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Effect of sargassum and turbinaria seaweed extracts on physiological and yield attributes in pigeonpea (*Cajanus cajan* (L.) Millsp.)

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ABSTRACT

The study was attempted to identify the influence of Turbinaria and Sargassum extracts on growth and yield parameters in pigeonpea. Foliar spray of seaweed extracts at 2.5 and 5.0 per cent concentrations was given at vegetative and flowering stages. Both the seaweed extracts improved the growth and yield attributes but the effect was more pronounced with Sargassum. Indices of growth *viz.*, plant height, root length and dry weight, physiological attributes *viz.,* chlorophyll content, leaf area and leaf area duration and yield components, number of pods and grain weight were improved by seaweed application. Higher uptake of nitrogen, phosphorus and potassium was also evident in the treated plots. It is presumed that growth regulator like substances present in the seaweed extracts would have elicited positive responses in physiological and growth characters, resulting in enhanced yield.

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Key words : Sargassum, Turbinaria, Seaweed extract, Pigeonpea, Growth, Yield

INTRODUCTION

Commercial exploitation of seaweeds has met with varying degrees of success owing to conflicting views on the influence of seaweeds (Finnie and Van Staden, 1985) on yield improvement. However, the adverse effects of synthetic fertilizers upon environment, necessitate identification of bio-stimulants and organic manures for usage as foliar and soil amendments (Quastel and Webley, 1947; Metting *et al.*,1991) for enhancement of yield in agricultural crops. Natural form of manures using seaweeds, not only supply major nutrients but also add trace elements and metabolites that mimic growth regulators. They are easy to apply, relatively cheap and can represent an alternative to conventional synthetic fertilizers and enhance germination and growth (Sekar *et al.,* 1995). Research work on the exploitation of seaweeds on growth and yield of agricultural crops is scanty and few studies available have been restricted to germination and early stages of growth (Gandhiappan and Perumal, 2001) in sesamum; Thirumal Thangam *et al.*, 2004 in guar). The standing crop of seaweeds in intertidal and shallow water in India accounts for 91,000 tons and that of deepwater resources for 75,000 tons and these remain mostly underutilized for crop production (Kaliaperumal *et al.*, 2004). Pigeonpea [*Cajanus cajan* (L.) Millsp.], one of the important pulse crops, occupies an area of 77.5 per cent with a production of 81.0 per cent of total pulses (Ahlawat *et al.,* 2005). Being an important supplement for protein to majority of Indian population, pigeonpea production oriented towards organic cultivation will be worth attempting. Against this background, experiments were initiated using two seaweeds *viz., Turbinaria conoides* and *Sargassum polycystum* through foliar spray in pigeonpea to assess their effect on physiological and growth attributes.

MATERIALS AND METHODS

The seaweeds belonging to the order Phaeophyta (brown marine algae) *viz.,* Turbinaria and Sargassum, collected from Central Marine Fisheries Institute, Indian Council of Agricultural Research, Mandapam, located in the South east coast of Tamil Nadu, India were washed thoroughly and dried under sun followed by oven drying for 36 h at 40^0 C and powdered. 500 g of dry powder was soaked in 100 ml of alcohol for 12 h and shaken vigorously to dissolve the alcohol soluble constituents and the supernatant separated. The residue was boiled with 100 ml of distilled water for 30 min cooled and filtered. Alcohol and water-soluble constituents were mixed and the volume was made up to 500 ml with water to constitute 100 per cent extract. From this 2.5 and 5.0 per cent concentrations were prepared and used.

The field experiment was carried out at Agricultural College and Research Institute, Madurai ($9^05'$ North and

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78^0 5' East and altitude of 147 M. above mean sea level). The soil properties of the field were, sandy clayey loam with a pH of 7.9, E.C 0.25 dSm^{-1}, organic carbon 0.63 per cent and available nitrogen 180 kg, phosphorus 8 kg and potassium 320 kg ha^{-1}. Uniform sized seeds of pigeonpea cv. APK 1 obtained from the Regional Agricultural Research Station, Aruppukottai, Tamil Nadu Agricultural University, India was used for the study. The field received a basal application of farmyard manure @ 12.5 tons ha^{-1}. Except farmyard manure, the crop did not receive any other fertilizer. A spacing of 45×30 cm was adopted with other recommended crop management practices in a Randomized Block Design replicated thrice. Foliar application with seaweed extracts was given at vegetative (50 days after sowing) and flowering (75 days after sowing) stages. The trial was raised during *Kharif* (June) and *Rabi* (November) 2009 seasons. Because of minimum seasonal variations for most of parameters studied, the pooled data alone were presented. Observations on plant height (cm), root length (cm), dry weight (g) after drying at 80^{0}C for 16 h, total chlorophyll content mg g^{-1} after Yoshida *et al*. (1971)**,** leaf area index after Williams (1946), leaf area duration after Power *et al.* (1976), number of branches, number of pods, single plant yield (g), and nutrient uptake of nitrogen after AOAC (1960), phosphorus and potassium after Jackson (1973) were recorded. Except leaf area duration, which was recorded between 60 and 90 days, the other observations were recorded on 90 days after sowing. For individual observation, ten plants per plot at random were taken. Mean data were analysed after Snedecor and Cochran (1961) statistically.

RESULTS AND DISCUSSION

Both the seaweed extracts had a positive influence on the parameters observed and the response was higher only at lower concentrations. At this strength, foliar application of Sargassum enhanced the plant height (by 8.9 %), root length (by 10.9%), dry weight (by 22.9 %) and total chlorophyll (by 10.9%) followed by Turbinaria application (by 3.9 %, 29.8 %, 16.0% and 7.2 %, respectively for these parameters (Table 1) over control. Leaf area index (by 1.49 and 0.12), leaf area duration (by 24.5 and 11.1 days), number of branches (by 4.5 and 0.8) and pods (by 20.9 and 12.9) were also higher in Sargassum and Turbinaria treatment (Table 2). The uptake of nitrogen, phosphorus and potassium was enhanced by 2.5, 0.9, 2.6 kg/ha in Sargassum application. The same trend was noticed for grain yield also. At higher concentrations, these two attributes exhibited similar

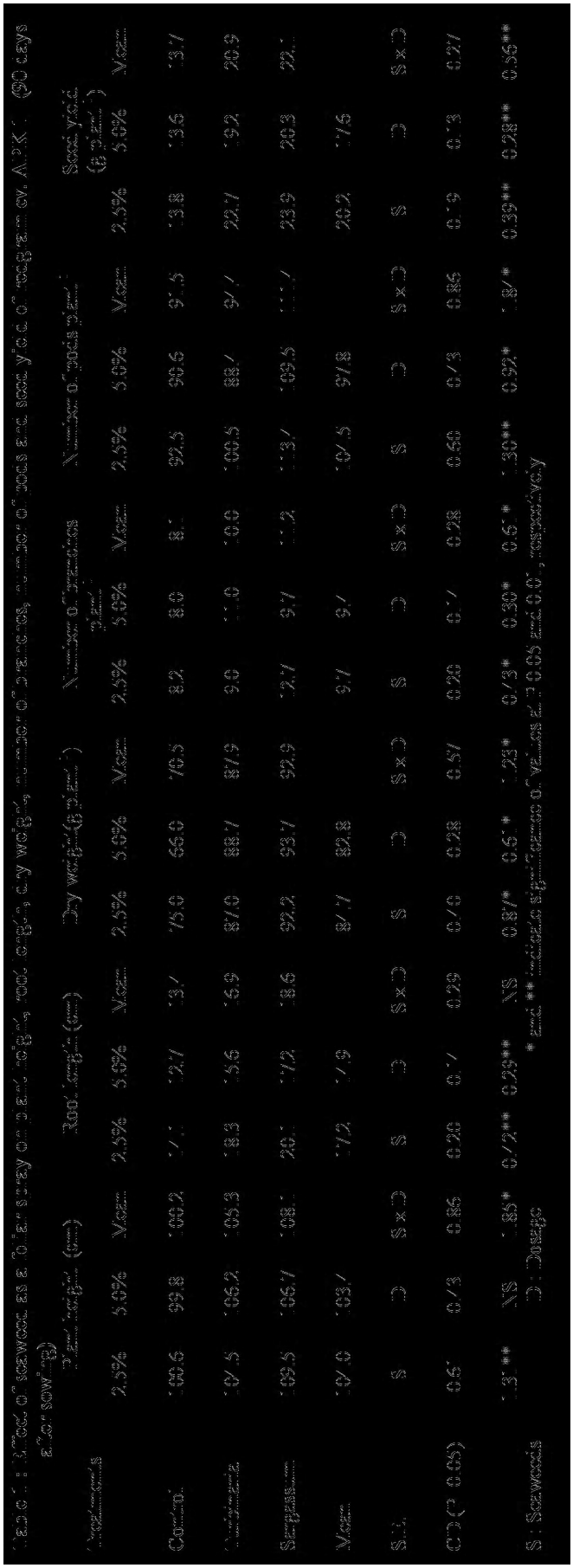

Table 2 : Effect of seaweed as a foliar spray on total chlorophyll content, leaf area index and leaf area duration in redgram cv. APK 1 (90 days after sowing)

Treatments	Total chlorophyll (mg gm^{-1})			Leaf area index			Leaf area duration (days)		
	2.5%	5.0%	Mean	2.5%	5.0%	Mean	2.5%	5.0%	Mean
Control	5.42	5.33	5.38	4.71	4.61	4.66	54.2	55.6	54.9
Turbinaria	5.81	4.89	5.36	4.59	4.44	4.51	65.3	59.0	62.1
Sargassum	6.01	5.46	5.74	6.08	5.62	5.85	78.7	70.2	74.4
Mean	5.75	5.23		5.15	4.96		67.0	63.2	
S.E.±	S	D	S x D	S	D	S x D	S	D	S x D
	0.40	0.28	0.57	0.38	0.27	0.54	0.43	0.31	0.62
CD (P=0.05)	0.87*	0.61*	1.23*	0.82**	0.58*	0.17*	0.94*	0.66**	1.33*

S : Seaweeds D: Dosage * and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Effect of seaweed as a foliar spray on nutrient uptake of redgram var. APK 1 (90 days after sowing)

Treatments	Nutrient uptake at flowering stage (kg ha^{-1})								
	Nitrogen			Phosphorus			Potassium		
	2.5%	5.0%	Mean	2.5%	5.0%	Mean	2.5%	5.0%	Mean
Control	14.7	13.1	13.9	0.8	0.9	0.8	4.2	3.8	4.0
Turbinaria	16.1	15.2	15.6	1.1	0.9	1.0	5.3	5.0	5.1
Sargassum	17.2	16.4	16.8	1.7	1.4	1.5	6.8	6.1	6.4
Mean	16.0	15.1		0.8	0.9		5.5	4.8	
S.E.±	S	D	S x D	S	D	S x D	S	D	S x D
	0.28	0.20	0.40	0.18	0.13	0.26	0.49	0.35	0.70
CD (P=0.05)	0.58*	0.41*	NS	0.39*	NS	NS	1.31*	NS	NS

S : Seaweeds D: Dosage * and ** indicate significance of values at P=0.05 and 0.01, respectively NS=Non-significant

responses but at a lower magnitude (Table 3) in both the seaweed treatments.

Seaweed extracts have a fair amount of major nutrients like nitrogen, phosphorus and potassium. Among the two seaweeds attempted, Sargassum had higher nitrogen (1.02 %), phosphorus (0.92 %) and potassium (0.22 %) as compared to Turbinaria (0.96 % N, 0.80 % P and 0.20 % K). The readily available form of nutrients in foliar spray would assist for efficient absorption and subsequent transport to the sink. Delayed senescence (Shaw *et al*., 1965), well developed root system (Blunden and Wildgoose, 1977; Nelson and Van Staden, 1984) and leaf area (Featonby Smith and Van Staden, 1983), due to application of seaweed have been reported. Enhanced root system and chlorophyll content combined with higher leaf area duration observed in the present study might enable for higher nutrient uptake and delayed senescence leading to higher accumulation.

More than one group of plant growth regulators *viz.,* cytokinin (Mooney and Van Staden, 1987) and auxin (Abe *et al*., 1972, Fries and Aberg, 1978) in *Sargassum heterophyllum* and *Sargassum muticum* (Jacobs *et al*., 1985; Zhang *et al*., 1991) have been identified. Plant growth regulators differ from fertilizers in that fertilizers simply supply macronutrients and minerals needed for growth, while plant growth regulators alter physiological properties leading to increase in growth and development. Liquid seaweed extracts to a larger extent have replaced the seaweed manure owing to their effectiveness at lower concentrations (Temple and Bomke, 1989), mainly due to the growth regulating properties present in them. In this study, the positive influence could be observed in both the seaweeds at lower concentrations and the effect was higher in Sargassum when compared with Turbinaria. Seaweed bio-stimulants could be preferred not only for their macronutrients but also trace elements and metabolites similar to plant growth regulators and Bradley (1991) suggested that endogenous hormones in seaweeds play a significant role in expressing beneficial effects. Recent studies have clearly established that the beneficial effects of seaweeds on growth and yield could be attributed to growth promoting substances present in them (Metting *et al.,* 1991; Crouch *et al*., 1992; Crouch and Van Staden, 1993; Allen *et al*., 2001).

In the present study, all the physiological, growth and yield parameters were higher in seaweed application and the effect was more with Sargassum at 2.5 per cent concentration. Though the study has not attempted for

identification of plant growth regulator like substances in seaweed extracts, the enhanced growth responses observed in seaweed application, could also be attributed to the plant growth regulator mediated responses leading to increase in the yield.

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