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Evaluating Groundnut Yield and Resilience under Resource Constraints in Pollachi Taluk, Coimbatore District, Tamil Nadu, India

C. Sudhalakshmi [a++*], V. Vasuki [b++], M. Gopalakrishnan [c++] and S. Rani [d#]

[a] Department of Soil Science and Agricultural Chemistry, Coconut Research Station, Aliyarnagar, India.
[b] Department of Agronomy, TNAU, Coimbatore, India.
[c] Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore, India.
[d] Department of Agronomy, Agricultural College and Research Institute, Madurai, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Groundnut is an energy rich crop but grown under energy starved conditions. A field experiment was conducted at Coconut Research Station, Aliyarnagar with eight treatments comprising of T_1 – Complete pack of practice, T_2 : T_1 – Fertilizer, T_3 : T_1 – Plant Protection, T_4 : T_1 – Weeding, T_5 : T_1 –

[++] *Associate Professor;*
[#] *Assistant Professor;*
**Corresponding author: E-mail: soilsudha@yahoo.co.in, soilsudhalakshmi@gmail.com;*

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(Fertilizer + Weeding), T_6 : T_1 – (Plant Protection + Weeding), T_7 : T_1 – (Fertilizer + Plant Protection) and T_8: T_1 – (Fertilizer + Plant Protection + Weeding) in Randomized Block Design with each of the above treatments replicated thrice to elicit the impact of resource constraints on the cultivation of *kharif* groundnut. Growth attributes like plant height and number of branches together with yield attributes and yield were higher in the treatment which received complete package of practice. Of the individual constraints, unweeded plots had a drowning effect on yield and in the interaction effects, treatment devoid of weeding and fertilizer application had a negative impact on yield. Net returns and BCR were higher in T_1 (2.60) and the lowest benefit was witnessed in T_7 (1.92), the treatment which lacks fertilizer and plant protection.

Keywords: Groundnut; weeding; fertilizer; plant protection; resource constraint.

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) eulogized as 'King of Oilseeds' assumes a significant role in the agrarian and agro-industrial economy of South Asia [1,2]. It is rich in oil (48.50 %), protein (25-28 %), carbohydrates (20-26%) and energy (56 kcal g^{-1}) together with several minerals, vitamins, dietary fiber, phytosterols, flavonoids and phenolic acids [3]. Groundnut is the predominant leguminous oilseed crop of India which has turned out to be a sensitive victim to climate change episodes like rising CO_2 levels, erratic rainfall pattern, high temperature and moisture stress leaving deleterious imprints in physiology, disease resistance, fertility and productivity [4]. Globally, groundnut is cultivated over an area of 32.7 million ha (mha) with a production of 53.9 million tons (mt) and productivity of 1,648 kg/ha [5]. India is the second largest groundnut producer of the world wherein the crop is cultivated over an area of 5.97 mha area with a production of 10.2 mt and productivity of 1,716 kg/ha [5]. Groundnut is an energy rich crop but grown under energy starved conditions [6] and there is immense scope for enhancing the productivity through appropriate use of resources.

About 90 % of the yield is from *kharif* groundnut and there is possibility for improvement in yield of *kharif* groundnut. Groundnut yield is affected by climate, crop species, soil, crop management practices and choice of cultivar. Biotic and abiotic stresses pull down the potential productivity of groundnut. Groundnut cultivation is a victim to an array of constraints like inadequate fertilization, weed menace, lack of appropriate plant protection and water scarcity. Farmers are neglecting the application of fertilizers, use of plant protection measures and weed control due to paucity of funds and lack of knowledge [7,8] opined that a better understanding of the resource constraints is imperative to correlate the yield loss witnessed due to a specific constraint. In areas of Tamil Nadu, where resource constraints compromises groundnut productivity, there is a need for better comprehension of the most alarming constraint which has a drowning effect on potential productivity. Hence the present investigation was undertaken to identify the impact of resource limitation on the yield of *Kharif* groundnut to prioritize resource allocation for the system to reap maximum productivity.

2. MATERIALS AND METHODS

An experiment was conducted at Coconut Research Station, Aliyarnagar to elicit the impact of resource constraints on *Kharif* groundnut. Experiment was conducted in Randomized Completely Block Design with each of the following treatments replicated thrice across a plot size of 5 x 4 m^2. Test variety was VRI 6 with a duration of 110 days. The soil is sandy loam in texture classified taxonomically as *Vertic Ustropept* with pH – 7.35, electrical conductivity – 0.51 dSm^{-1}, organic carbon – 0.32 %, $KMnO_4$ N-218 kg /ha (Low), Olsen P – 22.16 kg/ha (Medium) and 1NNH_4Oac-K – 248 kg/ha (Medium). Recommended dose of nutrients (RDN) is 12.5 kg N, 25 kg P_2O_5 and 12.5 kg K_2O ha^{-1} applied as urea, single super phosphate and muriate of potash. Weeding was done on 20 and 45 days after planting in all the treatments except T_4, T_5, T_6 and T_8. Seeds were treated with Tebuconazole @ 1.5 g kg^{-1} seeds except for the treatments T_3, T_6, T_7 and T_8. Experimental view is depicted in Fig. 1. Principal Component Analysis was performed employed KAU Grapes Software [9].

The crop was harvested manually after attaining the physiological maturity (110 days). Harvested nuts were dried to 12% moisture, and weighed. Shelling percentage was calculated by dividing seed weight by pod weight. Kernel yield was

calculated as the multiple of pod yield and shelling percentage. Harvest Index was computed as the ratio of economic yield and biological yield. Data was analysed statistically employing Panse and Sukhatme, [10].

List 1. Treatment details

T_1	Full package as per recommendation
T_2	T_1 – Fertilizer (F)
T_3	T_1 –Plant protection (PP)
T_4	T_1 – Weeding (W)
T_5	T_1 –(Fertilizer +Weeding)
T_6	T_1 – (Plant protection + Weeding)
T_7	T_1 – (Fertilizer + PP)
T_8	T_1 – (Fertilizer + PP + Weeding)

3. RESULTS AND DISCUSSION

(i) Growth attributes (Table 1)

The plant height was maximum in the treatment, which received the recommended package of practice without any constraint (T_1). The lowest plant height with a percent reduction of 13.7 % over T_1 was recorded in the treatment in which fertilizer, plant protection and weeding practices were not adopted. Of the various constrained environments, weeding holds great promise on the plant height by reducing the relative competition of other plant species in the growth environment. Similar result was reported by Madhu Bala and Kedarnath, [11] in groundnut at Gujarat wherein non-weeded plots showed concomitant reduction in plant height. Number of branches per plant was higher in the treatment which received full package and the lowest number of branches was recorded in the treatment devoid of fertilizer and weeding. The results are in close correlation with Sagvekar et al*.,* [12] who underlined that appropriate nutrient and weed management is imperative for improved growth attributes in groundnut.

(ii) Yield attributes and Yield

Yield attributes and yield recorded across different treatments is presented in Table 2. Number of pods per plant was highest in the treatment which received the full package of practice as per recommendation. The weight of dry pods per plant was highest in the treatment which received full package and was lowest in the treatment devoid of nutrient application, plant protection and weeding. One of the majorful factors responsible for low productivity of groundnut is weed infestation. Weeds present a formidable challenge to achieving optimal crop yields, competing fiercely with crops for essential resources like light, nutrients, water and space. In groundnut cultivation, weed infestation stands out prominently among various constraints [13]. Bhattarai et al*.,* [14] postulated that groundnut crop compete with the repeated flush of diverse weeds throughout the growing season which causes substantial yield loss up to 50 -70 %. It is a natural corollary that the weed free environment has resulted in increased number of matured pods at harvest. As the crop was not infested by major pest, lack of adoption of plant protection did not have a great say on the number of pods per plant.

Fig. 1. Overall view of the Experimental Site

Table 1. Growth attributes of groundnut at harvest as influenced by resource constraints

Treatments	Plant height (cm)	Number of branches plant^{-1} at harvest	Number of matured pods plant^{-1} at harvest	Dry pod weight (g plant^{-1})
T_1: Full package as per recommendation	62.00	7.33	26.14	18.14
T_2: T_1 – Fertilizer (F)	59.40	7.13	23.65	16.12
T_3: T_1 –Plant protection (PP)	58.20	6.60	25.13	17.74
T_4: T_1 – Weeding (W)	54.53	5.93	23.82	13.89
T_5: T_1 –(Fertilizer +Weeding)	53.60	5.80	18.13	14.38
T_6: T_1 – (Plant protection + Weeding)	56.13	6.40	18.16	13.52
T_7: T_1 – (Fertilizer + PP)	58.00	7.07	17.61	16.52
T_8: T_1 – (Fertilizer + PP + Weeding)	53.53	6.13	15.27	12.50
S.Em ±	3.796	0.640	2.118	1.675
LSD (0.05)	NS	NS	4.543	3.592
CV (%)	8.17	11.97	12.36	13.36

Table 2. Yield of groundnut at harvest as influenced by resource constraints

Treatments	Dry pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Dry haulm yield (kg ha^{-1})	Harvest Index
T_1: Full package as per recommendation	2593	2008	3963	0.40
T_2: T_1 – Fertilizer (F)	2295	1752 (12.7 %)	3828	0.37
T_3: T_1 –Plant protection (PP)	2350	1895 (5.6 %)	3713	0.39
T_4: T_1 – Weeding (W)	1840	1403 (30.1 %)	2868	0.39
T_5: T_1 –(Fertilizer +Weeding)	1820	1260 (37.3 %)	2870	0.39
T_6: T_1 – (Plant protection + Weeding)	1925	1500 (25.3 %)	2952	0.39
T_7: T_1 – (Fertilizer + PP)	2227	1647 (18.0 %)	3618	0.38
T_8: T_1 – (Fertilizer + PP + Weeding(G)	1633	1163 (42.1 %)	2650	0.38
S.Em ±	170.95	107.95	270.46	170.95
LSD (0.05)	366.69	231.56	580.14	366.69
CV (%)	10.04	9.69	10.01	10.04

(*Figures in parantheses represent percent reduction in yield over T_1)*

Table 3. Shelling percentage, Sound Mature Kernels and 100 kernel weight of groundnut at harvest as influenced by resource constraints

Treatments	Shelling per cent	Sound mature Kernels (%)	100-Kernel weight (g)
T_1: Full package as per recommendation	70.58	92.97	38.64
T_2: T_1 – Fertilizer (F)	66.78	88.97	35.34
T_3: T_1 –Plant protection (PP)	68.67	90.05	38.42
T_4: T_1 – Weeding (W)	63.20	83.52	32.80
T_5: T_1 –(Fertilizer +Weeding)	62.45	84.05	32.92
T_6: T_1 – (Plant protection + Weeding)	63.24	83.07	32.34
T_7: T_1 – (Fertilizer + PP)	66.69	89.01	35.59
T_8: T_1 – (Fertilizer + PP + Weeding)	58.41	80.50	30.62
S.Em ±	3.216	2.949	2.010
LSD (0.05)	3.899	6.325	4.312
CV (%)	3.06	4.17	7.12

Table 4. Economics of groundnut cultivation as influenced by resource constraints

Treatments	Cost of cultivation (Rs.ha^{-1})	Gross returns (Rs.ha^{-1})	Net returns (Rs.ha^{-1})	B:C Ratio
T_1: Full package as per recommendation	89587	34450	55137	2.60
T_2: T_1 – Fertilizer (F)	77113	31685	45428	2.43
T_3: T_1 –Plant protection (PP)	78853	33000	45853	2.39
T_4: T_1 – Weeding (W)	63540	26250	37290	2.42
T_5: T_1 –(Fertilizer +Weeding)	54280	24850	29430	2.18
T_6: T_1 – (Plant protection + Weeding)	55407	25450	29957	2.18
T_7: T_1 – (Fertilizer + PP)	58473	30500	27973	1.92
T_8: T_1 – (Fertilizer + PP + Weeding)	45933	22500	23433	2.04

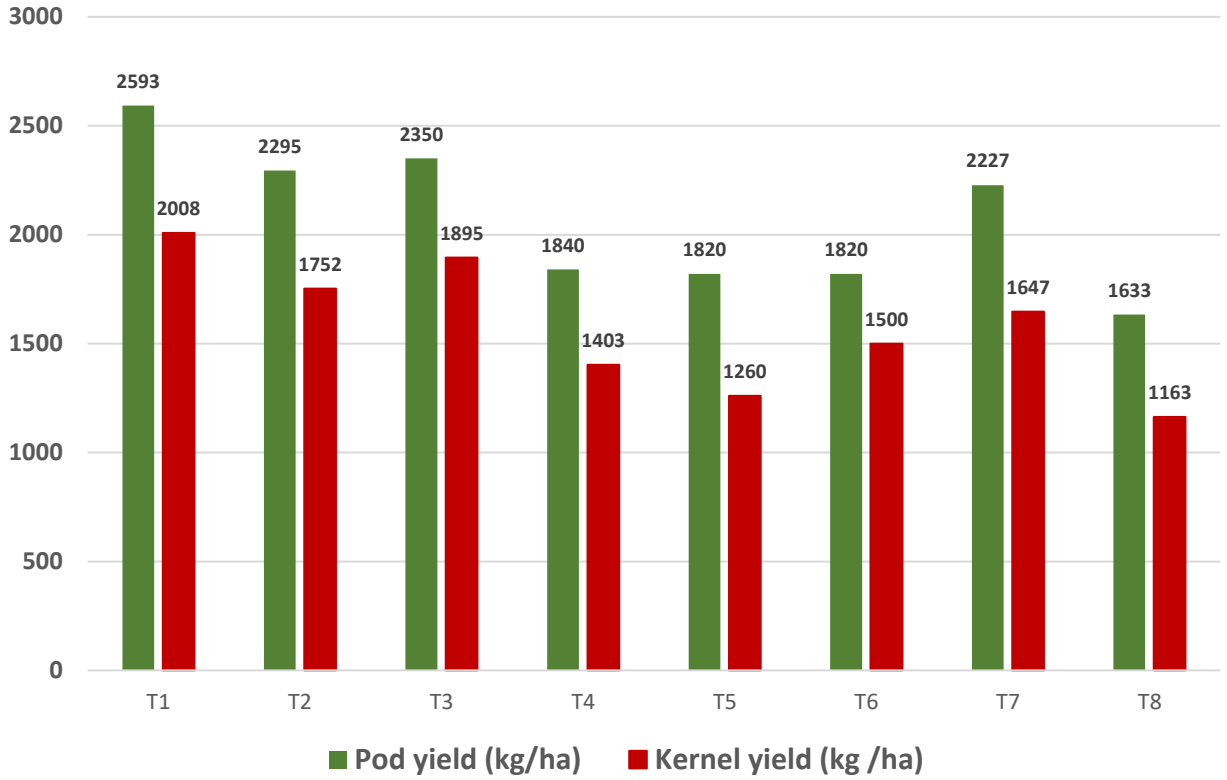

Fig. 2. Pod and Kernel yield of groundnut as influenced by resource constraints

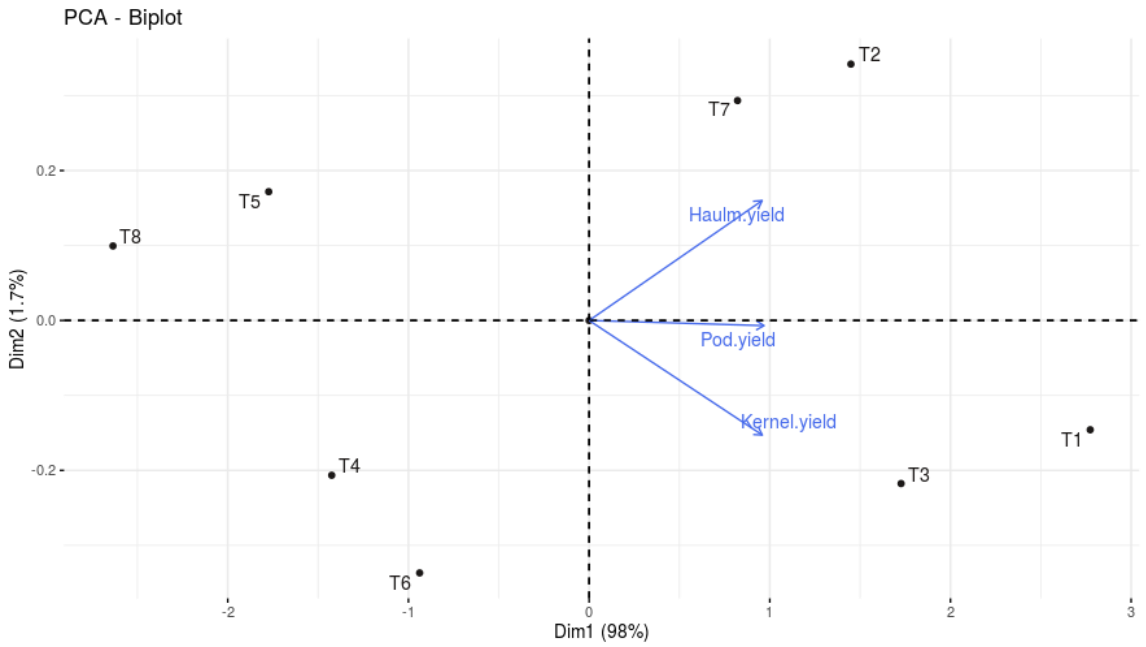

Fig. 3. Principal Component Analysis of various treatments on yield of groundnut

Dry pod yield and kernel yield were higher in the treatment which received full package of practice (2593 and 2008 kg ha^{-1} respectively) and it was followed by the treatment lacking plant protection (Fig. 2). Synergistic interaction of non-adoption of weeding, plant protection and fertilizer management resulted in conspicuous decline in pod and kernel yield of groundnut to the tune of 42 %. Among the individual factors, weeding plays a crucial role in improving crop productivity rather than fertilizer application and plant protection. According to Wesley et al. [15] the critical period of grass weed control was found to be from four to nine weeks after planting whereas, that of broad leaved weeds control was from two to eight weeks. Zimdhal [16] reported that groundnut yield decreased with increasing time of weed interference and hence not performing weeding is the major constraint in the yield depression in the present experiment. Singh et al., [17] opined that productivity of groundnut in India remains low to the tune of 1000 kg/ha and low consumption of fertilizer (3.8%) inspite of prominent nutrient deficiencies is the major factor limiting groundnut yield. The principal component analysis depicting the influence of various treatments is presented in Fig. 3.

(iii) Harvest Index, Shelling out turn and Sound matured kernels (Table 3)

Dry haulm yield and harvest index were highest in the treatment which received full package as per recommendation (T_1)**.** In the same treatment, sound matured kernels, shelling percentage and 100 kernel weight were higher. Weed-free environment facilitates better growth and development of plants, flowering, peg initiation and entry into the soil, pod formation and development, and harvesting which tends to increase mature pods per plant [18]. The losses due to diseases may amount to 40–50% in terms of mortality of crop [19] particularly in *kharif* groundnut when the climatic conditions are more favourable for pathogen Also balanced nutrition and better management of pre-harvest diseases helped in high shelling out-turn compared to the rest of the treatments in which groundnut was grown in a constrained environment.

(iv) Economics of Cultivation

The economics of cultivation is presented in Table 4. The cost of cultivation was higher in T_1 due to the expenditure incurred towards weeding, fertilizers and plant protection chemicals and the lowest was recorded in T_8. Gross returns was highest in T_1 and lowest in the treatment T_8. Of the individual factors of production, unweeded plots resulted in concomitant reduction in gross returns followed by non-application of fertilizers. In the interaction effects, non adoption of weeding and fertilization (T_5) showed a dip in gross returns compared to other factors. Highest net returns of Rs. 55137 per ha and Benefit cost ratio of 2.60 was realized in T_1 and the lowest net returns of Rs. 23433 and

ratio of 1.92 was observed in T_7. These findings are in tune with Madhu Bala and Kedarnath, [11] Patro and Ray, [20] and Sagvekar et al*.,* [12].

4. CONCLUSION

Thus in the present study it is confirmed that to achieve highest productivity in *kharif* groundnut, appropriate nutrient management, regular weed control and timely plant protection is imperative. Highest pod yield and kernel yield of 2593 and 2008 kg ha^{-1} was obtained due to the adoption of full package of practice. Of the various factors of production, weeding is an essential operation which otherwise would pave way for drowning effect in yield and net returns in *kharif* groundnut cultivation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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