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Growth and yield of groundnut in relation to soil application of panchgavya and foliar spray of endogenous plant leaf extracts

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ABSTRACT

In view of the cost effectiveness and eco-friendly characteristics of the panchgavya, a field experiment was conducted on the high pH soils of arid zone of India to examine the effect of soil applied panchgavya and foliar applied plant leaf extracts on the growth yield of groundnut (*Arachis hypogaea* L.) during *kharif* 2006 and 2007 at Jaisalmer. The results of the experiment revealed that successive increase in panchgavya solution from 0 to 3.0 l/m^2 recorded significant increase in growth and yield of groundnut. The pod, haulm and biological yield were 85, 93 and 90 % higher than control with soil application of panchgavya solution at 3.0 l/m^2. The improvement in dry matter accumulation and physiological growth in terms of SLW, CGR, RGR and NAR were recorded significantly higher with soil application of panchgavya at 2.0 l/m^2. Foliar application of neem (*Azadirachta indica*), datura (*Datura metel*) and tumba (*Citrullus colocynthis*) plant leaf extracts in combination with panchgavya in 1: 1 ratio at 35 and 55 days after application recorded higher growth and yield compared to water sprayed control. The CGR, RGR and NAR at 45-70 DAS and 70 DAS –harvest and pod, haulm and biological yields were however recorded significantly maximum with foliar application of datura + panchgavya solution among sources of foliar application.

Key words: Growth, Groundnut, Leaf extract, Panchgavya, Yield

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop in India. India is the second largest producer of groundnut accounting for 38% of the total area (7.7 million ha) and 31% production (6.7 m t) of the world (Chandrasekaran *et al*. 2007) in groundnut production. India has immense potential for exporting large seeded groundnut; however, lack of production technologies exclusive for organically produced groundnut has restricted the scope for exports. In the existing technologies of organic farming where farm yard manure and compost are being used as sources of nutrient supply, productivity of soils falls 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). Thus, it is imperative to develop technologies that sustain yield levels of all crops during the transitory period from the very first year. Role of panchgavya in production of many plantation crops grown over wide agroclimatic conditions has been well documented in India There are reports indicated that efficacy of panchgavya solution enhanced manifold with the mixing of endemic plant leaves (Selvraj 2006). The endemic plants such as tumba (*Citrullus colocynthis*) and datura (*Datura metel*) grow naturally on the waste lands of Indian Thar desert producing lot of biomass of no values. Thus, these vegetations could serve as resource for supplying plant nutrients in agriculture. However, information on use of panchgavya in combination with leaf extracts of endemic plants on groundnut is very meager. In view of the above considerations, present study was conducted to examine the effect of soil applied panchgavya and foliar applied plant leaf extracts in combination with panchgavya on the growth and yield of groundnut in the desertic areas under irrigated conditions.

MATERIALS AND METHODS

The experiment was conducted at Central Arid Zone Research Institute, Regional Research Station, Jaisalmer, Rajasthan during *kharif* 2006 and 2007 under irrigated condition. 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. The experiment was laid out in a split-plot-design with four levels of soil applied panchgavya (0, 1.0, 2.0 and 3.0 l/m^2) in main plots and four levels of foliar applied sources (control, neem, datura and tumba) in sub plots with three replications. The control was run with tape water. Panchgavya was prepared by thorough mixing of fresh cow dung (7.0 kg), cow ghee (1.0 kg), fresh cow urine (10.0 l), cow milk (3.0 l) and cow milk curd (2.0 l) followed by fermentation for 20 days in an open plastic drum. The leaf extracts of neem (*Azadirachta indica)*, datura (*Datura metal*) and tumba (*Citrullus colocynthis*) were prepared by mixing fresh ground leaves with cow urine in 1:1 ratio followed by fermentation. After a pre-sowing irrigation, the groundnut cultivar 'MA-10' was sown in the second week of July in both the years. The seeds were treated with *Trichoderma viridae* (6 g/kg seed) as prophylactic measure against seed borne diseases. Sowing was done in rows spaced at 45 cm apart using a seed rate of 80 kg/ha. Thinning was done at 10 days after sowing (DAS) in order to maintain plant to plant distance of 25 cm. The fermented panchgavya solution was diluted 15 times with water and applied near the groundnut plants in soil just after second irrigation at 25 DAS as per the treatments. The filtrates of leaf extracts were mixed with the filtered panchgavya solution in 1:1 ratio and diluted 30 times with water for foliar application. The foliar application of the sources was done twice on the groundnut leaves at 35 and 55

Table 1. Chemical properties of finally filtered and undiluted panchgavya and foliar sources

Sources	Organic carbon (%)	pH	Electrical conductivity (dS/m)	Nitrogen (%)	Phosphorus (%)
Panchgavya	1.50	4.35	19.36	0.58	0.90
Neem	1.90	4.39	33.70	1.05	0.78
Tumba	1.60	5.42	34.90	0.83	0.39
Datura	1.67	4.00	34.20	0.86	0.76

DAS as per treatments. Five plants in each treatment were uprooted manually for analysis of growth. The plants of the sample were separated into its component plant parts – leaves, stems and pods- and leaf area was measured using the planimeter method (Milthorpe 1956). Dry weights of plant parts were obtained after oven drying at 70° C for 72 hours, to determine shoot dry matter and its distributions. The leaf area index (LAI), specific leaf weight (SLW), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) were calculated using formula as given in the literature (Gardner *et al*. 1995). Biological yield and pod yield was computed from the plants harvested from net plots in each treatment.

RESULTS AND DISCUSSION

Effect of panchgavya: The mean results of the two *kharif* seasons on dry matter partitioning are presented in Table 2. Contribution of leaf and stem towards total plant dry matter production decreased with the progress in growth. At 45 DAS, leaf and stem contributed 43 and 57 % in the total plant dry matter which remained only 22 and 35 % at harvest. The increase in total plant dry matter production at 70 DAS coincided the pod formation stage in the groundnut. The contribution of pods in the total plant dry matter increased from 31 % at 70 DAS to 43 % at harvest. Dry matter accumulation in leaf, stem, pods as well as plant increased linearly with the successive increase in soil applied panchgavya from 0 to 3.0 l/m^2 at all the phenophases, highest being with 3.0 l/m^2. The physiological parameters viz., per plant leaflets and leaf area, LAI, SLW, CGR, RGR and NAR were influenced by panchgavya levels. The number of leaflets, leaf area and LAI per plant increased significantly with successive increase in panchgavya levels up to 3.0 l/m^2 (Table 3) while SLW, CGR, RGR, and NAR at all the observed stages recorded significantly maximum with 2.0 l/m^2 of panchgavya (Table 4). The biological, haulm and pod yields per hectare also responded positively to the increased levels of panchgavya. Soil application of panchgavya at 3.0 l/m^2 recorded 85, 93 and 90 per cent higher pod, haulm and biological yield compared to control (Figure 1).

The increase in the dry matter accumulation in the study

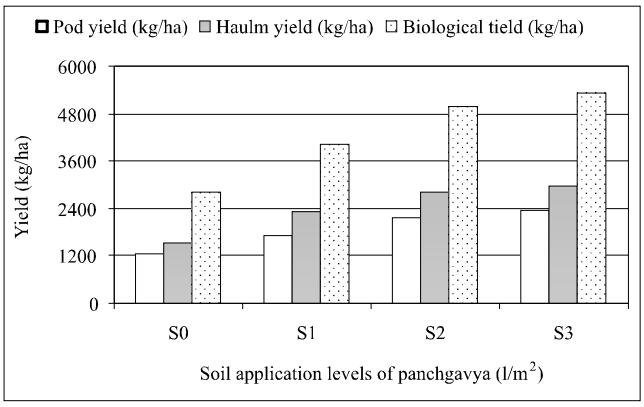

Fig 1. Effect of soil applied panchgavya on yield of groundnut (kg/ ha), mean of *kharif* 2006 and 2007 (S0 = control (panchgavya), S1 = soil application of panchgavya @1.0 l/m^2, S2 = soil application of panchgavya @2.0 l/ m^2 and S3 = soil application of panchgavya @3.0 l/m^2.)

Table 2. Effect of soil applied panchgavya and foliar applied leaf extracts on the dry matter accumulation of groundnut at different growth stages (mean of *kharif* 2006 and 2007)

Treatments	Plant dry matter at 45 DAS (g/plant)			Plant dry matter at 70 DAS (g/plant)				Plant dry matter at harvest (g/plant)			
	Stem	Leaf	Plant	Stem	Leaf	Pod	Plant	Stem	Leaf	Pod	Plant
Soil application of panchgavya (l/m^2)											
S_0	1.99	2.82	4.81	4.40	5.99	4.44	14.82	7.30	10.76	14.92	32.98
$S_{1.0}$	2.43	3.32	5.75	5.90	7.37	5.22	18.50	10.90	16.44	17.26	44.60
$S_{2.0}$	2.92	3.76	6.68	7.09	9.34	8.02	24.45	12.67	20.49	26.40	59.56
$S_{3.0}$	3.39	4.25	7.65	8.26	10.01	8.27	26.54	13.17	21.72	27.82	62.71
SEm±	0.05	0.08	0.09	0.11	0.16	0.11	0.46	0.13	0.30	0.30	0.73
CD (P=0.05)	0.16	0.24	0.29	0.35	0.49	0.33	1.41	0.41	0.92	0.91	2.24
Foliar sources											
Control (Water spray)	2.45	3.04	5.49	5.83	6.68	5.11	17.63	9.14	14.98	17.09	41.21
Neem leaf extract + panchgavya	2.99	3.86	6.84	7.01	9.11	7.25	23.37	12.44	19.43	22.84	54.71
Datura leaf extract + panchgavya	2.68	3.68	6.36	6.52	8.61	6.92	22.05	11.38	17.72	25.03	54.13
Tumba leaf extract + panchgavya	2.62	3.58	6.20	6.28	8.32	6.67	21.26	11.09	17.27	21.43	49.79
SEm±	0.05	0.06	0.09	0.10	0.15	0.10	0.44	0.13	0.28	0.28	0.69
CD (P=0.05)	0.14	0.18	0.24	0.29	0.43	0.29	1.24	0.37	0.81	0.80	1.97

S0= control (panchgavya), S1= soil application of panchgavya @ 1.0 l/m^2, S2= soil application of panchgavya @ 2.0 l/m^2 and S3= soil application of panchgavya @ 3.0 l/m^2

was attributed to improved availability of micronutrients, soil microbiology and reduction in soil pH and EC with the addition of panchgavya. The increased nutrient supply (added or native) in turn enhanced rapid initiation of leaves and their expansion thereby giving higher leaf area, higher chlorophyll synthesis and photosynthetic rate which ultimately reflected by higher dry matter accumulation in the plant. Further, panchgavya application increases the population of proven biofertilizers that play important role in the promotion of plant growth by secreting phytohormones, auxin, cytokinin and giberrelic acid (Mahalingam and Sheela 2003). The bioactive substances secreted by beneficial microorganisms might have kept the opening of stomata for longer period (both under favourable and unfavourable conditions) leading to increased LAI (Xu *et al*. 2000). The reduction in soil pH with application of panchgavya owing to low pH of the medium (4.35) increases the solubility of the Ca (Freney *et al*. 1962) and P in root rhizosphere, essentially required for the formation and development of the shell of the pods. Thus increased dry matter of pods per plant with increased levels of panchgavya was evident. The improvement in number of leaflets and plant dry matter with application of panchgavya might have resulted into increased LAI, SLW, CGR, RGR and NAR. The increased dry matter and yield attributes thus contributed for higher pod and biological yield with panchgavya levels compared to control. Selvaraj (2003) also observed 36 % increased yield of frenchbean with application of vermicompost + panchgavya due to restoration of soil fertility with these sources.

Effect of foliar applied sources: All the sources of foliar application recorded significantly higher accumulation of plant dry matter and its distribution compared to water sprayed control at all the observed stages (Table 2). Foliar application of neem leaf extracts however had recorded significantly the highest dry matter accumulation in leaf and stem over other foliar treatments. Though pod dry matter during pod formation stage (70 DAS) was recorded highest with neem leaf extracts, it was recorded statistically superior with datura leaf extracts at harvest. The number of leaflets, leaf area and LAI per plant at all the stages of crop growth was recorded significantly higher with foliar application of neem leaf extract than the other sources of application (Table 3). However, it remained at par with datura leaf extract in this regard during 45 and 70 DAS. The foliar applied neem, datura and tumba being at par with each other had statistically higher SLW than the control at all the stages of crop growth (Table 4). The CGR, RGR and NAR were recorded significantly higher with foliar application of datura leaf extract followed by neem and tumba both at 45-70 DAS and 70 DAS –harvest (Table 4). Foliar application of leaf extracts of neem and datura remained at par to each other in this regard except at 70 DAS-harvest where datura leaf extract recorded the highest RGR and NAR than other foliar sources. Though foliar application of neem leaf extract recorded

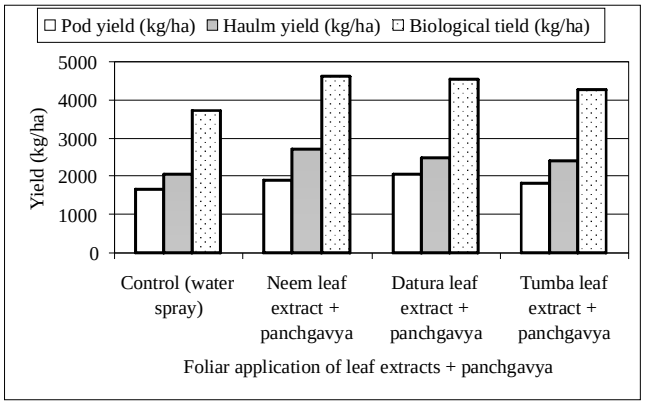

Fig 2. Effect of foliar application of leaf-extracts plus panchgavya on yield of groundnut (kg/ha) (mean of *kharif* 2006 and 2007)

Table 3. Effect of soil applied panchgavya and foliar applied leaf extracts on the number of leaflets, leaf area and leaf area index (LAI) of ground nut at different growth stages (mean of *kharif* 2006 and 2007)

Treatments	Number of leaflets/plant			Leaf area/plant (cm^2)			Leaf area index		
	45 DAS	70 DAS	Harvest	45 DAS	70 DAS	Harvest	45 DAS	70 DAS	Harvest
Soil application of panchgavya (l/m^2)									
S0	171	295	471	1056	1291	1825	0.88	1.08	1.52
S1	187	336	668	1272	1521	2676	1.06	1.27	2.23
S2	228	387	758	1446	1880	3254	1.20	1.57	2.71
S3	237	405	787	1555	1997	3429	1.30	1.66	2.86
SEm±	3	5	9	26	30	40	0.02	0.02	0.03
CD (P=0.05)	8	15	29	80	91	123	0.07	0.07	0.10
Foliar sources									
Control (Water spray)	195	326	648	1181	1465	2588	0.98	1.22	2.16
Neem leaf extract + panchgavya	213	375	710	1427	1808	3035	1.19	1.51	2.53
Datura leaf extract + panchgavya	210	366	669	1387	1737	2817	1.16	1.45	2.35
Tumba leaf extract + panchgavya	204	357	657	1334	1678	2744	1.11	1.40	2.29
SEm±	3	5	11	25	28	41	0.02	0.02	0.03
CD (P=0.05)	7	13	30	72	79	115	0.06	0.06	0.10

S0= control (panchgavya), S1= soil application of panchgavya @ 1.0 l/m^2, S2= soil application of panchgavya @ 2.0 l/m^2 and S3= soil application of panchgavya @ 3.0 l/m^2

Table 4. Effect of soil applied panchgavya and foliar applied leaf extracts on the specific leaf weight (SLW), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) of groundnut at different growth stages (mean of *kharif* 2006 and 2007)

Treatments	SLW (mg/cm^2)			CGR (g/m^2/day)		RGR (mg/g/day)		NAR (mg/cm^2/day)	
	45 DAS	70 DAS	Harvest	45-70 DAS	70 DAS-harvest	45-70 DAS	70 DAS-harvest	45-70 DAS	70 DAS-harvest
Soil application of panchgavya (l/m^2)									
S0	2.67	4.64	5.89	3.34	3.03	83.12	24.47	0.342	0.235
S1	2.61	4.84	6.14	4.25	4.35	88.57	28.20	0.365	0.255
S2	2.60	4.96	6.29	5.93	5.85	106.25	28.65	0.429	0.280
S3	2.78	5.02	6.38	6.30	6.03	98.80	27.59	0.427	0.274
SEm±	0.04	0.05	0.06	0.14	0.06	2.19	0.38	0.007	0.003
CD (P=0.05)	0.13	0.15	0.18	0.43	0.19	6.75	1.16	0.022	0.008
Foliar sources									
Control (Water spray)	2.58	4.55	5.78	4.05	3.93	87.31	26.54	0.363	0.237
Neem leaf extract + panchgavya	2.70	5.03	6.38	5.51	5.22	96.29	26.63	0.407	0.262
Datura leaf extract + panchgavya	2.69	4.93	6.24	5.23	5.35	97.49	29.18	0.397	0.284
Tumba leaf extract + panchgavya	2.69	4.95	6.29	5.02	4.75	95.65	26.56	0.395	0.261
SEm±	0.04	0.05	0.06	0.13	0.06	1.75	0.38	0.006	0.002
CD (P=0.05)	0.12	0.14	0.17	0.37	0.18	4.96	1.08	0.018	0.006

S0= control (panchgavya), S1= soil application of panchgavya @ 1.0 l/m^2, S2= soil application of panchgavya @ 2.0 l/m^2 and S3= soil application of panchgavya @ 3.0 l/m^2

statistically higher haulm yield, pod yield per hectare was observed significantly higher with datura leaf extract (Figure 2). Foliar application of datura leaf extract recorded 22 and 21 per cent higher pod and biological yields compared to water sprayed control.

The higher dry matter accumulation in plant and its parts with neem, datura and tumba leaf extract in the study was attributed to higher chlorophyll content, nitrate reductase activity, root nodule weight and plant nutrients which in turn increases the photosynthetic capacity of the plants. The higher chlorophyll content, nitrate reductase activity and root nodule weight with these leaf extract might be due to supply of more of plant nutrients to crop plants owing to higher N and P content of the medium used in the study compared to control (Table 1). Besides, sources of foliar application (neem, datura and tumba) have many beneficial microorganism that maintain 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). Increased pod intensity per plant with application of neem leaf extract has also been reported by Oparaeke *et al*. (2001) in cowpea. The significant improvement in dry matter and photosynthetic source thus might have increased the physiological growth indices of the groundnut in the study compared to control. However, the role of datura in increasing growth and pod yield is not known and is a point of further exploration.

The study suggested that soil application of panchgavya at 3.0 l/m^2 and foliar application of datura leaf extract at 35 and 55 DAS could be a best combination of treatments to get maximum plant dry matter, growth and pod yield of groundnut on the high pH calcareous soils of the arid western India.

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