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Pradeep Kumar
AICRPDA, AU, Kota, Rajasthan, India

CK Arya
AICRPDA, AU, Kota, Rajasthan, India

MK Sharma
AICRPDA, AU, Kota, Rajasthan, India

Pratap Singh
Directorate of Research, AU, Kota, Rajasthan, India

Corresponding Author:
Pradeep Kumar
AICRPDA, AU, Kota, Rajasthan, India

Effect of Nutrient management on productivity and profitability of Soybean (*Glycine max*) - based double cropping systems under Dryland farming

Pradeep Kumar, CK Arya, MK Sharma and Pratap Singh

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Abstract
An experiment was conducted in field of clay textured soil during *Kharif* & *Rabi* season of three consecutive years from 2018-19 to 2020-21 at Agricultural Research Sub Station, Aklera to evaluate nutrient management in soybean based double cropping systems under residual moisture The experiment was laid out in split plot design consisting of three level of cropping system *i.e.* Soybean-Chickpea, Soybean-coriander and Soybean-Linseed in Main plots and six levels of nutriment managements practices *i.e.* 100% RDF (Inorganic), 100% RDF (Inorganic) + Sulphur @ 10 kg ha^{-1}, 75% RDF (inorganic) + 25% through FYM, 75% RDF (inorganic) + 25% through FYM + Sulphur @ 10 kg ha^{-1}, 50% RDF (inorganic) + 50% through FYM and 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1}. The results of experiments shown that under different cropping system Soybean-Chickpea results significantly highest system productivity (3594 kg ha^{-1}), system Net return (81583/- ha^{-1}) and B:C ratio (2.02) as compared to other treatments. Among nutrient management practices, application of nutrient as 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1} gave maximum system productivity (3285 kg ha^{-1}), Maximum System net return (Rs. 72881/- ha^{-1}) & highest B:C ratio (1.94) which were found at par with the application of 50% RDF (inorganic) + 50% through FYM as (3208 kg ha^{-1}), (Rs. 70467/- ha^{-1}) & (1.91), respectively.

Keywords: Soybean, chickpea, coriander, linseed, cropping system, productivity, economics

Introduction
Soybean, also known as wonder crop, is one of the furthermost significant legume as well as oilseed crop. It is the third largest oilseed crop of India after rapeseed mustard and groundnut and ranks first in edible oil in world. India ranks fifth in area and production of soybean in the world.

Traditional non-fermented food uses of soybeans include soy milk from which tofu and tofu skin are made. Fermented soy foods include soy source, fermented bean paste, natto and tempeh. Together protein and soybean oil content account for 56% of dry soybeans by weight (36% protein and 5% ash). 100 grams of raw soybeans supply 446 calories and 9% water, 30% carbohydrates, 20% total fat and 36% protein.

Nutrient management play major role in higher production of crops especially in cropping system under dryland condition. Effective nutrient management facilitate required nutrient for the plant and help the crop to survive several types of biotic and abiotic stress in cropping system. Now days, the inorganic fertilizers are fabricating very perilous effects on soil properties and sometimes enter in food chain and are injurious to human being also. Therefore, it is essential to utilize organic sources of nutrients in order to increase the production of crop by maintaining soil fertility. Farmyard manure is major source of nutrients, which also helps in maintaining soil fertility and increasing the water holding capacity of soil and productivity of the soil. Among soybean based double cropping, in haroti region of Rajasthan, coriander, linseed and chickpea are major crops that can be grown in on residual moisture in Rabi season under dryland agriculture. Coriander is major spices crop grown in experimental domain area of Jhalawar.

The pulses make enrichment of the soil through symbolic nitrogen fixation from atmosphere. Role of pulses in Indian agriculture, food and nutrition is well known as these crops fit well in crop rotation models; being rich in protein and some of the essential amino acids, acts as a major source of protein to the predominantly vegetarian population of the country. Chickpea is second most important pulse crop worldwide; it is second in area and third in production. The crop meets up to 80% of the soil's nitrogen needs.

In Rajasthan, it is cultivated on 2.11 million ha with a production of 2.26 million tonnes and contributes 14% of total country's chickpea production (Anonymous 2021) [1]. In India and Rajasthan, its cultivation is mainly restricted to less fertile/marginal soil under rainfed conditions, Chickpea is having deep root system, able to utilize deeper residual moisture more efficiently and also facilitate deep sowing because of their large size seeds. Therefore, this experiment was conducted to study the nutrient management in soybean based double cropping systems under Dryland farming.

Materials and Methods

A field experiment was conducted during *Kharif* & *Rabi* season of three consecutive years from 2018-19 to 2020-21 at Agricultural Research Sub Station, Aklera, AU, Kota. Geographically, this is located in the south east part of the Rajasthan with 24.41º Latitude and 76.56º Longitude. According to Agro-climatic zones the domain comes in Humid South Eastern Plain, i.e. zone V of the Rajasthan. The Humid South Eastern plains (zone V) are popularly known as the Hadauti plateau. Summer temperatures reach up to 45ºC and in winter it falls to 2.4ºC. The relative humidity is generally high. The annual rainfall varies from 452 to 985 mm. The landscape is characterized by hills pediments and vast alluvial plain formed by the rivers Parbati, Parwan and their tributaries. The soil of experimental field was Black of alluvial origin with pH 8.1, available N (146.57 kg ha^{-1}), available P (29 kg ha^{-1}), available K (239 kg ha^{-1}), available S (26 kg ha^{-1}) and has about 0.17% SOC.

The experiment was laid out in split plot design consisting of three level of cropping system *i.e.* Soybean-Chickpea, Soybean-coriander and Soybean-Linseed in main plots and six levels of nutriment managements practices *i.e.* 100% RDF (Inorganic), 100% RDF (Inorganic) + Sulphur @ 10 kg ha^{-1}, 75% RDF (inorganic) + 25% through FYM, 75% RDF (inorganic) + 25% through FYM + Sulphur @ 10 kg ha^{-1}, 50% RDF (inorganic) + 50% through FYM and 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1}. The varieties were taken up as Soybean-JS-20-29, Chick pea –GNG- 1958, Coriander RKD -18 and Linseed KBA-3. The data recorded were statistically analyzed by using technique of ANOVA analysis of variance and significance was determined as given by Panse and Sukhatme (1967) [4] by computerised programme.

Results and Discussion

Analysis of this experiment's observed data showed that under different cropping system Soybean-Chickpea results significantly highest soybean equivalent yield of *Rabi* crops (2444 kg ha^{-1}). Deep root system of chickpea could leads to efficient utilization of residual moisture and nutrients in deeper layer of soil profile. Bold seed of chick pea also give scope for deep sowing with long sowing window after harvesting of soybean crop, resulting good germination and emergence of chickpea crop especially at initial stages of life cycle. This might have resulted in higher yield of soybean-chickpea cropping system.

Table 1: Effect of nutrient management in soybean based double cropping system under residual moisture on Soybean equivalent yield of Rabi crops, system productivity, net return and B:C ratio (pooled)

Treatment	Soybean equivalent yield of Rabi crops (kg ha^{-1})	System productivity (kg ha^{-1})	RWUE (kg ha^{-1}mm^{-1})	System Net return (₹)	System B:C ratio
	Cropping system				
Soybean-Chickpea	2444	3594	3.35	81583	2.02
Soybean-Coriander	1724	2840	2.65	61943	1.69
Soybean-Linseed	1250	2382	2.23	48065	1.22
S.Em ±	28	35	0.16	1297	0.03
CD (P=0.05)	97	125	0.48	5161	0.12
	Nutrient management				
100% RDF (Inorganic)	1673	2610	2.44	52239	1.58
100% RDF (Inorganic) + Sulphur @ 10 kg ha^{-1}	1703	2680	2.50	54290	1.61
75% RDF (inorganic) + 25% through FYM	1782	2900	2.71	61096	1.75
75% RDF (inorganic) + 25% through FYM + Sulphur @ 10 kg ha^{-1}	1810	2980	2.79	63443	1.79
50% RDF (inorganic) + 50% through FYM	1926	3208	2.99	70467	1.91
50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1}	1969	3285	3.07	72881	1.94
S.Em±	15	33	0.12	1159	0.03
CD (P=0.05)	44	92	0.34	3221	0.08

Similarly highest system productivity (3594 kg ha^{-1}), RWUE (3.35 kg ha^{-1}mm^{-1}), system net return (81583/- ha^{-1}) and B:C ratio (2.02) were found in soybean-chickpea cropping system as compared to other treatments of soybean-coriander and soybean-linseed cropping system.

Among nutrient management practices, application of nutrient as 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1} gave maximum soybean equivalent yield of *Rabi* crops (1969 kg ha^{-1}), system productivity (3285 kg ha^{-1}), Maximum System net return (Rs. 72881/- ha^{-1}) & highest B:C ratio (1.94) which were found at par with the application of 50% RDF (inorganic) + 50% through FYM as (1926 kg ha^{-1}), (3208 kg ha^{-1}), (Rs. 70467/- ha^{-1}) & (1.91), respectively.

Fig 1: Soybean- Chickpea cropping system under application of 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1}

Similar results were found by Chaturvedi and chandel, 2005 [2]. This might be due to improved soil physical structure, grander accessibility of macro & micronutrients, form of organic and inorganic cradles which aided in hastening of various metabolic processes of N P and K which help in better absorption of nutrients tied with proper distribution, these results are in conformity with the reports of Dash *et al*. (2005) [3]. Highest RWUE (3.07 kg ha^{-1} mm^{-1}) was found by application of 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1} however, it was at par with 50% RDF (inorganic) + 50% through FYM, 75% RDF (inorganic) + 25% through FYM + Sulphur @ 10 kg ha^{-1} and 75% RDF (inorganic) + 25% through FYM but significantly superior to 100% RDF (Inorganic), 100% RDF (Inorganic) + Sulphur @ 10 kg ha^{-1}.

Conclusion

The results concluded that Soybean –chickpea cropping system and application of nutrient as 50% RDF (inorganic) + 50% through FYM + Sulphur @ 10 kg ha^{-1} was found productivity operative and economically worthwhile, with high RWUE under Dryland farming situations.

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