended dose of FYM (0.77 % N, 0.14 % P and 0.42 % K) @ 11 t/ha was applied uniformly in all the treatments before sowing of crop. After a pre-sowing irrigation, the groundnut 'MA-10' was sown for 2 successive years on 17 July, 2006 and 21 July, 2007 and harvested on 17 November, 2006 and 16 November, 2007 respectively. The seeds were treated with *Trichoderma viride* (6 g/kg seed) as prophylactic measure against seed borne diseases. Sowing was done in rows spaced at 45 cm apart with a seed rate of 80 kg/ha. Thinning of plants was done at 10 DAS to maintain plant to plant distance of 15 cm. The initially prepared and filtered solutions of *panchgavya* and plant leaf extracts were diluted with water by 30-time and applied on the crop foliage as per treatment. Five plants per treatment were uprooted manually at each sampling (45 DAS, 70 DAS and harvest) for growth analysis. Each sample was separated into its component plant parts – leaves, stems and pods. The root nodules were also detached manually from the roots of each sample. Dry weights of plant parts were obtained after drying at 70° C for 72 hours, to determine shoot dry matter and its distributions. The leaf area index, crop growth rate, relative growth rate and net assimilation rate were calculated using formula as given in the literature (Gardner *et al*., 1995). Total chlorophyll in the fresh leaves was determined at each sampling using the method advocated by Arnon (1949). Nitrate reductase activity at 45 and 70 DAS was estimated in the uppermost fully expanded fresh leaves of the plants as described by Jaworski (1971). One hundred pods and kernels were selected randomly from each treatment and weighed to express yield attributes as pod and kernel index. Biological yield and pod yield was computed from the plants harvested from net plots in each treatment. The oil and protein content in the kernels was estimated from the oven dry samples following standard methods of analysis. To test the significance of variation due to treatments of foliar application and their stages of application, experimental data obtained for various treatment effects (interaction, simple and main effects) were analyzed using SPSS software. The data were analyzed

separately for 2 years 2006 and 2007 and individual year's data were subjected for pool analysis to obtain a trend among results over the years.

RESULTS AND DISCUSSION

Physiological growth

Plants under foliar application of *panchgavya* + neem leaf extract (NLE) significantly attained higher chlorophyll content, NR activity, dry root nodule weight, leaf area index (LAI), crop and relative growth rates (CGR and RGR) and net assimilation rate (NAR) in both the years at all the stages of plant growth than rest of the foliar sources. Pooled data (Table 1) revealed that foliar application of *panchgavya* + NLE increased total chlorophyll content in fresh leaves by 28 and 20 % and NR activity by 49 and 59 % over control at 45 and 70 DAS, respectively. Similarly, root nodule weight at 45 and 70 DAS recorded 42 and 39 % increase over control with *panchgavya* + NLE. The physiological growth of leaf in terms of LAI (Table 2) recorded increasing trend with progress in crop growth from 45 DAS to harvest while that of CGR, RGR and NAR (Table 1) recorded decreasing trend. Foliar application of *panchgavya* + NLE recorded significantly the highest values of these growth parameters at all the observed stages of plant growth among sources of foliar application. The frequency of foliar application had significant effect on the content of chlorophyll, activity of NR, root nodule weight and physiological growth at all the stages of observation (Tables 1 & 2). Single application of foliar sources at branching recorded significantly higher values of these parameters at early growth (45 DAS) while at later growth stages (70 DAS and harvest), dual application at branching + flowering found significantly superior over single spray at branching or flowering. The effect on CGR, RGR and NAR however, were found inconsistent with frequencies of foliar application.

The observed increase in chlorophyll content and NR activity with all the sources of foliar application in the study might be associated with the supply of essential nutrients to the plants (Fig. 1). Since chlorophyll synthesis in the plants is directly related to the availability of the physiologically active Fe, N, P and S nutrients, the fermented solutions of *panchgavya* and leaf extracts contain various salts rich in N, P, K, S and micronutrients in plant available form. Hence availability of these nutrients to plants helps in the formation of chlorophyll in the leaves. Increased chlorophyll 'a', 'b' and carotenoids content in green leaves with foliar application of organic solution has also been observed by Tejada and Gonzalez (2003) in rice. The activity of NR enzyme is very sensitive to the supply and availability of N to the crop plant. Thus, increased supply of N with *panchgavya* and *panchgavya* + leaf ex-

Table 1. Effect of foliar applied sources and their stages of application on chlorophyll content, nitrate reductase (NR) activity, dry root nodule, crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) of groundnut at different growth stages (Pooled data)

Treatments	*Total chlorophyll (mg/g FW leaf)		*NR activity (µmol NO_2/g/h FW leaf)		Dry root nodule weight (mg/plant)		CGR (g/m^2/day)		RGR (mg/g/day)		NAR (mg/cm^2/day)	
	45 DAS	70 DAS	45 DAS	70 DAS	45 DAS	70 DAS	45-70 DAS	70 DAS-harvest	45-70 DAS	70 DAS-harvest	45-70 DAS	70 DAS-harvest
Foliar sources												
Control	1.32	3.45	181.24	27.02	33.9	144.1	19.72	11.29	352.47	20.50	0.89	0.67
Panchgavya	1.51	3.54	222.00	33.35	39.2	177.3	23.03	11.81	372.20	18.47	0.96	0.67
Panchgavya + neem	1.69	4.13	270.21	42.85	48.2	199.8	34.03	18.81	456.97	20.32	1.15	0.81
Panchgavya + *datura*	1.60	3.76	265.02	35.62	44.6	183.8	29.68	16.44	426.88	20.25	1.09	0.81
Panchgavya + tumba	1.59	3.94	250.37	37.28	42.2	184.7	30.90	16.72	454.84	19.98	1.09	0.75
SEm±	0.03	0.08	8.54	0.93	0.95	2.2	0.38	0.47	9.13	0.72	0.02	0.03
CD (P= 0.05)	0.09	0.23	24.19	2.65	2.69	6.4	1.07	1.32	25.88	NS	0.06	0.08
Stages of foliar application												
Branching (B)	1.58	3.73	250.56	33.10	46.7	174.5	27.00	14.55	368.34	19.52	0.99	0.70
Flowering (F)	1.42	3.51	205.90	33.04	31.5	164.6	24.92	13.59	456.38	19.93	1.05	0.74
B + F	1.61	4.06	256.84	39.53	46.7	194.7	30.50	16.90	413.30	20.26	1.07	0.78
SEm±	0.03	0.06	6.61	0.72	0.74	1.7	0.29	0.36	7.08	0.56	0.02	0.02
CD (P= 0.05)	0.07	0.18	18.74	2.05	2.08	4.9	0.80	1.00	20.00	NS	0.05	0.06

*FW: Fresh weight

tracts might have increased the activity of NR significantly compared to control at all observed stages in the study. The activity of NR also affected by the presence of hormones, *viz.*, gibberellins, cytokinins, auxins and monochloro-indole acetic acids (Ahmad *et al*., 2001) besides availability of nitrogen. The supply of these phytohormones with foliar sources might have increased the NR activity in functional leaves of the plants by increasing the synthesis of enzyme or protein by affecting the basic processes of translation/transcription favourably. The LAI is also related to the supply and availability of N to plants. Supply of N either from foliar sources or symbiotic fixation resulted in greater nitrogen contents in the leaf canopy and thus increased above ground biomass production and leaf area. Besides, fermented sources of foliar application might have contained microbial metabolites in appreciable amount that help in maintaining the opening of stomata for longer period both in optimum and adverse conditions during the crop growth which led to increased leaf area index providing stronger source for sink (Xu *et al.*, 2000). The higher root nodule weight with foliar sources in the study was attributed to increased plant growth and translocation of carbohydrates to developing nodules. Increased allocation of food material to roots in turn enhances the root volume and thereby weight of root nodules concomitantly (Poorter and Nagel, 2000).

Dry matter accumulation

Dry matter accumulation in leaf, stem, pods as well as plant increased significantly with application of all the foliar sources when compared with control, being significantly highest with *panchgavya* + NLE at all the observed stages of plant growth (Table 2). Pooled data revealed that foliar application of *panchgavya* + NLE increased total plant dry matter by 36, 69 and 68% over control at 45 DAS, 70 DAS and harvest, respectively. Foliar application of *tumba* + *panchgavya* and Datura + *panchgavya* while remaining at par with each other was the next best treatments in this regard. Frequency of foliar application at critical growth stages also affected accumulation of dry matter favourably in various plant parts (Table 2). Dual application of foliar sources both at branching + flowering recorded significantly higher accumulation of dry matter at 70 DAS and harvest over single application of the sources either at branching or flowering. At harvest application of the foliar sources both at branching + flowering recorded 13, 19 and 32% higher accumulation of dry matter in leaf, stem and pod on pooled basis compared to single application at flowering. The significant improvement in the accumulation of dry matter in plant and its distribution in different plant parts in the study was attributed to increased supply of plant nutrients, specific weight

Table 2. Effect of foliar applied source and their stage of application on leaf area index (LAI) and dry matter accumulation (DMA) of groundnut (pooled data)

Treatment	LAI			DMA at 45 DAS (g/plant)			DMA at 70 DAS (g/plant)				DMA at harvest (g/plant)			
	45 DAS	70 DAS	Harvest	Leaf	Stem	Total	Leaf	Stem	Pod	Total	Leaf	Stem	Pod	Total
Foliar source														
Control	1.53	3.15	3.31	2.43	1.46	3.88	22.53	10.39	4.24	37.16	23.45	11.68	40.15	75.28
Panchgavya	1.62	3.48	3.61	2.68	1.55	4.23	24.03	12.92	6.14	43.10	24.64	13.86	44.47	82.97
Panchgavya + neem	1.91	4.40	4.90	3.33	1.93	5.26	34.59	19.19	8.90	62.68	36.82	20.68	68.65	126.16
Panchgavya + *datura*	1.78	3.95	4.19	2.98	1.79	4.77	31.68	15.91	7.26	54.85	33.10	18.31	58.91	110.33
Panchgavya + tumba	1.84	4.18	4.74	2.99	1.69	4.68	32.64	16.74	7.46	56.83	35.08	19.21	58.97	113.26
SEm±	0.04	0.10	0.08	0.08	0.04	0.09	0.42	0.39	0.11	0.63	0.61	0.50	1.59	1.52
CD (P= 0.05)	0.12	0.30	0.23	0.23	0.12	0.25	1.19	1.09	0.30	1.79	1.74	1.41	4.51	4.32
Stage of foliar application														
Branching (B)	1.83	3.88	4.13	3.17	1.81	4.98	29.05	14.93	6.55	50.53	30.19	16.43	53.03	99.65
Flowering (F)	1.59	3.39	3.94	2.30	1.42	3.73	25.73	14.40	5.65	45.79	28.89	15.43	47.33	91.65
B + F	1.79	4.22	4.37	3.17	1.82	4.99	32.50	15.76	8.20	56.46	32.78	18.39	62.34	113.50
SEm±	0.03	0.08	0.06	0.06	0.03	0.07	0.33	0.30	0.08	0.49	0.47	0.38	1.23	1.18
CD (P= 0.05)	0.09	0.23	0.18	0.18	0.09	0.20	0.92	0.85	0.23	1.39	1.34	1.09	3.50	3.34

Table 3. Effect of foliar applied source and their stage of application on N and P content (%) of groundnut parts at different growth stages

Treatments	45 DAS				70 DAS				Harvest			
	Leaf		Stem		Leaf		Stem		Haulm		Kernel	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
						Nitrogen content (%)						
Foliar source												
Control	1.354	1.285	1.179	1.183	2.112	2.087	2.057	2.048	2.188	2.163	3.124	3.082
Panchgavya	1.359	1.369	1.269	1.232	2.192	2.126	2.203	2.152	2.463	2.415	3.186	3.144
Panchgavya + neem	1.460	1.448	1.342	1.324	2.889	2.789	2.612	2.575	2.709	2.698	3.405	3.368
Panchgavya + *datura*	1.402	1.371	1.303	1.266	2.364	2.314	2.344	2.331	2.527	2.518	3.224	3.184
Panchgavya + tumba	1.454	1.402	1.297	1.300	2.542	2.527	2.447	2.392	2.652	2.602	3.291	3.255
SEm±	0.026	0.025	0.023	0.023	0.043	0.042	0.034	0.034	0.052	0.051	0.054	0.053
CD (P= 0.05)	0.075	0.073	0.067	0.066	0.125	0.122	0.100	0.098	0.150	0.148	0.156	0.154
Stage of foliar application												
Branching (B)	1.462	1.391	1.312	1.314	2.415	2.364	2.336	2.303	2.525	2.457	3.214	3.171
Flowering (F)	1.331	1.302	1.189	1.173	2.341	2.292	2.292	2.239	2.404	2.416	3.186	3.147
B+F	1.424	1.432	1.333	1.295	2.503	2.450	2.371	2.357	2.595	2.565	3.338	3.302
SEm±	0.020	0.020	0.018	0.018	0.033	0.033	0.027	0.026	0.040	0.040	0.042	0.041
CD (P= 0.05)	0.058	0.057	0.052	0.051	0.097	0.095	0.077	0.076	0.116	0.115	0.121	0.120
						Phosphorus content (%)						
Foliar source												
Control	0.294	0.291	0.269	0.260	0.224	0.215	0.132	0.131	0.145	0.147	0.446	0.433
Panchgavya	0.336	0.292	0.276	0.279	0.236	0.233	0.164	0.158	0.169	0.163	0.489	0.477
Panchgavya + neem	0.350	0.385	0.303	0.305	0.286	0.289	0.209	0.211	0.190	0.190	0.582	0.573
Panchgavya + *datura*	0.339	0.315	0.288	0.278	0.276	0.276	0.190	0.190	0.179	0.175	0.515	0.504
Panchgavya + tumba	0.326	0.342	0.299	0.295	0.265	0.257	0.191	0.187	0.180	0.178	0.563	0.553
SEm±	0.006	0.007	0.006	0.006	0.004	0.004	0.003	0.003	0.003	0.003	0.008	0.008
CD (P= 0.05)	0.017	0.020	0.017	0.017	0.011	0.011	0.009	0.009	0.010	0.010	0.022	0.022
Stage of foliar application												
Branching (B)	0.359	0.335	0.305	0.301	0.263	0.253	0.180	0.174	0.171	0.167	0.517	0.500
Flowering (F)	0.289	0.286	0.251	0.248	0.227	0.224	0.164	0.162	0.155	0.155	0.502	0.491
B + F	0.338	0.354	0.306	0.302	0.282	0.285	0.188	0.190	0.192	0.190	0.539	0.533
SEm±	0.005	0.005	0.005	0.005	0.003	0.003	0.002	0.002	0.003	0.003	0.006	0.006
CD (P= 0.05)	0.013	0.015	0.013	0.013	0.009	0.008	0.007	0.007	0.008	0.008	0.017	0.017

of leaf, chlorophyll synthesis, nitrogen metabolism, root nodules and phytohormones with the application of *panchgavya* and *panchgavya* + leaf extracts. The supply of N in plant increased specific area of leaf and content of N into the leaf and for a given species, photosynthetic rate of leaves are strongly related to the specific leaf area and N concentration per unit dry mass. Improved nutrition (Fig. 1) may enable greater leaf area production that results in greater interception of light thereby increasing dry matter productivity. Apart from nutrient supply, *panchgavya* contain proven biofertilizers, *viz.*, *Azospirillum*, *Azotobacter*, *Phosphobacter*, *Pseudomonas* that play important role in stimulation of plant growth by secreting IAA and GA_3 (Mahalingam and Sheela, 2003).

Nutrient content and uptake

In both the years, content of N in vegetative parts of plant recorded consistence increase with progress in plant growth from 45 DAS up to harvest while reverse trend

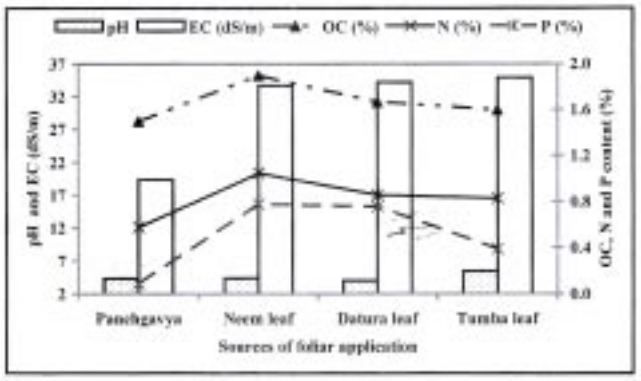

Fig. 1. Physicochemical properties of concentrated *panchgavya* and plant leaf solutions used for foliar application on groundnut

was noticed with content of P in plant parts with all the foliar sources (Table 3). The content of N and P in various plant parts recorded significantly higher with *panchgavya* + neem at all the stages followed by *panchgavya* + tumba. Similarly, foliar application of *panchgavya* + NLE recorded significantly higher N and P uptake by haulm and kernels (Table 4). At harvest, foliar application of *panchgavya* + NLE recorded 24 and 9 % higher N in 2006 and 25 % and 9 % in 2007 while 31 and 30 % higher P in 2006 and 29 % and 32 % in 2007 in haulm and kernel over control, respectively. Similarly, total uptake of N in 2006 and 2007 increased to the tune of 79 and 55 % while P uptake by 116 and 79 % with application of *panchgavya* + NLE over control, respectively. Similar to physiological growth, dual application of the foliar sources at branching + flowering recorded the highest content and uptake of N and P in haulm and kernel at harvest than application either at branching or flowering. Both content and uptake of N and P in plant parts recorded significantly lowest with foliar application of the sources at flowering among the stages of foliar application. The higher nutrient content in various plant parts with *panchgavya* + NLE was attributed to higher dry matter accumulation which in turn favours translocation of more carbohydrates towards developing roots. Increased allocation of food material to roots in turn enhanced the root volume and weight of root nodules thereby concomitantly increased uptake of more plant nutrients (Poorter and Nagel, 2000).

Yield, yield attributes and economics

The yield attributes as of pods/plant, pod index, kernel index, shelling per cent, harvest index and protein content

Table 4. Effect of foliar applied source and their stage of application on N and P uptake (kg/ha) by groundnut at harvest

Treatment	N						P					
	Haulm		Kernel		Total		Haulm		Kernel		Total	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Foliar source												
Control	44.8	40.1	45.7	37.7	90.7	77.8	3.08	2.70	6.53	5.31	9.61	8.01
Panchgavya	56.5	50.1	52.2	40.8	108.6	91.2	3.84	3.43	8.00	6.23	11.85	9.66
Panchgavya + neem	69.6	62.4	92.2	58.6	162.7	120.9	4.99	4.40	15.81	9.95	20.79	14.34
Panchgavya + datura	55.1	54.3	70.8	50.3	126.2	104.4	3.90	3.81	11.33	7.97	15.23	11.78
Panchgavya + tumba	61.0	57.9	73.2	51.4	134.2	109.8	4.18	4.00	12.62	8.72	16.81	12.73
SEm±	2.8	2.2	2.9	1.6	3.6	3.0	0.20	0.15	0.50	0.24	0.48	0.31
CD (P= 0.05)	8.1	6.5	8.3	4.8	10.3	8.7	0.58	0.44	1.45	0.71	1.40	0.90
Stage of foliar application												
Branching (B)	53.7	51.4	64.0	46.0	117.5	98.1	3.64	3.55	10.35	7.34	13.99	10.89
Flowering (F)	48.4	49.0	52.4	41.5	101.3	90.5	3.14	3.15	8.41	6.54	11.55	9.69
B + F	69.9	57.8	84.1	55.7	154.6	114.0	5.22	4.31	13.82	9.02	19.03	13.33
SEm±	2.2	1.7	2.2	1.3	2.8	2.3	0.15	0.12	0.39	0.19	0.38	0.24
CD (P= 0.05)	6.2	5.0	6.4	3.7	8.0	6.8	0.45	0.34	1.12	0.55	1.09	0.69

were recorded significantly highest with *panchgavya* + NLE in 2006 and 2007 (Table 5). On an average, application of *panchgavya* plus neem increased pods/plant, pod index, kernel index, shelling per cent, harvest index and protein content by 37, 26, 28, 7, 10, and 9 %, respectively over control. The pod and biological yields also recorded significantly higher with the *panchgavya* + NLE in both the years (Table 6). Pod and biological yields were recorded considerably higher in 2006 when compared with 2007 probably because of higher (369 mm) and well distribution of rainfall during 32 to 36 standard meteorological weeks than 2007. Compared to control, pod yield increased to the tune of 68 and 35 % in 2006 and 2007 while biological yield recorded 48 and 23 % increase with *panchgavya* + NLE, respectively over control. In both years yield attributes and yield were recorded significantly higher with application of sources both at branching + flowering over single application either at branching or flowering. On an average, pod and biological yield recorded 37 and 30 % increase with branching + flowering spray over spray at flowering. The data on economics (Table 6) revealed that foliar application of *panchgavya* + leaf extracts and *panchgavya* alone increased net returns and B:C ratio compared to control during both the years, being significantly highest net return of Rs 59,160/ha (2006) and Rs 31,638/ha (2007) and B:C ratio 2.85 (2006) 1.53 (2007) recorded with *panchgavya* + NLE. Similarly, application of sources at branching + flowering resulted in significantly higher net return (Rs 55,376/ha and Rs 30,385/ha) as well as B:C ratio (2.66 and 1.46) over application at branching or flowering in 2006 and 2007, respectively (Table 6). The significant improvement in dry

Table 5. Effect of foliar applied source and stage of application on yield attributes of groundnut

Treatment	Pods/plant		Pod index (g)		Kernel index (g)		Shelling %		Harvest Index (%)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Foliar source										
Control	42.1	36.2	107.6	62.1	27.9	27.4	67.0	70.7	51.4	48.2
Panchgavya	46.3	37.9	112.8	66.6	30.3	29.7	68.9	71.9	50.6	46.4
Panchgavya + neem	58.2	49.0	134.3	79.6	35.6	34.9	73.3	74.4	59.3	50.2
Panchgavya + *datura*	53.6	41.8	130.7	73.5	34.8	34.1	71.4	73.3	57.6	49.7
Panchgavya + tumba	54.2	44.3	126.9	69.4	32.7	32.1	70.9	72.5	57.5	49.3
SEm±	1.4	1.7	0.9	0.9	1.1	1.1	0.6	0.6	1.9	1.2
CD (P= 0.05)	4.1	5.0	2.5	2.7	3.3	3.3	1.8	1.7	5.4	3.5
Stage of foliar application										
Branching (B)	49.9	41.4	122.2	69.5	31.7	31.1	69.8	72.2	56.7	48.8
Flowering (F)	45.9	36.6	114.5	67.7	30.6	30.0	69.5	71.8	53.0	47.2
B + F	56.9	47.5	130.7	73.5	34.4	33.8	71.7	73.7	56.1	50.2
SEm±	1.1	1.3	0.7	0.7	0.9	0.9	0.5	0.4	1.5	0.9
CD (P= 0.05)	3.2	3.9	1.9	2.1	2.6	2.5	1.4	1.3	4.2	2.7

Table 6. Effect of foliar applied source and stage of application on yield (t/ha) and economics (x 10^3 Rs/ha) of groundnut

Treatment	Pod yield		Biological yield		Cost of cultivation (mean)	Net returns		Net B:C ratio	
	2006	2007	2006	2007		2006	2007	2006	2007
Foliar source									
Control	2.18	1.72	4.23	3.58	20.04	28.64	19.02	1.43	0.95
Panchgavya	2.37	1.80	4.66	3.88	20.58	32.59	20.62	1.58	1.00
Panchgavya + neem	3.67	2.33	6.24	4.64	20.73	59.16	31.64	2.86	1.53
Panchgavya + *datura*	3.05	2.15	5.23	4.30	20.73	45.79	27.57	2.21	1.33
Panchgavya + tumba	3.16	2.17	5.46	4.40	20.73	48.16	28.21	2.32	1.36
SEm±	0.15	0.05	0.19	0.08		3.03	1.08		
CD (P= 0.05)	0.43	0.16	0.54	0.24		8.77	3.11		
Stage of foliar application									
Branching (B)	2.83	2.00	4.95	4.09	20.46	41.40	24.73	2.02	1.21
Flowering (F)	2.36	1.83	4.38	3.85	20.46	31.83	21.12	1.56	1.03
B+F	3.47	2.28	6.16	4.53	20.76	55.38	30.39	2.66	1.46
SEm±	0.12	0.04	0.15	0.06		2.35	0.83		
CD (P= 0.05)	0.33	0.12	0.42	0.18		6.80	2.41		

matter accumulation, chlorophyll content and nitrogen metabolism described above may be ascribed to higher yield and yield attributes with *panchgavya* + neem. Since dry matter accumulation/plant showed significant increase with *panchgavya* + neem when compared with control. Selvaraj (2003) also observed 36% increased yield of french bean with application of vermicompost + *panchgavya*. Increased pod intensity/plant with application of neem leaf extract was reported by Oparaeke *et al*. (2001) in cowpea. Natarajan (2002) opined increased yield of crop plants with *panchgavya* application due to enhancement in the biological efficiency of crop plants.

From the study it is inferred that application of *panchgavya* + neem leaf extract at branching and flowering is advantageous in increasing chlorophyll content, nitrate reductase activity, physiological growth, nutrient content and uptake, dry matter accumulation, yield and yield attributes and economics of groundnut. Therefore, it can be recommended as an alternate source of nutrients for organic cultivation of groundnut.

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