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Foliar application of panchagavya and leaf extracts of endemic plants on performance and quality of groundnut (*Arachis hypogaea* L.)

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Abstract
An experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the "Foliar application of panchagavya and leaf extracts of endemic plants on performance and quality of groundnut (*Arachis hypogaea* L.)." during 2010 on loamy sand soils. The soil was low in organic carbon and available nitrogen medium in available phosphorus and high in available potash. The eighteen treatments of foliar spray combinations in the experiment comprised of six sources of foliar application and 3 stages of application. Plant height, number of nodules were recorded maximum under application of foliar spray of panchagavya plus neem followed by treatment panchagavya plus glyricidia leaf extract. Pod yield, haulm yield, harvest index, protein content and oil content of groundnut increased by 87, 53, 14, 19 and 4 % respectively with foliar application of panchagavya plus neem leaf extract over the control.

Keywords: Custard apple, glyricidia, groundnut, leaf extract, neem, oak, panchagavya

Introduction
Agriculture is considered to be one of the oldest occupations, perhaps as human civilization. About half of the world‟s population is engaged in agriculture, of which the developing countries of Asia contribute more than 75%. Indian agriculture contributes about 40% of the nation‟s income, though about 72% of the population engaged in it and it is approaching the "take off" to scientific farming. Portending a continuing demand for scientific information to improve the basis for agriculture in the future. In fact, sixty percent of our agricultural land, which is currently under cultivation suffer from serious problems of soil health, mainly due to indiscriminate use of chemical fertilizers. Heavy use of chemicals in agriculture has weakened the ecological base in addition to degradation of soil, water resources and quality of the food. At this juncture, a keen awareness has sprung on the adoption of "organic farming" as a remedy to cure the ills of modern chemical agriculture (Kannaiyan, 2000) [1]. Panchagavya, an organic product has potential to play the role in promoting growth and providing immunity in plant system. The use of organic liquid products such as Panchagavya results in higher growth, yield and quality of crops. These liquid organic solutions are prepared from cow dung, urine, milk, curd, ghee, legume flour and jaggary. These liquid products contain macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Palekar, 2006; Natarajan, 2007 and Sreenivasa *et al*., 2010) [7, 5, 14]. Neem (*Azadirachta indica*) leaves are of tremendous use in agricultural industry; the leaves possess insect repellent properties and are used as herbal pesticide, insecticide and reported that neem leaf extract increased growth and yield of crops as well as control the insect pests. Custard apple (*Annona squamosa* L.) leaf extract is used for, increasing the number of biochemical targets in the insects limiting prospect of reducing pesticides dose and producing lot of biomass which could be utilized for plant nutrient and increased growth and yield of crops. *Glyricidia sepium* is a medium-sized leguminous tree. Glyricidia leaf extract increase plant growth and yield as a nutrient solution. Swallow-wort or- oak (*Calotropis gigantea*) leaf extract may be utilized as the probable for the development of bio insecticide to control insect and improve the growth and yield of crop. *Calotropis gigantea* leaf extract was found to be more active in plant growth, yield and insecticidal potential.

Material and Methods

The experiment was laid out is situated geographically at 24º - 19'North latitude and 72º – 10' East longitude with an altitude of 154.52 meter above the mean sea level. It represents the North Gujarat Agro-climate Zone. The climate in the area is semi-arid subtropical, warm and moderately humid; winter is fairly cold and dry while summer is quite hot and dry with an average annual rainfall of 1049 mm (75–80% of which is typically received from June to September). The temperature data for the period under revealed that as the mean weekly maximum temperature varied from 30.5 to 41.2 °C. Similarly, the mean weekly minimum temperature varied from 18.8 to 28.9 °C. The weekly relative humidity, in morning varied from 74.3 to 97.5 per cent. Similarly, the mean weekly relative humidity in evening varied from 30.1 to 84.0 per cent (Fig. 1).

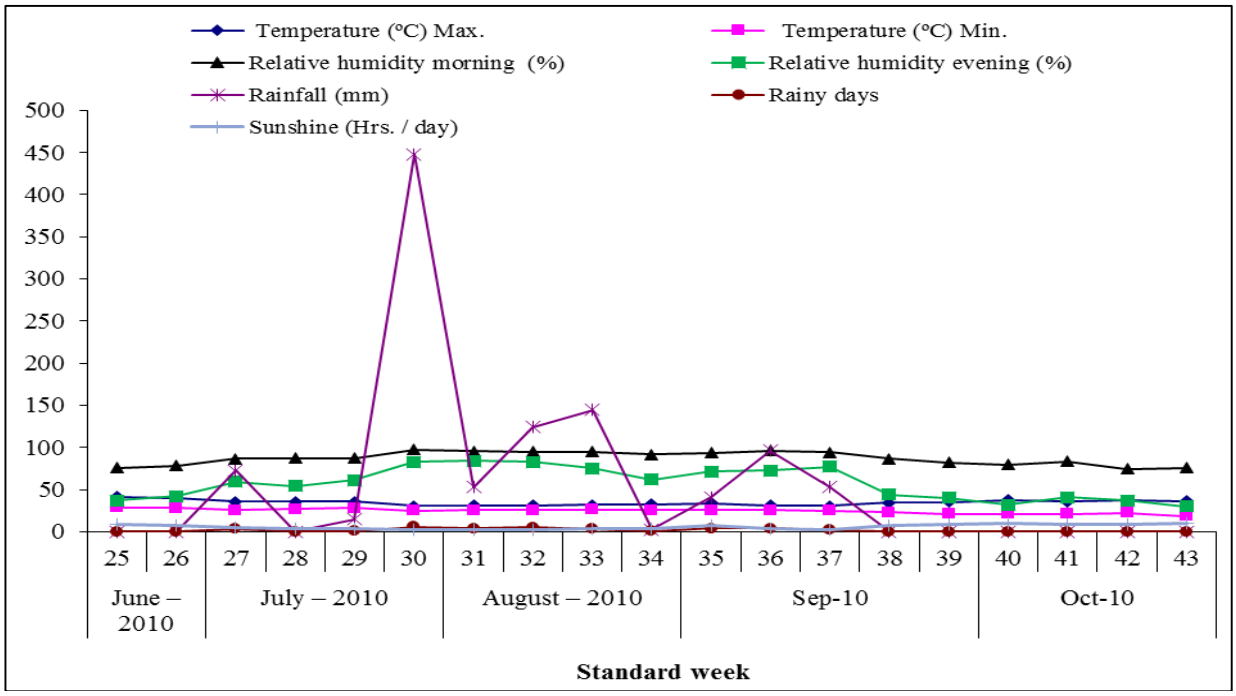

Fig 1: Mean weekly meteorological data for period of investigation during *kharif* 2010.

Physico-Chemical Properties of Soil

To find out physico-chemical characteristics of soil, soil sample were taken randomly before the commencement of experiment from different spots in the field at a depth of 0-15 cm and 15-30 cm. The soil samples were mixed thoroughly, air-dried, crushed to pass through a 2-mm sieved and stored in sealed plastic jars before analysis. The values of soil analysis along with method followed are given in Table 1. The soil of the experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potash. Electrical conductivity was very low showing that the soil was free from salinity hazard.

Table 1: Physico- chemical properties of experimental soil

S. No		Particulars	Values at soil depth (cm)		Method employed
			0-15	15-30	
[A]	**Physical Characteristics**				
	(a)	Sand (%)	83.89	84.95	International pipette method (Piper, 1966)
	(b)	Silt (%)	5.56	5.45	
	(c)	Clay (%)	9.82	9.02	
	(d)	Soil texture	Loamy sand		
[B]	**Chemical Properties**				
	(a)	Soil pH (1:2.5, Soil : Water ratio)	7.5	7.8	Potentiometric method (Jackson, 1973)
	(b)	Electrical conductivity (dSm at 25ºC)	0.16	0.12	Schofield method (Jackson, 1973)
	(c)	Organic carbon (%)	0.15	0.17	Walkely and Black's method (Jackson, 1973)
	(d)	Available N (kg ha^{-1})	149	138	Alkaline permanganate Method (Jackson, 1973)
	(e)	Available P_2O_5 (kg ha^{-1})	46	49	Olsen· s method (Olsen *et al*., 1954)
	(f)	Available K_2O	287	279	Flame photometric method (Jackson, 1973)

Experimental design and treatments

The field experiment was laid out in a factorial randomized block design (FRBD) with 18 treatments combinations comprised of six sources of foliar application and three stages of application replicated thrice in table 2.

Table 2: Details of experimental treatments

Foliar applied source		
i.	Control	F_1
ii.	Panchagavya	F_2
iii.	Panchagavya + neem	F_3
iv.	Panchagavya + oak	F_4
v.	Panchagavya + glyricidia	F_5
vi.	Panchagavya + custard apple	F_6
Stage of foliar application		
i.	Branching	S_1
ii.	Flowering	S_2
iii.	Branching + flowering	S_3

Preparation of panchagavya

Panchagavya is a special preparation made from five products of cow along with certain other ingredients (as given below) incubated for specific duration in an earthen or wide plastic container.

Ingredients for preparation used are

Fresh cow dung - 5 kg
Cow urine - 3 lit.
Cow milk - 2 lit.
Cow curd - 2 lit.
Cow ghee - 500 gram
Jaggery - 500 gram
Tender coconut water - 2 lit.
Jaggery and coconut water used to accelerate fermentation.

Flow sheet for preparation of panchagavya: -

Mix thoroughly fresh cow dung (5 kg) + cow ghee (500 g)
Incubate for 2 days
Add cow urine (3lit.)
Cow milk (2 lit.)
Cow curd (2 lit.)
Jaggery (500 g)
Coconut water (2 lit.)
The ingredients were incubating for 20 days after that, the preparation was filtered through double- layered muslin cloth and stored in transparent bottles in a refrigerator.

Chemical and biological properties of panchagavya

Panchagavya contains several nutrients i.e. macronutrients like nitrogen, phosphorus, potassium and micronutrients which are required for the growth and development of plants and also contains various amino acids, vitamins, growth regulators like Auxins, Gibberellins and also beneficial microorganisms like yeast and lactobacillus. Effective Micro Organisms (EMO) in panchagavya are the mixed culture of naturally occurring, beneficial microbes' mostly lactic acid bacteria (Lactobacillus) and certain fungi (Aspergillus) (Swaminathan *et al*. 2007) [15]. Presence of macro (N. P, K and Ca) and micro (Na) nutrients besides total reducing sugars (glucose) in panchagavya have been detected. The pH of panchagavya is low due to fermentation and presence of Lactobacillus bacteria which is effective in killing of plant pathogens (Manthivanan *et al*. 2006) [3] in Table 3.

Table 3: The values of panchagavya analysis

Chemical composition		
pH	:	5.15
EC dSm^2	:	12.41
Total N (ppm)	:	241.00
Total P (ppm)	:	205.00
Total K (ppm)	:	266.00
Sodium	:	96.00
Calcium	:	25.00
IAA (ppm)	:	8.70
GA (ppm)	:	3.10
Microbial Load		
Fungi	:	32 600/ml
Bacteria	:	18 30 000/ml
Lactobacillus	:	23 20 000/ml
Totalanaerobes	:	10 000/ml
Acidformers	:	310/ml
Methanogen	:	240/ml

Seeding, seed rate and seed treatment

In this experiment a bunch type groundnut cultivar Gujarat Groundnut 2 (GG 2) was sown. The crop was sown keeping inter- row spacing of 45 cm and intra row spacing of 10 cm using seed rate of 100 kg kernel ha-1. Prior to sowing seeds were treated with Tricoderma veridi then after Metarazine. Inoculum was prepared by dissolving 100 g jeggary in 1: 1 of boiled – cooled water followed by addition of required quantity of culture. The above treated seeds were kept under shade for two hours for drying and then inoculated with rhizobium and PSB.

Irrigation scheduling and weed management

A good quality of tube well water was used for irrigation. First irrigation was given immediately after sowing and second light irrigation was applied 7 DAS for good germination and establishment. The subsequent irrigations were given to groundnut crop as per requirement of crop considering the weekly rainfall. Two interculturing and two hand weedings were carried out in groundnut crop to maintain weed free condition during crop season.

Statistical Analysis

The statistical analysis of data of all the characters studied during the course of investigation was carried out through the procedure appropriate to the design of an experiment as described by Panse and Sukhatme (1967) [8] by using computer system at the Computer Centre, Department of Agricultural Statistics, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. To test significance of results, five per cent level of significance was used. In remaining cases only standard error of mean was worked out.

Results and Discussion

Soil and Weather

Before going into discussion of the present investigation, it is important to discuss the weather conditions prevailed during crop growth and the soil condition on which it was grown. The analysis of initial soil samples indicated that the soil of the experiment plot was loamy sand in texture having pH 7.5 to 7.8 and EC 0.12 to 0.16 dSm^{-1}. The soil was very low in organic carbon and available nitrogen, medium in available phosphorus and high in available potash (Table1). Thus, the soil was found suitable for growing groundnut. The meteorological data given in Fig.1 revealed that the weather conditions prevailed during the crop growth period was almost satisfactory. There was no adverse effect of various weather parameters *viz,* rainfall, maximum and minimum temperature, relative humidity and bright sunshine hrs on the subsequent growth and development of groundnut crop as evident from the data recorded at the meteorological observatory and also from the observation recorded on growth and development of the crop.

Plant Population

A perusal of data presented in Table 4 revealed that plant population of groundnut recorded at 30 DAS and at harvest was not influenced significantly due to different panchagavya and leaf extracts spray. Sufficient soil moisture present at the time of germination and during initial growth stage was responsible for maintain in the satisfactory plant population in the experiment.

Growth Characteristics

The mean data on plant height of groundnut recorded at 60 DAS and at harvest as influenced by different foliar spray of panchagavya and other leaf extracts applied at different stages are presented in Table 4. The plant height at harvest was significantly higher with panchagavya + neem leaf extract spray as compared to rest of the other treatments which was at par with panchagavya + glyricidia leaf extract spray. On average, application of panchagavya plus neem leaf extracts spray increased plant height at harvest by 15 % over control. On an average plant height recorded 6 % increase with spraying both at branching + flowering over spray at flowering alone. The possible higher height might be due to presence of growth promoting hormones (IAA & GA) which enhanced the cell multiplication and elongation and thus increased height. Another possible reason for higher growth characters and increased height might be due to the growth enzymes present similarly Sanjutha *et al.* (2008) [11] recorded higher plant height with Panchagavya which favoured rapid cell division and multiplication due to growth enzymes present in it.

On an average number of nodules $plant^{-1}$ at harvest recorded 7 % higher with application at branching + flowering over spray at flowering alone. However, some inoculant strains succeed in forming more nodules despite the presence of competing indigenous rhizobia, *e.g*., NC 92 on groundnut (Nambiar *et al.,* 1988) [4]. The higher root nodules 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) [9].

Yield Characteristics

On an average, application of panchagavya + neem leaf extract spray increased pod yield, haulm yield and harvest index by 87, 53 and 14 % over control in Table 4. The maximum pod yield was recorded with application of different foliar spray sourcesat branching + flowering over single application either at branching or flowering. On an average pod yield, haulm yield and harvest index recorded 7, 7 and 11 % higher with application at branching + flowering over spray at flowering. Also, Natarajan (2002) [6] reported increased yield of crop plants with Panchagavya application due to enhancement in the biological efficiency of crop plants. Vivekanandan (1999) [16] reported that 3 % panchagavya foliar spray concentration ensures continuous flowering and in annual moringa doubles the fruit yield besides giving resistance to pest and diseases, and as 2.0 per cent was effective by enhancing the growth and yield of rice. The maximum improvement in grain and biological yield with all the foliar sources might be associated with increased yield attributes due to concomitant increase in dry matter accumulation, chlorophyll content, nitrate reductase activity and supply of all the plant nutrients (Kumawat *et al*., 2009) [2].

Quality Characteristics

The highest protein content in seed was recorded highest with panchagavya + neem leaf extract spray and it was at par with panchagavya +glyricidia. On an application of panchagavya + neem leaf extract spray increased the seed protein content by 19%, over control. On an average foliar spray at both branching and flowering stages recorded 9% higher seed protein content over single spray at flowering. Swaminathan *et al.,* (2007) [15] studied the crude protein content of black gram under irrigated condition. they observed that, two different treatments namely, 3 per cent panchagavya and recommended dose of fertilizer along with 2 per cent diammonium phosphate (DAP) spray significantly influenced the crude protein content in black gram. The highest value for crude protein content was observed in inorganic fertilizers (22.53%) followed by panchagavya (22.17%) due to application of DAP as foliar spray as well as the application of fermented panchagavya, contributing to higher NPK content, thereby favouring the highest protein yield in black gram. Higher protein content due increased the net photosynthesis facilitated by the increased leaf area. Another reason for increased net photosynthesis might be due to RUBP carboxylase activity in carbon cycle and thus more source to sink as evidenced through economic yield (Somasundaram *et al*.2007 and Rao *et al*.2010) [10].

Table 4: Plant population, Plant height and Number of nodules of groundnut as influenced by foliar applied sources and different stages of application

Treatments	Plant population (per meter row length)		Plant height (cm)		Number of nodules $plant^{-1}$ at 50 DAS
	30 DAS	At harvest	60 DAS	At harvest	
Foliar applied source					
F_1	9.10	8.07	22.62	35.23	65.13
F_2	9.20	8.30	23.46	37.32	72.77
F_3	9.60	8.80	25.58	40.22	85.32

F_4	9.30	8.47	23.72	38.60	77.79
F_5	9.50	8.67	23.94	39.71	81.65
F_6	9.40	8.37	23.70	37.58	78.82
S.Em. ±	0.19	0.20	0.64	0.92	1.81
C. D. (P=0.05)	NS	NS	NS	2.64	5.22
Stage of foliar application					
S_1	9.36	8.45	24.09	38.52	75.68
S_2	9.20	8.31	23.24	36.74	71.95
S_3	9.50	8.58	24.18	39.07	83.12
S.Em. ±	0.14	0.14	0.45	0.65	1.28
C. D. (P=0.05)	NS	NS	NS	1.87	3.69

Oil content was not found remarkably influenced by different foliar spray treatments (Table 4.7). However, numerically higher value of oil content was recorded under panchagavya + neem leaf extract (49.01%) followed by treatments panchagavya + glyricidia, panchagavya + oak and panchagavya + custard apple leaf extract spray (48.71, 47.75 and 47.40 %, respectively) over control (47.09 %) in Table 5. Present results were supported with the help of panchagavya because cow milk is also one of the integral components of the panchagavya. Foliar sprays of 3 per cent panchagavya at monthly intervals had given vigorous plant growth in Thyme (*Thymus vulgaris*) and in Rosemary (Selvaraj *et al*., 2003) [12]; besides this oil content was also increased in both.

Table 5: Pod yield, Haulm yield, Harvest Index, Protein content and Oil content of groundnut as influenced by foliar applied sources and different stages of application

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index (%)	Protein content (%)	Oil content (%)
Foliar applied source					
F_1	1225	2386.21	33.92	21.34	47.09
F_2	1616	2850.53	36.18	22.04	47.18
F_3	2298	3665.37	38.53	25.37	49.01
F_4	2051	3480.94	37.07	24.28	47.75
F_5	2160	3557.21	37.79	24.69	48.71
F_6	1926	3291.93	36.91	23.79	47.40
S.Em. ±	51.14	88.75	0.93	0.29	0.60
C. D. (P=0.05)	146.98	255.07	2.67	0.82	NS
Stage of foliar application					
S_1	1897	3236.24	37.12	23.83	48.38
S_2	1804	3076.98	34.67	22.42	47.26
S_3	1937	3302.88	38.40	24.50	47.93
S.Em. ±	36.16	62.05	0.66	0.20	0.43
C. D. (P=0.05)	104	180.36	1.89	0.58	NS

Conclusion

Our results showed that application of foliar spray of panchagavya + neem leaf extract at branching and flowering stage were advantageous in increasing, plant height, number of nodules, yield, protein content and oil content of groundnut. Therefore, it can be recommended as an alternate source of nutrients for organic cultivation of groundnut.

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